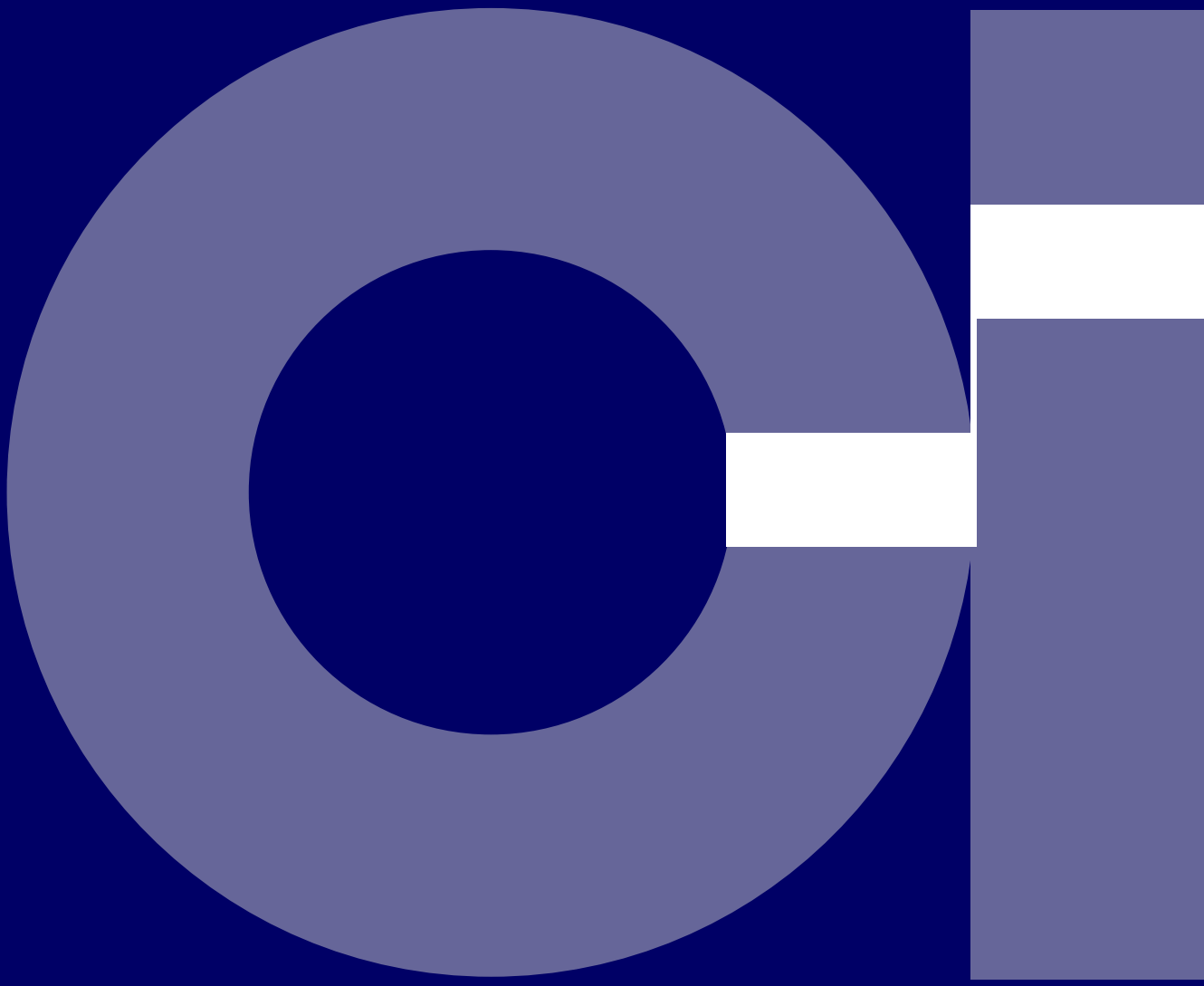


BRINGING CITY FORM BACK INTO PLANNING

CITTA 3RD ANNUAL CONFERENCE ON PLANNING RESEARCH

EDITED BY PAULO PINHO AND VITOR OLIVEIRA

FEUP Edições FCT Citta

PROCEEDINGS OF CITTA 3RD ANNUAL CONFERENCE ON PLANNING RESEARCH

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Preface

Paulo Pinho
Director of CITTA

Following two previous and successful conferences organized around the topics of ‘Evaluation in Planning’ and ‘Planning in times of uncertainty’ the idea of ‘Bringing city form back into Planning’ was chosen to inspire the 3rd Annual Conference of our research centre, CITTA. City form and structure have long been associated with modern urban planning and yet, over recent decades, the mainstream theoretical debate on urban planning have seemed to privilege planning processes rather than planning policies, plans and outcomes. In our view, this focus has surely contributed to the growing and damaging divide between planning theory and planning practice.

More recently, the urban sustainability debate has underlined the importance of the physical dimension of our cities and city regions, through design-responsive urban regeneration strategies and urban transport policies. In this more general context, the main objective of the conference was to bring the whole debate on urban form and city structure back into planning by exploring recent advances on space syntax and revisiting classical disciplines such as urban morphology. We were honored with the presence and the stimulating keynote speech of Prof. Bill Hillier from the Bartlett School of the University College of London, surely one of the main contributors to the emergence, development and consolidation of these themes worldwide.

This book of proceedings includes an interesting selection of the papers presented at the conference. It is organized in five parts and reports research work carried out at CITTA and at other planning research centres in Portugal and abroad. In the first part we include a keynote speech on the return to urban design from a Portuguese perspective and the reporting of two major CITTA lines of research on urban and suburban morphologies. The second part includes fifteen papers organized under the heading of Planning and Environmental Assessment. The third part also gathers fifteen contributions under the heading of Urban Planning and Housing. The fourth part includes seven contributions covering the fields of Transport Planning and Logistics. Finally, the book closes with five short papers addressing, nonetheless, a number of relevant issues to the general theme of the conference.

Part 1. Keynote speeches and research projects

The return to urban design

Manuel Teixeira

Faculdade de Arquitectura, Universidade Técnica de Lisboa

manuelcteixeira@gmail.com

In western urbanism there is a moment of rupture with the modern movement. Its precepts, although theoretically formulated in the first decades of the twentieth century, were mainly put in practice in the 1950s and the 1960s, after the Second World War. Up to that moment, independently of the changes in the functions and the morphologies of the cities, urban spaces were organised in a traditional way, by means of streets, squares and blocks, and the unbuilt urban spaces were also designed, and an essential component of the design of the city. With Modernism, this city is replaced by a city functionally segregated, in which the streets are no longer streets but parts of a road network, the urban blocks no longer exist, and the urban spaces are replaced by a shapeless continuum un which the buildings are implanted isolated. The urban spaces – the "voids"- which up to then were also designed, and were privileged scenarios of urban life, disappear. Instead of them, we have now interstitial spaces between the constructions, which are not designed and which are, for the most part, residual spaces. The legislation has accompanied and supported these transformations. In the last decades the large-scale planning instruments have replaced, in practice, the detailed plans meant to define the form and structure of the city. Concrete plans were progressively rejected in favour of all-embracing plans, while regulations prevail over the plan's design. The form and the chronology of execution of the plan, as well as the design of public spaces are in most cases left to the hazard or solved casuistically, without a guiding coherent design, resulting in the actual negation of the city. The return to urban design is a fundamental condition to bring the city back into planning.

1.

Contemporary urbanism is in a situation of impasse. If, on the one hand, old models of pre-industrial urbanism no longer apply and cannot be literally replicated, given the different nature of the city's functions and the new urban needs, on the other hand, the modernist models, elaborated in the first half of the twentieth century, have already shown their inadequacies. Nevertheless, albeit criticized, these modernist models continue to be applied, because the economic mechanisms behind the development of the city and the existing legal framework objectively favour the construction of the city according to such models or, what's worse, their ersatz.

As a result of that, the contemporary city is being de-characterized. New urban spaces are no longer built in continuity with the existing city, have no coherent structure, no defined hierarchies, no structuring elements recognized as such. The location of services and central urban functions is often aleatory, with no relation with the urban structure and the relationship between architecture and the urban plan is deficient.

In is context, it is necessary to revisit traditional processes of city planning and city building and the resulting urban morphologies. The objective is not to reproduce or copy them, in a mimetic way, but instead to understand its underlying principles and reinterpret them according to contemporary needs. Portuguese urbanism is part of the European urban culture, while at the same time presenting specific characteristics. Portuguese cities are, on the one hand, expression of vernacular principles of territorial organization, characterized by a very close relationship of the city with the physical characteristics of the territory, which resulted in non-geometrical layouts; on the other hand, Portugues cities are also expression of the erudite urban culture of the specialized technicians who conceived them, which was usually translated into geometrical layouts.

In every historical period, Portuguese urbanism was always the synthesis of these two components: an erudite component, characterized by rationality and regularity, and a vernacular

component, characterized by its ability to adapt to the territory. By means of this process of synthesis, a plan based in geometrical principles was subsequently adapted to the site, and willingly moulded both to its physical characteristics and to existing man-made constructions, altering the regularity of the original plan whenever necessary.

This gave rise to a set of formal characteristics, largely immutable through time, which we may observe in urban settlements built in a variety of historical and geographical situations. It is these characteristics, which we may call the invariants of Portuguese urbanism, that give Portuguese cities a strong identity. They refer to the following aspects: the strategies for location and selection of the site; the geometrical structures subjacent to the plan; the relationships with the territory; the generator and structuring elements of the urban plan; the hierarchies of urban layouts; the relationships of urban plans with architecture; the structures of urban blocks and subdivision of land; the role of squares in the organization of urban spaces.

Until the end of the eighteenth century, these formal characteristics were clearly legible in the Portuguese city, both vernacular and erudite. In the nineteenth and the twentieth centuries, despite an apparent rupture, Portuguese urbanism was still based in processes and was translated into morphologies that had its genesis in these same traditional principles. The result was a city not crystallized into rigid models, open to alterations provoked by physical and environmental circumstances or by built pre-existences, and with the capacity to adapt to changing functional or social needs.

2.

The modern movement was a moment of rupture in western urbanism that, although theoretically formulated in the first decades of the twentieth century, would be mainly put in practice after the Second World War. The modern movement meant a rupture of the morphologies and of the processes that traditionally had been the basis of the city building processes.

Up to that moment, notwithstanding all the changes that had occurred in the functions and the organization of the city, there was a juxtaposition of urban functions within the same areas of the city and urban spaces were organized by means of a system of streets, squares and blocks. Although at different historical moments those elements might have had different concepts and expressions, one may observe links of continuity and permanence through time. The city could be graphically represented almost indistinguishably by the streets or the built-up fabric. There was a total congruence between these different elements.

With modernism, and fundamentally with its succedaneous that came to subvert many of its original principles, the city of streets, squares and blocks is replaced by a city in which its various compositive elements are disssociated: the streets are no longer streets, but traffic routes, separated from the built-up spaces; the blocks, in the traditional concept, no longer exist, replaced by towers and strips built isolatedly; the squares, that synthesized the very concept of urbanity, are replaced by shapeless spaces where the buildings are implanted.

The urban spaces, the “voids” that in the pre-modernist city were also designed, and constituted privileged settings for the urban life, disappeared. In their place, there are today interstitial

spaces between the constructions, spaces that are not designed. In the best situations, these are mere sceneries for the valorisation of architecture; more frequently they are just residual spaces.

Actually, many conditioning elements of the morphologies of pre-industrial cities became irrelevant. Urban form became independent of the physical characteristics of the territory in which the city was located. Topography was no longer a major restriction, and the relationship of urban form with defence, religion and most types of economic activities became irrelevant. In a perverse way, this lack of restrictions or frames of reference resulted in a disarticulation of urban design. The location of singular buildings and important urban functions became independent from the spatial logic of the city, and their role as references of the urban layout is no longer understood. Often, they are built haphazardly, not where they would make most sense in order to hierarchize the city.

The same happens with the street network. In the pre-modernist city, major structuring roads were hierarchically more important in terms of the traffic that flew through them and the functions that were located along them, but also formally and symbolically. Today, the streets are no longer structuring elements of the plan, articulated with the urban fabric, or urban spaces of reference. Major arterial roads are just traffic roads, segregated from the other functions and contributing to the disarticulation of urban spaces.

The squares, or their equivalent, are no longer located in the confluence of major streets or in the articulation of different sectors of the urban fabric, translating their role of fulcral elements in the organization of the city. The confluence of streets and avenues are today solved as traffic roundabouts, and the squares, if they do exist, are disarticulated from the street system, losing much of their role as places of confluence of people, of functions and of meaning. In most cases, today, squares are just empty spaces located somewhere, with no relationship with the logic of the plan or the functioning of the city.

Suburban urban developments are not built in the continuity of the existing city; they are in no way articulated with, or following the logic of the existing urban fabric. The expansion of the city is made by means of successive urbanizations, independent from each other. Each one of these urbanizations hangs from a road, with no urban status and increasingly congested, that leads to the inner city. Each one of these new developments has its own inner logic, without a higher urban logic in which they would fit in. As a result of that, the urban fabric looses fluidity and continuity and becomes disaggregated. In this new, de-hierarchized, urban fabric, there are no clear landmarks, no hierarchies of spaces, no logical structure, geometrical or otherwise. It is urgent to resist and to contradict this logic of development. New urban developments must be built in the continuity of the existing city and it is necessary that its structuring elements assume urban characteristics and urban typologies.

3.

Although criticised, modernist principles are still the basic vocabulary of city building. In this, they are supported by the existing legal framework. The actual Portuguese legal framework is based on two principles: prohibitions, on the one hand, and abstract principles, on the other. The prohibitions create interdictions relating to land uses, whereas the abstractions include undefined concepts and urbanistic parameters.

In the negative of the areas where different types of prohibitions are in place, the plans delimit other areas, where urban development is allowed, and to which are applied urbanistic parameters, abstract criteria and undetermined concepts, which have in no account local specificities. At the moment, the actual planning system is reduced to prescribing limits to edification and qualifying the land as potentially urban or non-urban. The applications for urbanization or construction are analysed regarding the land classification and the urbanistic parameters prescribed for that location. The eventual approval of such applications is made after a subjective interpretation of such undetermined concepts such as “aesthetic of settlements”, “beauty of the landscape” or “capacity of existing infrastructures”. The result is the pulverization of constructions, allied to their general lack of quality.

This means that, instead of developing concrete plans for defined parts of the territory, the tendency is to formulate plans with no design involved, consisting of general and abstract rules, which will eventually be concretized by means of the application of mathematical formulas and urbanistic parameters, following the caprices of both private and public initiatives. Urban form – it is thought – will eventually take shape by means of the application of such parameters.

The creation, the reconstruction and the expansion of cities in Portugal from, at least, the eighteenth century until the first half of the twentieth century was based on the elaboration of concrete plans, materialized in urban design proposals, which were framed by specific regulations establishing the procedures and the conditions for their fulfilment. The plans consisted in the definition of the street system, the structure of blocks, the subdivision of land, the design of squares, streets, avenues, gardens, as well as other components of the urban fabric, sometimes even the design of buildings. The legal apparatus included existing legal dispositions, some of them created specifically, as well as the plan’s regulations. This was the model for the reconstruction of Lisbon after the earthquake of 1755, for the plan of improvements of 1864, for Ressano Garcia’s plan of the 1880’s and for the plans of urbanization in the period of Duarte Pacheco. In fact, we may see instances of this type of intervention, which articulated architecture, urban planning and the corresponding legal framework, as far back as the early sixteenth century, in the urban interventions carried out by D. Manuel I.

In these urbanistic operations there was always a plan, designed and complemented by specific ordinances. These regulations could be more or less specific, and give private owners and developers a greater or a smaller power, but there was always a design that defined public spaces and gave the area a formal coherence as a whole. An important aspect to be emphasized is that urban expansion was, as a general rule, carried out in the continuity of the existing urban fabric. This model of intervention, which resulted in qualified urban spaces, was abandoned in favour of a system based on large scale instruments, diffused plans and generalist regulations.

This latter process began in 1946, with the approval of the Anteplans of Urbanization, and was reinforced in 1965, when private operations of subdivision of land were allowed, which could be carried out independently of the existence or not of a previous plan of urbanization. When the Detailed Plans were instituted in 1971, these operations of subdivision of land had already occupied the space of the Partial Plans of Urbanizations, which were further debased by the approval, in 1965, of the Municipal Master plans.

The plan-image disappeared in the practice of urbanization and was replaced by the plan-management, based on zoning and abstract regulations, from which urban design was conspicuously absent. The combination of functional zoning with the establishment of urbanistic parameters, complemented by the plan's regulations full of undetermined concepts, became the recipe to be applied any time, to any place. Aspects like the form and the time of the plan's execution, the conformation of public spaces and the aesthetics of buildings were left to hazard or disregarded.

The intermediate stage of urban design was lost. Urban development was now carried out in "areas fit for urbanization", most times delimited very generously, beyond the actual needs for urban land. That led to the loss of control of the process of urban growth and to a dispersion of urbanized areas and constructions throughout the territory. Despite the growing legal apparatus relating to urbanism and the management of the territory, the result has been the increasing chaos in the countryside, the cities and the urban peripheries. The ideal model, which is actually inscribed in the legislation, consists of Municipal Master Plans, distinct from the operative plans – Plans of Urbanization and Detailed Plans. However, such model is often perverted by prescinding from the operative plans, and using the Master Plans as instruments for current management.

The changes that we observe in the legal apparatus ruling the process of urbanization, consisting in the replacement of plans with a design content for general rules and abstract principles, was carried out in accordance with, and sustaining, the principles of the Modern Movement. The Modern Movement was based in supposedly universal and immutable rules, meant to be applied to the construction of cities as well as to the design and the organization of the dwelling. The objective was to attain ideal forms of organization of the spaces inhabited by man.

The starting point was an ideal type of man, with universal needs, and the objective was to reach, by scientific means, an ideal type of house and city, able to satisfy this ideal man. Efficiency, rationality, functionalism, technology, were key words in the search for and the application of such universal models. Actually, the use of general principles and rules relating to land uses, which the legal apparatus came to reinforce, the disregard of the local dimension and of their identity, produced in most cases a banal and frightful uniformity and led to the decharacterization of urban spaces. Furthermore, the use of abstract parameters fails to take into account the specific architectural characteristics necessary for buildings and the functions they fulfil to be successfully integrated into the city.

In which concerns public spaces, the consequences were disastrous. Public spaces were, for centuries, the focus and the support for the city's development. Today, they are just residual spaces, the amorphous spaces left over after constructions. Public spaces are reduced to the minimums imposed by law, or the Municipal master Plan. They become in most cases remnant spaces, with no identity or dignity, built just to fulfil legal obligations. Public spaces cannot be the remainders of urbanization or dealt with as a mere ratio or percentage, destined to such vague functions as green spaces, or equipments. On the contrary, public spaces must be the essential element for the city's urban design, around which the different urban functions and buildings are organized, structured and hierarchized. Each place must be dealt with according to its own specificities, and urban design must be – again – the basis for the organization and the structure of the city.

Rather than promoting new legal reforms one must interpret and apply the present legal apparatus having in mind a set of principles that will enable the re-establishment of the relationships between the normative and the designed components of these plans. Namely, the abandonment of the casuistic management, based in a set of norms, indices and abstract concepts; the clarification of the contents and objectives of each level of planning – Municipal Master Plan, Plan of Urbanization, Detailed Urban Plan – avoiding superpositions and contradictions; the promotion of the effective participation of the public in the process of planning; and the return to the primary aim of a urban plan, which is the definition of the image of the city.

4.

Today, there is a general agreement regarding the problems of the modernist city, and the quest continues for the urban form adequate to contemporary needs. However, in most cases, the resulting proposals are not very far from the modernist canons or fall into pastiches of pre-industrial urban forms.

The components of traditional urban form that must be rethought and reinvented are the urban layout and the circulation systems, the urban fabric and the buildings, in which we must include both the exceptional buildings (the res-publica) and the current constructions (the res-privata), and the urban spaces, the main elements that characterize urban form. In the pre-modernist city, the urban layout organized the distribution of spaces in the city by means of a geometry or the articulation of singular elements, the urban fabric was made up of buildings organized in urban blocks, and the urban spaces were mostly made up of streets and squares. These are the building blocks that ought to be reinvented for the conception and the construction of the contemporary city.

In the same way that exists a contemporary Portuguese architecture whose genealogy may be traced to Portuguese traditional architecture, it is also possible to conceive a contemporary urbanism that answers today's needs and that at same time has its morphologies, processes of conception and design strategies rooted in Portuguese traditional urbanism. It is possible today – as it has always been, in all historical times – to conceive a Portuguese urbanism simultaneously rooted in contemporary needs and in traditional characteristics.

There is a traditional Portuguese urbanism, which is present in Portuguese cities built mainly until the end of the eighteenth century, but still present in nineteenth and early twentieth centuries' urbanizations, and whose characteristics – of form and of processes – we may identify. The understanding of such urbanistic principles – the invariants of Portuguese urbanism – is necessary for the rehabilitation of historical urban nuclei or neighbourhoods, and the same principles are still relevant as references for the design of the contemporary city. Both types of intervention need to be anchored in the understanding of these historical characteristics, in order not to jeopardize them and to ensure the continuity with our culture and urban tradition, while at the same time ensuring the levels of functionality and performance adequate to today's needs.

The way these principles of design are formalized does not need to reproduce morphological solutions from the past, but to ensure the permanence of the concepts in which they are based. The plan for the reconstruction of the Baixa of Lisbon after the earthquake of 1755 does not literally reproduce models from the past, but Eugénio dos Santos makes a conscious revisitation of the main

themes of traditional Portuguese urbanism. The same exercise must be renewed. By means of the study of Portuguese traditional urbanism – its process of conception, its strategies of design and its morphologies – one may formulate new proposals and intervene in the present urban reality, while maintaining the roots in tradition.

Portuguese urbanism was never characterized by rigid and abstract schemes; instead, it was adapted to the topography and to other existing conditions, and was able to adapt to all alterations occurring through time. As a result, Portuguese urban layouts were rarely geometrically regular. One can understand their logic and their regularity, but these are subverted most times, in order to be more closely adapted to the territory and to the functional, formal or symbolic roles they are meant to fulfil. But this plasticity did not mean, or was translated in, amorphous urban layouts. On the contrary, Portuguese cities were eminently structured and hierarchized.

At the same time, the plasticity of Portuguese urbanism made possible its accommodation and its response to every change, which did not happen with urban layouts rigorously planned, which were finite, and definitive entities in its formal logic, difficult to adapt to transformations of scale, of use, or of meaning. Both in architecture and in urban planning, the best designs are those that have the capacity to accommodate future transformations, and in this respect, Portuguese urbanism is exemplary and Portuguese cities are probably in a much better position to adapt to new urban needs.

In this context, there is a set of principles, rooted in tradition, which must be taken as reference for the conception and the design of the contemporary city:

i. To continue the existing city, create a compact city. New urban spaces must be designed and built in continuity with the existing urban fabric, with no vacant, and expecting, empty lands in between. The limits between the urban and the non-urban land and between the different neighbourhoods must be easily recognisable.

ii. To understand the site, design with the site. New urban layouts must be designed having into account, and being adapted to, the physical and environmental characteristics of the sites in which they are built, as well as to pre-existing constructions. The main streets must be built superimposed on the natural lines of the territory, these structuring axes must be articulated in fulcral points, according to the topography, and squares must be structured at these junctures.

iii. To define a grid of support for urban growth. The growth and the organization of the city must be supported in a grid – either a conceptual or an actual grid – clearly perceptible in its logic and in its hierarchies, which structures the territory. The role of this grid is to become the support of all urban or architectural interventions to be carried out in the future.

iv. To define structuring elements, hierarchize the city. The hierarchization of the city is fundamental for the quality of urban spaces. In the plan of the city the main structuring elements (derived either from topography or from geometry) must be clearly understandable, as well as the hierarchies of the traffic systems, the hierarchies of the nodes of articulation of the urban fabric, and the hierarchies of urban areas. In association with functional hierarchies, formal and symbolic hierarchies must also be defined.

v. To select privileged places for the location of singular functions and the construction of singular buildings. The most important sites – in terms of topography or of the geometrical logic subjacent to the urban layout – must be reserved for the location of exceptional urban functions and

exceptional buildings, associated with singular urban spaces. These should be the main elements of the urban plan.

vi. To recover the relationship of the built up spaces with the street. The relationships between built and unbuilt spaces, between public, semi-public and private spaces must be re-established. One should be able to represent the different components of the urban fabric and the result should be identical, evidencing the intimate articulation of the various systems that compose the city.

vii. To reinvent the intermediate scales. The intermediate scales between the building and the city must be reformulated. In the historical city such intermediate scales are represented by the aggregation of buildings in blocks, in streets, in squares, in neighbourhood units. This contributes to a greater sense of appurtenance and organizes the city in distinct units with morphological affinities.

viii. To design the public spaces. Public spaces, rather than the buildings, define the personality of the city. Urban spaces must be designed, morphologically recognizable, have names and functions associated with them. They cannot be mere interstitial spaces between buildings. The squares must regain their role as the main ordering elements of the urban spaces, located in fulcral points of the urban fabric, articulating main routes or distinct urban units, and the places where the main urban functions and singular buildings are located.

ix. To re-establish the relationship between urbanism and architecture. The relationship between urbanism and architecture should be re-established, either adopting or reinventing the classical vocabulary, defining hierarchies, axis, perspectives, fulcral points, alignments. The hierarchies of buildings and urban spaces should reinforce each other.



Figure 1. Traditional urban layouts. Lisbon: Alfama, Bairro Alto, Baixa.

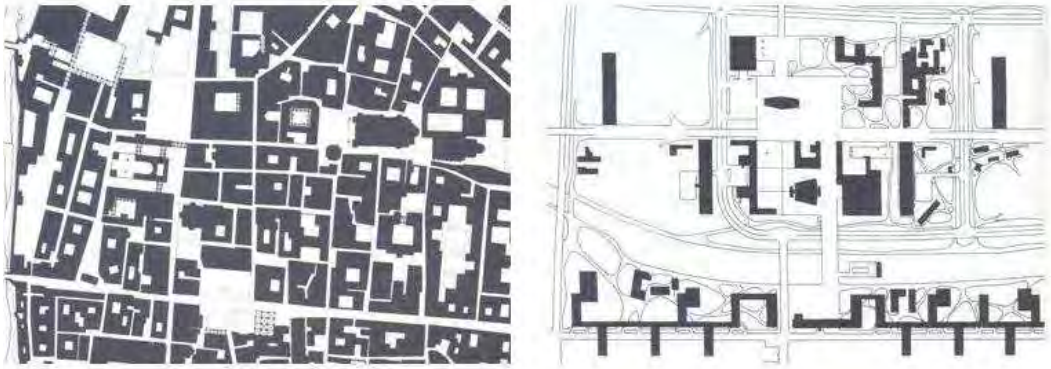


Figure 2. The relationship built / unbuilt spaces in traditional and modernist urban layouts: Parma, Le Corbusier's plan for Saint-Dié.



Figure 3. The representation of the city by means of the street network and the built up spaces. Bairro Alto: the congruity of the systems. Olivais Norte: the separation of the two components.

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The study of urban form in CITTA

Vítor Oliveira, Paulo Pinho

CITTA – Research Centre for Territory, Transports and Environment

Faculty of Engineering, University of Oporto, vitorm@fe.up.pt, pcpinho@fe.up.pt

Phone/fax numbers: 00 351 225081903 - 00 351 225081486

Since the establishment of CITTA, the Research Centre for Territory, Transports and Environment, in the beginning of this decade, a systematic morphological research has been carried out in its Unit One. The first part of the paper overviews different approaches in the study of urban form, paying particular attention to the Portuguese context. After defining the position of the research centre in the national context, the paper identifies the main approaches, theories, concepts, methods and techniques that are being used in CITTA's morphological research on the city of Oporto. Three aspects of the research deserve particular attention: i) the development of the cartographic redrawing method; ii) the link between two concepts established by the Conzenian School (morphological period) and by Space Syntax (integration); and finally, iii) the knowledge acquired on the morphogenetic history of Oporto. The last part of the paper focuses, as it would be expectable due to the nature of the research centre, on moving from description and explanation to prescription, contributing as such for bringing city form back into planning.

Keywords: Urban morphology, urban form, Oporto, Conzenian school, space syntax

1 Introduction

This text gathers the main aspects of CITTA's morphological research on the city of Oporto developed throughout the last years and published in a set of papers in scientific journals[1]. Each part of the text draws on one, or more, of these papers. In addition, the last part of this text provides some conclusions on the work already developed and outlines the future research.

Consensual definitions of the terms 'urban morphology' and 'urban form' among the different approaches in this field, are hard to find. Accordingly, the paper draws on the basic grounds that 'urban morphology' refers to the study of urban form (and of the actors and processes shaping it), and that 'urban form' encompasses the main physical elements that compose the city (for an amplification of this debate see for example Kropf, 2009).

2 The study of urban form

The study of urban form, or the field of urban morphology, is characterized by the co-existence of different approaches, theories, concepts, methods and techniques. Despite the urgency of comparisons between different approaches – see for example Whitehand (2009a)'s call – critical analysis on different morphological perspectives are not very common. Nevertheless, some papers on this issue have been published in the last two years in the *Journal of Urbanism* and in *Urban Morphology* – Kropf (2009), Osmond (2010) and Pinho and Oliveira (2009b). The next paragraphs briefly present the main approaches on the study of urban form that are proposed by the literature.

The historico-geographical approach developed by the Conzenian school (see for example Whitehand, 2007) focuses on the urban form and structure for descriptive purposes, with the aim of developing a theory of city building. It analyses how cities are built and why. It purposes a tripartite division of townscape into town plan (site, streets, plots and block plans of buildings), building fabric

[1] See Oliveira (2006); Oliveira and Pinho (2006, 2008, 2009, 2010a, 2010b); Oliveira, Barbosa and Pinho (2011); and Pinho and Oliveira (2009a, 2009b).

(three-dimensional form), and land use. The historical development is analysed according to concepts such as morphological period, fringe belt, morphological region, burgage cycle and morphological frame. The morphogenetic method (aiming at tracing the historical development of urban form) and the use of cartographic representation are other important features of this approach.

The process typological approach promoted by the Muratorian School (for a brief synthesis see Cataldi, 2009) focuses on the urban form for prescriptive purposes, with the aim of developing a theory of city design resting on historical city-building traditions. It discusses how cities should be built. As in the previous school, this approach develops around a number of concepts such as type, fabric, organism, operative history, to name just a few.

Space syntax (for a review see the introduction to the e-version of 'Space is the Machine' by Hillier, 2007) is based on a theory of space as an aspect of social life. It focuses on space, providing a representation of spatial relationships, expressed by a number of syntactic measures aiming at the establishment of a pattern language oriented approach. It holds a number of key concepts namely spatial configuration, axial map and axial line. Methods such as axial analysis and segment analysis, or software applications (Depthmap, Confeego, Segmen, to name a few) have are used by space syntax's international community.

Besides space syntax some other quantitative approaches have emerged in the last decades. Batty (2005) uses three of these – Cellular Automata, Agent-Based Models, and Fractals – to understand the city in all its complexity. The first approach represents physical systems as cells within a grid, subject to transition rules which specify the cell's behaviour based on inputs from neighbouring cells. Drawing on the first, the second approach focuses on autonomous, goal-directed software entities, on agents that carry out their pre-programmed instructions without further interference from the programmer. The last approach focuses on fractals, a particular type of shape, with an irregular but self-similar form, in which irregularities are repeated across many scales.

In addition, two other approaches should be referred, Isovist Analysis and Shape Grammars. The first focuses on the isovist, which is the area in a spatial environment directly visible from a location within the space (see for example Morello and Ratti, 2009). The second approach involves sets of rules for performing recursive operations – rotation, translation, combination, replacement – on an initial 2D or 3D shape, to obtain a set of alternative forms (see for example Jowers and Earl, 2010).

3 The study of urban form in Portugal

Contrarily to what happens in England or in Italy, there is not a Portuguese school on urban morphology. Despite the existence of some interesting works produced since the first half of the twentieth century, and even some relationships between master and disciples, or the consolidation of some research centres, Portuguese urban morphology is mainly constituted by uncoordinated efforts undertaken by individual researchers (for a comprehensive review see Oliveira et al, 2011).

Nevertheless it is possible to identify different morphological approaches being developed in our country, and for each of these, the fundamental researchers promoting it: the historico-geographical approach developed by Manuel Teixeira in Lisbon or by Walter Rossa in Coimbra; the process typological approach promoted by a number of researchers in the *Faculdade de Arquitectura*

da Universidade do Porto; the syntactical analysis carried out by Mário Kruger or Teresa Heitor; the shape grammars promoted by José Duarte; to name just a few.

A key issue in this debate is that the internationalization of Portuguese urban morphology is constrained by the fact that most of the Portuguese researchers do not publish in English language. In fact only 30% of the texts in our recent review on the study of urban form in Portugal were written in English. Among the others only a residual percentage include bilingual texts – surprisingly some of these correspond to the earliest texts.

Finally, our review highlighted the obvious need to establish a Portuguese network gathering the different approaches, developing morphological research, providing opportunities for contact between members, and encouraging the dissemination of findings, both nationally and internationally.

4 CITTA's research: approaches, concepts, methods

Bounded by the different approaches being developed in Portugal and by the specific nature of the research centre, CITTA's investigation took two different approaches – historico-geographical and space syntax – and assumed, as one of the main concerns, the relationships between urban morphology and urban planning.

Both historico-geographical and syntactical approaches were roughly presented in the second section of this text. The next three paragraphs provide more information on the elements that have been used in CITTA' s research.

An important theoretical issue, referred to before, mainly explored by Conzen, is the conceptualization of historical development. One of these concepts is the morphological period, corresponding to the influence exerted by a time period on the urban forms of a particular territory. Another important concept is the morphological region, defined by the German geographer as an area of homogenous urban form in terms of plan type (in our research we mainly focus on plan type areas), building type and land use, becoming distinguishable from the surrounding areas. For more on the morphological region see Whitehand (2009).

The focus on space and the relationships between space and movement are two fundamental aspects of the space syntax approach. Spatial configuration is also a key concept in this approach, meaning the relationships between two spaces considering a third one, or more generally, the relationships between space within a system considering all the other spaces in that same system.

The way that spatial relationships within an urban area (or a building) are represented is another distinctive element of space syntax. This representation is translated into an axial map which is constituted by the least set of axial lines that covers the whole system, in a way that any convex space is crossed by one of those lines. The axial line corresponds to the longest line that can be drawn through an arbitrary point in the spatial configuration. A number of topological measures can be extracted from the map to quantify the characteristics of the spatial configuration. In our research we mainly focus on: global integration, measuring the relative depth of each axial line to all other lines of the system; local integration, measuring the accessibility up to three steps away; and connectivity, measuring the degree of intersection or one step possibilities of each axial line.

5 Oporto case study

5.1 Introduction

Being the place where we live and work the selection of Oporto as our case study was obvious. The definition of the last two centuries as the timeframe for this study was due to the availability of cartographic material and to the low rates of urban growth prior to the 1800s. The first-known representation of the city of Oporto is the *Planta Redonda* by George Balck, made in 1813. Table 1 shows all the available cartographic surveys for the city. It reveals that the preparation of the town plans is not evenly distributed over time and that there are some long time periods between the production of two consecutive maps - between the maps of 1865 and 1892, and 1903 and 1932.

Table 1. Oporto town plans: 1813-2005

Oporto town plans	
1813	*Planta Redonda* - George Balck
1824	*Plano da Cidade do Porto* - José Francisco de Paiva
1833	*Oporto* - W. B. Clarke
1839	*Planta Topográfica da C. do Porto* - Joaquim da Costa Lima
1865	*Planta da Cidade do Porto* - Frederico Perry Vidal
1892	*Planta Topográfica da C. do Porto* - Telles Ferreira
1903	*Planta da Cidade do Porto* - STCMP
1932	*Planta Topográfica da Cidade do Porto* - STCMP
1937	*Planta Topográfica da Cidade do Porto* - STCMP
1948	*Carta Militar de Portugal* - IGE
1960	*Planta Topográfica da Cidade do Porto* - STCMP
1978	*Levantamento Aerofotogramétrico* - DGPU
1992	*Cartografia Digital* - STCMP
1997	*Carta Militar de Portugal* - IGE
2005	*Planta da Situação Existente* - STCMP

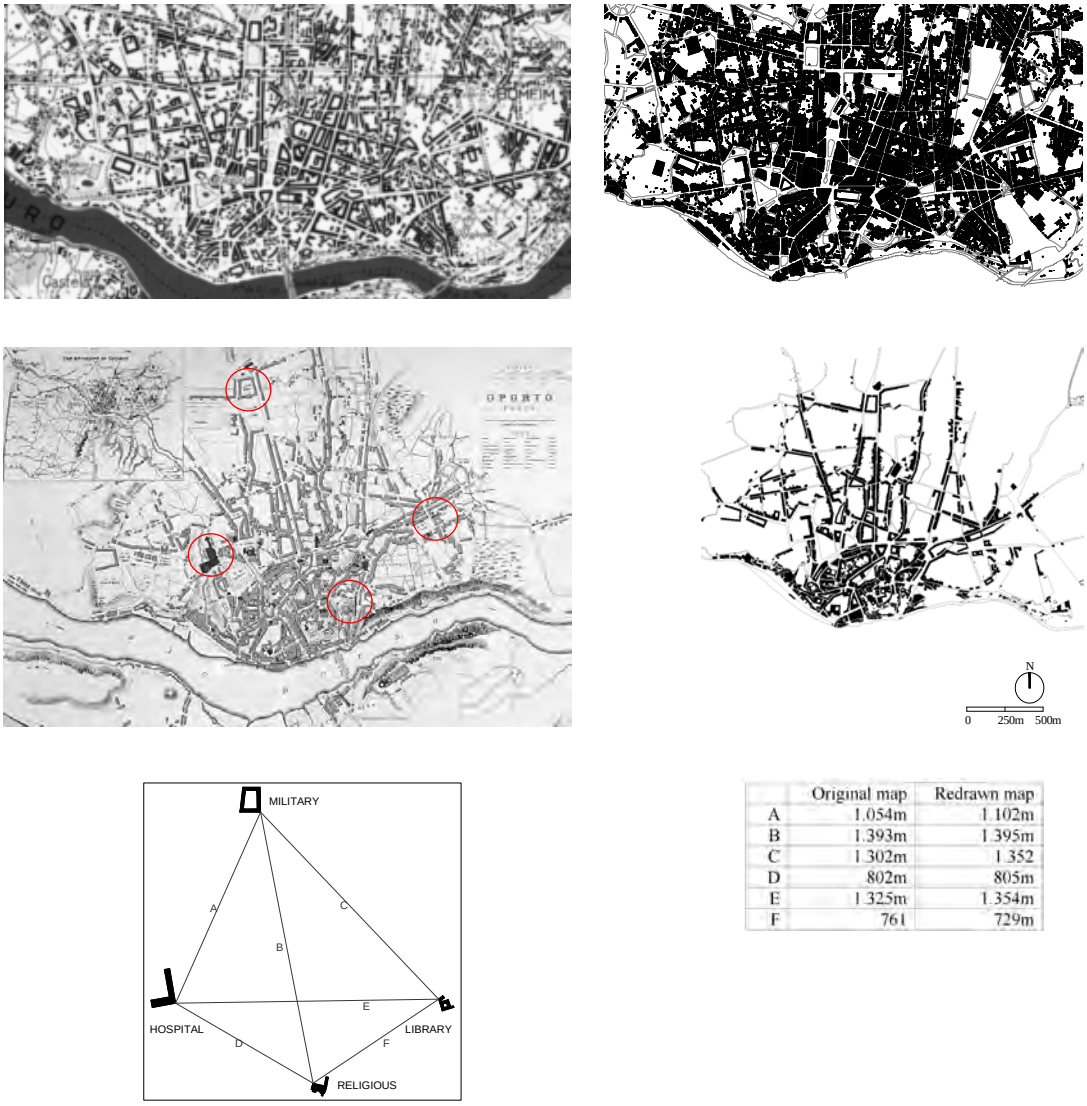
A limitation of this research was, for each map under analysis, the lack of information beyond city boundaries. It is known that these boundaries were continuously expanding, particularly in the maps from the beginning of the 19th century (between 1813 and 1865). For this reason the peripheral area of Oporto was represented with a grey background, with complementary data from another map, the *Plan de la Ville du Port et des Environs d'Oporto en Portugal* from the 1832 Atlas of Calmet-Beauvoisin. This map enabled the redrawing of the then surrounding area of Oporto right up to the present city boundaries.

The evolution of Oporto urban form throughout the nineteenth and twentieth centuries was analyzed, first under an historico-geographical approach, and then under a syntactical approach.

5.2 Cartographic redrawing method

The re-drawing of these maps started with a rigorous computer-made representation of the latest map produced for Oporto. After some initial work, including the assembly of the different map sheets and the erasing of all unnecessary layers of information, the 2003 map was ready to generate all the previous maps, by successive subtractions of all the physical elements that, in each and every case, were built *a posteriori*. In practice, each new re-drawn map was the framework for the redrawing of the previous one. In each of these steps it was necessary not only to remove all the urban forms that were built after the date of the given plan, but also to introduce all the detailed adjustments for a precise overlapping of each pair of maps. Figure 1 presents two maps, before and after redrawing. It

also presents the geo-referencing process of the 1833 map, using ArcInfo. After overlapping the 1839 redrawn map (derived from the 2003 map) and the 1833 original map, four singular buildings (a hospital, a library, military facilities, and a religious building) are selected in order to correct their coordinates. This effort to make all the successive town plans strictly compatible, allowed for the construction of a model, permanently updatable and, due to the layers organization, able to support different kinds of analytical work.



	Original map	Redrawn map
A	1.054m	1.102m
B	1.393m	1.395m
C	1.302m	1.352
D	802m	805m
E	1.325m	1.354m
F	761	729m

Figure 1. Original and redrawn maps – 1833 and 1948. *Carta Militar de Portugal* by IGE and *Oporto* by W. B. Clarke (original and redrawn maps). Source: Pinho and Oliveira (2009a).

A complex process as this, come upon with maps with rather different levels of rigour. For instance, all maps before 1892 had been produced with no contour curves or any other explicit topographic support what made this exercise far more difficult. In addition, some plans included

dashed representations of a number of projected urban forms that we found have never been built, judging by the subsequent plans.

In the end, and in order to emphasize the essential aspects of the urban form evolution of the city, all the irrelevant information from the original cartography have been removed. The analysis of the redrawn maps makes evident the essential elements of the urban form – the urban spaces for circulation, the urban spaces for permanence, the ordinary buildings, and the singular buildings. The urban spaces for circulation comprise the street system and the pedestrian circulation scheme. The urban spaces for permanence comprise the spaces for urban leisure. The ordinary buildings are characterized by the typological definition of the buildings, by their aggregated forms, and by the way one can access the exterior space from the buildings, or the exterior spaces between the buildings. The plot is not considered due to the absence of a uniform pattern of rigour, in the whole set of maps included in our analysis time period.

Cartographic redrawing, on a GIS platform, offers a new approach to the evolution of cities over a long period of time. First, scale is no longer a problem and large cities can be selected as case studies. Until now, Oporto had never been the object of this kind of cartographic study. Throughout the 1990s a set of Portuguese researchers decided to analyse smaller cities because they did not had the required tools to approach the larger ones. Second, this methodology can enhance the rigour of the original maps through the geo-referencing process illustrated in Figure 1.

Five outputs from the use of this method have been identified. The first output is the overall and simultaneous perspective of the urban form evolution of a particular city on a long period of time. In this study, it allowed for a clear understanding of the long-term characteristics and of the ruptures in the processes of urban transformation, leading to the definition of morphological periods, characterised by specific urban forms, agents and social contexts, and of morphological regions.

The second output is the construction of a representation framework of the urban form evolution. The representation framework of each city is composed of a set of maps, previously digitalized, registered and rectified, in order to obtain the same geographical coordinates and a homogeneous graphic appearance. In this representation framework, each map corresponds to a different layer, within a chronological sequence. Each map (primary layers) is made of the fundamental elements of the urban form (secondary layers) – the urban spaces for circulation, the urban spaces for permanence, the ordinary buildings, and the singular buildings. It is possible to visualize each of these elements, either in isolation or overlapping other elements from the same map, or side-by-side with other elements from a different map.

The third output corresponds to the rigorous identification and characterization of urban expansion areas. The overlapping of two consecutive maps, using different colours, allows for a direct perception of those areas that had gone through deeper urban transformations. The overlapping of 1960 and 1978 maps presents the most significant set of urban expansion areas. This is due to the early developments of the macro street structure – a new Oporto bridge over the *Douro* River, an inner ring road, and a Northern high circulation axe – and to the construction of sixteen small neighbourhoods, corresponding to more than six thousand dwellings

The fourth output resulting form the use of cartographic redrawing is the possibility to identify different morphological regions, taking advantage of a rigorous and versatile cartographic base.

The fifth output corresponds to the opportunity to analyze, in a systematic way, unexplored urban development processes such as those supported by the *Boavista* and *Constituição* East-West axes. This will be developed in the next section.

5.3 Morphological periods and integration measures

Our historico-geographical approach allowed for the identification of three morphological periods: a *monarchic period* corresponding to the five earliest town maps, dating from 1813 to 1865; a *late-monarchic and dictatorial period* corresponding to the six subsequent town maps, dating from 1892 to 1960; and a *democratic period* corresponding to the latest four town maps, dating from 1978 to 2003.

The *monarchic period* corresponds to the initial stages of the urban expansion of Oporto outside the medieval walls. This urban expansion was supported by a great illuminist gesture, the opening up of the *Almada* street, and by the consolidation of five gateway roads to some of the most important nearby cities of the North of Portugal: *Matosinhos*, *Viana do Castelo*, *Braga*, *Guimarães* and *Penafiel*. The spatial organization of Oporto was profoundly marked by the industrialization process and by the massive construction of substandard houses for the working class, mainly in the form of the so-called *ilhas*.

The *late-monarchic and dictatorial period* corresponds to the northern and western urban expansions of Oporto, supported on three main avenues – *Boavista*, *Marechal Gomes da Costa* and *Antunes Guimarães* – and by the *Constituição* Street. The city growth was organized along these large axes, defining new directions, supporting new building facades and organizing the built up areas of the surrounding urban fabric. The public transport system had a fundamental role in the spatial arrangement of the city in this period, enabling the emergence of larger distances between residence and work. By this time, the urban fabric of Oporto was marked by the construction of the first social housing estates, built with the special purpose to eradicate all the *ilhas* from the city. These housing developments corresponded to two storey unifamily buildings initially and, later on, throughout the 1950s and 1960s, to large housing estates made of several multifamily buildings, three, four storey high, freely disposed on the ground, following the dominant modernist model at the time.

Finally, the *democratic period* corresponds to the construction of heavy urban road infrastructures cutting or destroying the traditional intricate urban fabric of Oporto city. These fast circulation roads represented a radical change in mobility policies and in the structuring and organization of the Oporto urban fabric. Concerning major facilities and public equipments, the city accommodated two new university campus, a new museum of contemporary art, and a rather large urban park on the West side, nearby the sea waterfront.



Figure 2. Oporto (1813-1839). Town plans of Oporto from 1813, 1824, 1833 and 1839, based on the original prints of *Planta Redonda* by George Balck, of *Plano da Cidade do Porto* by J. Francisco de Paiva, Oporto by W. B. Clarke, and of *Planta Topográfica da Cidade* do Porto by J. C. Lima. Source: Pinho and Oliveira (2009a).

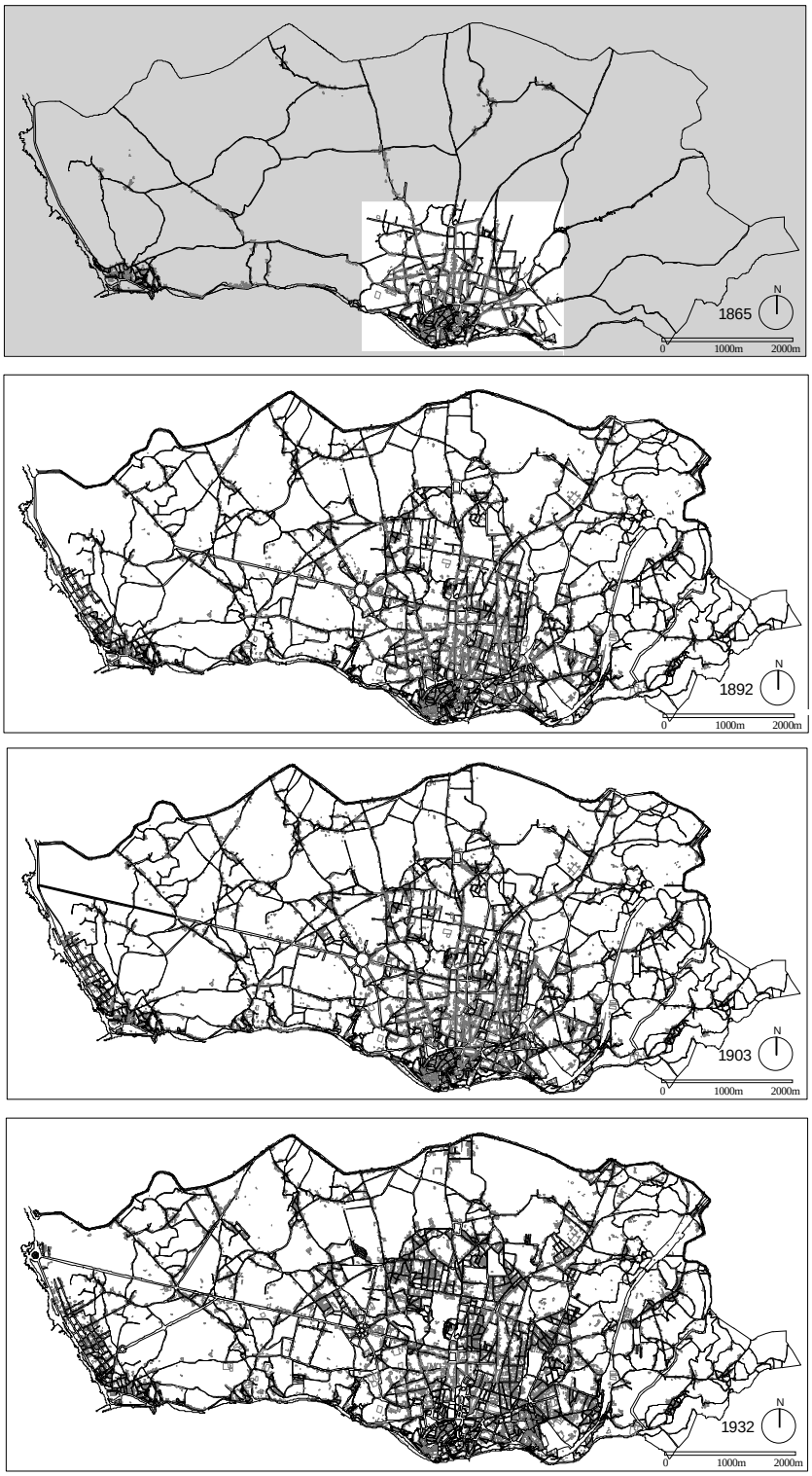


Figure 3. Oporto (1865-1932). Town plans of Oporto from 1865, 1892, 1903 and 1932, based on the original prints of *Planta da Cidade do Porto* by Frederico Perry Vidal, of *Planta Topográfica da Cidade do Porto* by T. Ferreira, of *Planta da Cidade do Porto* by STCMP, and of *Planta Topográfica da Cidade do Porto* by STCMP. Source: Pinho and Oliveira (2009a).

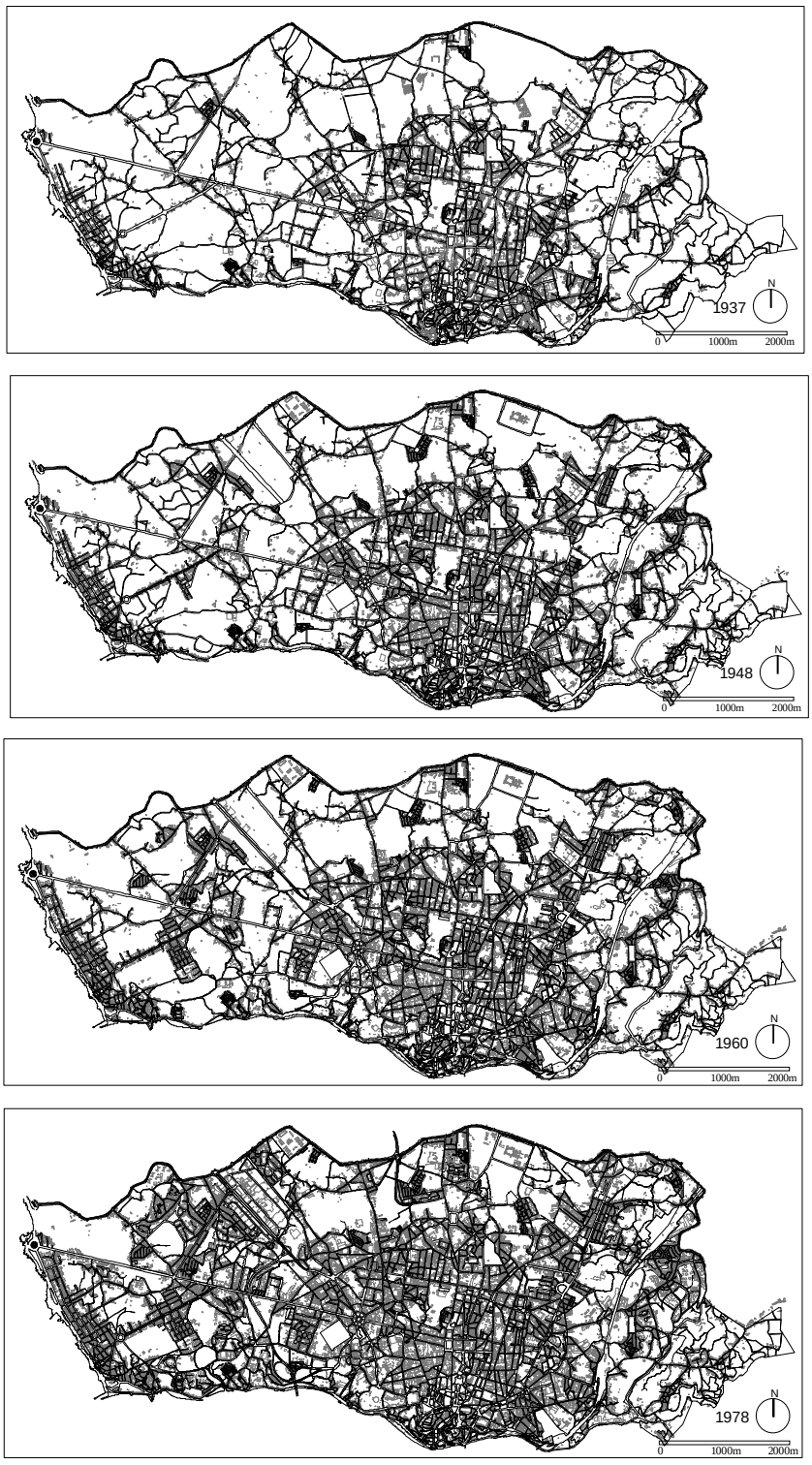


Figure 4. Oporto (1937-1978). Town plans of Oporto from 1937, 1948, 1960 and 1978, based on the original prints of *Planta Topográfica da Cidade do Porto* by STCMP, of *Carta Militar de Portugal* by IGE, of *Planta Topográfica da Cidade do Porto* by STCMP, and of *Levantamento Aerofotogramétrico* by DGPU. Source: Oliveira and Pinho (2009a).



Figure 5. Oporto (1992-2003). Town plans of Oporto from 1992, 1997, 2003, based on the original prints of *Cartografia Digital* by STCMP, of *Carta Militar de Portugal* by IGE, and of *Planta da Situação Existente* by STCMP. Source: Pinho and Oliveira (2009a).

A look at the fifteen-map sequence, particularly in the Late-Monarchical and the Dictatorial Period, makes evident the importance of two axes in the overall urban layout, *Boavista* and *Constituição*, leading the city towards West and North.

The 1813 map already represented the Eastern part of the *Boavista* axis, named as a street and not as an avenue. This street linked a large square, *República*, with one of the five gateway roads to some of the most important nearby cities in the North of Portugal. In 1813, *Boavista* was 11m width, 500m long, and 80 per cent of it had already been occupied with buildings. More than 150 years later, in 1978, the street was thirteen times longer, with the largest expansion between 1839 and 1892. The evolution of the percentage of building façade during the whole time period can be divided in two distinct parts, an initial decrease between 1813 and 1932, and a final increase between

1932 and 1978. Still, the building façade percentage in the latter was far from the initial percentage in 1813. The number of perpendicular streets had been growing throughout the years studied, more reduced in the twentieth century than in the 1800s.

The construction of *Rua da Constituição* started in 1843. Nevertheless, the first map to include this street and to represent the whole city, was the 1892 map. Despite its apparent unitary form, *Constituição* had been built in three moments, first its central part between a square, *Marquês*, and another gateway road, *Antero de Quental*, then a Western extension, and finally, an Eastern extension. The percentage of building facade along the street was not very high, particularly in the Eastern part. Here, a new orthogonal urban tissue emerged, limited to the North and to the South by the local topography. Curiously, building construction in these peripheral parts was higher than in *Constituição*. The street length remained the same between 1892 and 1932, and increased between 1932 and 1978. The percentage of building façade has been growing in a regular rhythm, from 20% by the end of the nineteenth century, to 58% by the end of the 1970s.

After developing a historico-geographical approach, the evolution of Oporto urban form throughout the nineteenth and twentieth centuries was analyzed under a syntactical approach (see Figure 6). The results from the application of space syntax methods have, on the one hand, reinforced the main conclusions of our previous study, and on the other hand, made evident some aspects that have not emerged in the morphogenetic analysis.

Tables 2 and 3 make evident the link between morphological periods and integration measures. The maps included in the first morphological period have a global integration between 0.8 and 1.0 (showing that this syntactic measure is distinctive of each morphological period), and a local integration comprised between 1.70 and 1.75. The maps included in the second morphological period hold a global integration comprised between 0.5 and 0.7, and a local integration comprised between 1.55 and 1.70. Finally, the maps included in the third morphological period have a global integration comprised between 0.7 and 0.8, and a local integration comprised between 1.70 and 1.75. Despite some similarities between the definition of the morphological periods and the values for connectivity, it was not possible to establish such a direct link as in the case of integration.

Table 2. Global integration and morphological periods

Global Integration	Maps	Morphological Periods
0,5-0,6	1892, 1903	2nd Morphological Period
0,6-0,7	1932, 1937, 1948, 1960	
0,7-0,8	1978, 1992, 1997, 2005	3rd Morphological Period
0,8-0,9	1813, 1824, 1833, 1865	1st Morphological Period
0,9-1,0	1839	

Table 3. Local integration and morphological periods

Local Integration	Maps	Morphological Periods
1,55-1,60	1892, 1903	2nd Morphological Period
1,60-1,65	1932	
1,65-1,70	1937, 1948, 1960	
1,70-1,75	1813, 1824, 1833, 1839, 1865	1st Morphological Period
	1978, 1992, 1997, 2005	3rd Morphological Period

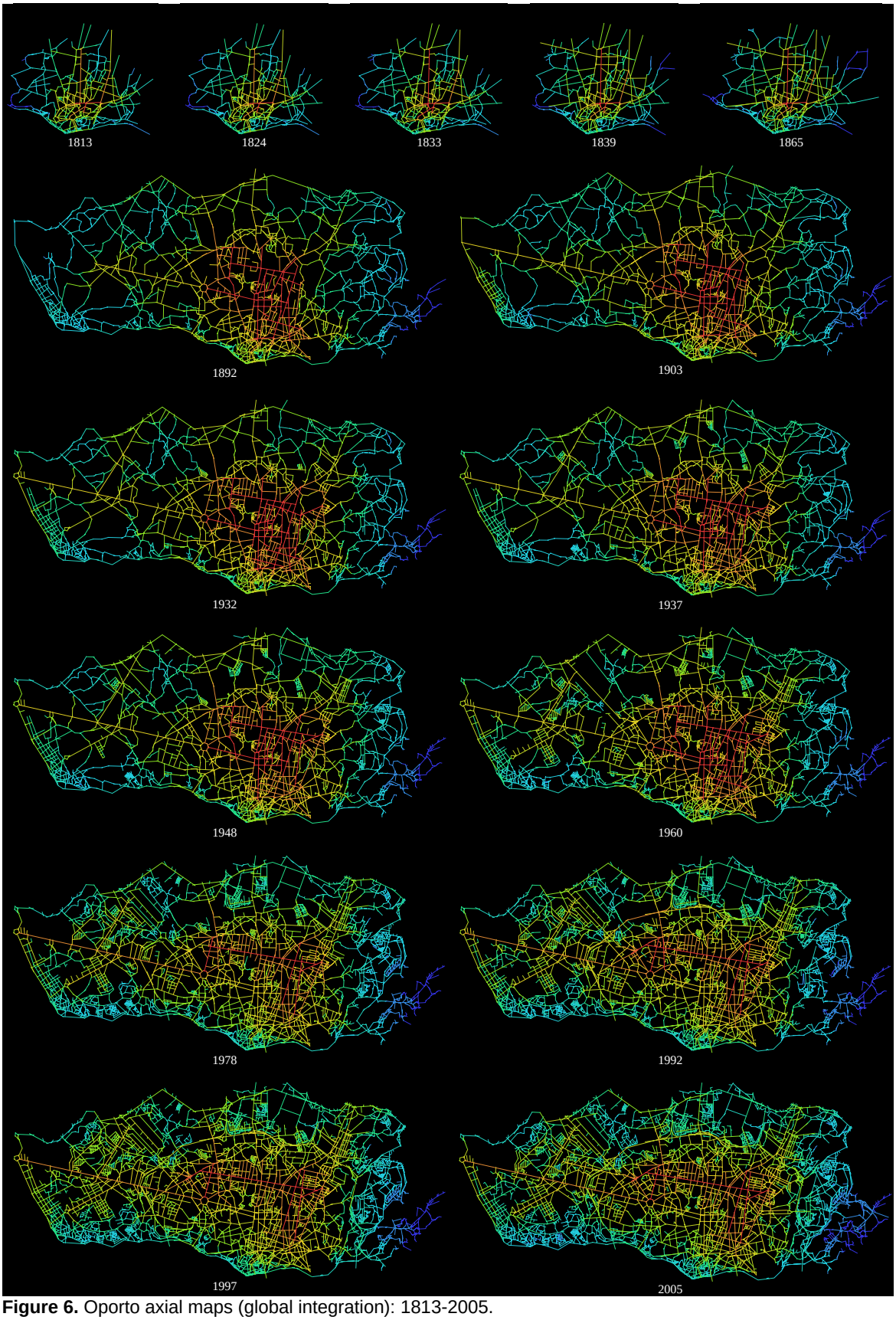


Figure 6. Oporto axial maps (global integration): 1813-2005.

Another important feature of our previous study was the identification of the most important axis of the overall city structure. Table n presents all the axial measures referred to before and now applied to each of the axial lines and includes an additional measure, control[2]. Syntactic analysis made evident the importance of the following axis: *Rua do Almada* (the longest axial line between 1813 and 1833 with the highest connectivity between 1813 and 1865, the highest control between 1813 and 1833 and the highest local integration between 1813 and 1865); *Rua da Boavista* (the longest line in 1839 and 1865) and *Av. da Boavista* (the longest line between 1892 and 2005 with the highest connectivity and control between 1892 and 2005 and the highest local integration between 1892 and 1960); and *Rua da Constituição* (the line with the highest global integration in 1892, 1903 and between 1937 and 2005, and with the highest local integration between 1978 and 2005). Besides these streets, axial analysis has also highlighted the importance of other axes that have been somehow devalued in our previous analysis, *Calçada dos Clérigos/Rua de Santo António*, *Rua de Santa Catarina*, and *Rua Fernandes Tomás*.

Table 4. Oporto fundamental axes: 1813-2005

Map	Number of lines	Line length (Maximum)	Integration (Maximum)	Connectivity (Maximum)	Control (Maximum)	Local Integration (Maximum)
1813	477	1267,080 ALM	1,391 CLE	13 ALM	3,418 ALM	2,957 ALM
1824	486	1267,080 ALM	1,402 CLE	13 ALM	3,418 ALM	2,954 ALM
1833	491	1267,080 ALM	1,410 CLE	13 ALM	3,368 ALM	2,963 ALM
1839	503	1369,070 BOA	1,471 CLE	13 ALM	3,287 FER	3,011 ALM
1865	542	1369,070 BOA	1,455 CLE	13 ALM+FER	3,621 FER	3,006 ALM
1892	2248	2830,930 aBOA	0,878 CON	22 aBOA	6,750 aBOA	3,455 aBOA
1903	2286	5021,930 aBOA	0,919 CON	30 aBOA	9,333 aBOA	3,785 aBOA
1932	2379	4961,380 aBOA	0,979 SAN	32 aBOA	11,060 aBOA	3,861 aBOA
1937	2494	4961,380 aBOA	1,018 CON	32 aBOA	10,893 aBOA	3,839 aBOA
1948	2645	4961,380 aBOA	1,018 CON	32 aBOA	10,824 aBOA	3,846 aBOA
1960	2978	4961,380 aBOA	1,033 CON	37 aBOA	13,779 aBOA	3,924 aBOA
1978	3505	4961,380 aBOA	1,194 CON	39 aBOA	13,834 aBOA	4,117 CON
1992	3728	4961,380 aBOA	1,210 CON	44 aBOA	16,163 aBOA	4,208 CON
1997	4065	4961,380 aBOA	1,193 CON	45 aBOA	16,780 aBOA	4,227 CON
2005	4287	4961,380 aBOA	1,259 CON	46 aBOA	16,847 aBOA	4,221 CON

ALM – Rua do Almada; BOA – Rua da Boavista; aBOA – Avenida da Boavista; CLE – Calçada dos Clérigos, Rua de Santo António; CON – Rua da Constituição; SAN – Rua de Santa Catarina; FER – Rua Fernandes Tomás

6 Urban morphology and planning

After two decades of a planning debate almost exclusively focused on the issues of method, discourse, and communication, there has been a call for a more substantive discussion and for a more informed and evidence-based intervention on the city (Faludi and Waterhout, 2006). Despite the inexistence of an overall assessment of planning practice in most of the Western countries – mainly due to the lack of systematic evaluations of planning activity (Alexander, 2006) – it is possible to assume that the different models and approaches provided by planning theory throughout the last decades, have not help them to cope with the morphological dimension of cities. Urban morphology, as a specific field of knowledge on the physical form of the city and on its process of transformation through time, has an unquestionable legitimacy to contribute to a more informed city planning. Within the different approaches to urban morphology, the application of theories, concepts and methods of

[2] Control expresses the proportional quantity of accesses to an axial line in relation to the adjacent lines.

analysis in planning practice, is currently acknowledged as a major challenge (Batty, 2008; Hillier et al, 2008; Whitehand, 2009b).

In CITTA, the analysis of the relationships between urban morphology, urban planning, and the process of urban development of Oporto has followed three lines of research. First, we have critically reviewed the most influential planning policies on the evolution of the urban forms of Oporto, since the second half of the nineteenth century to present times. The analysis of the strategic goals of each planning document, corresponding implementation practices, and the effective achievements of each plan in the reshaping of existing and construction of new urban spaces, provided enough evidence to support the conclusion that, in the overall, planning policies were not able to generate great or lasting impacts on the urban fabric of Oporto (when compared, for instance, with Lisbon, or with former periods of its history when planning was not institutionalized). It is argued that this was due, in the first part of the timeframe, to the lack of a strategic and ambitious vision for Oporto, and in the second part, to the reduced availability of technical and financial resources.

Second, we have assessed the incorporation of morphological criteria in one of the plans that were previously analysed, the 2006 PDMP (*Plano Director Municipal do Porto*). This was carried out with reference to a set of planning documents prepared by researchers of the Conzenian School for British and French towns, and taking account of differences in legal systems. Issues addressed included the maintenance of the character of the city, a form-based typological approach to zoning, and the introduction of design detail within the planning process.

Third, we have designed and applied, to the 2006 PDMP, a planning evaluation methodology – the Plan-Process-Results (PPR) approach – with an element of urban form analysis, which intends to assess, and with its results contribute to enhance the quality of the plan, of the local planning process, and of the built environment these are expected to shape. Such an evaluation sheds important empirical light on wider questions in planning practice, including the nature of the relationships between local politics and planning practices and the way plans and planning practices shape the new and emerging built forms of our cities.

7 Conclusions and further research

Since the establishment of CITTA in 2002 a systematic morphological research has been carried out. Different approaches, theories, concepts, methods and techniques have been critically reviewed and applied, aiming to build a morphological toolkit to support the analysis and design of cities. Despite some focus on other cities, such as Lisbon, Oporto has been our main case study, having developed a reasonable knowledge on its morphogenetic history and on its contemporary needs and ambitions, particularly at physical level.

A permanent concern of this morphological research has been the linkage between description, explanation and prescription. The weak relationships between research and practice are an acknowledged problem both in urban morphology (Samuels, 2008; Whitehand, 2009) and in planning (see *Planning Theory*'s issue of May 2010 on this theme, particularly Alexander, 2010, and Lauria, 2010). In fact, a number of problems need to be addressed to better link urban morphology, urban planning, and the effective processes of urban development: the absence of a clear perspective on planning activity in most of the Western countries; the absence of a clear view of what

urban morphology can offer planning practice; a number of divides, at several levels, between academics and professionals; a set of difficulties associated with moving from morphological analysis to prescription; the fact that municipal planning departments do not usually have the human and financial resources for the development of morphological analysis; and finally, the practical difficulties in urban morphology of dealing with the physical scale and complexity of large cities and conurbations, which explains the current dominant focus on small towns and historic kernels.

Morphological research in CITTA in the next years will mainly pass by two different projects. The first of these projects, with a comprehensive nature, aims at developing new tools on the issues of accessibility, urban form and structure, to better support the planning process. The second project, more focused, aims at defining a set of morphological aspects with potential for application in Portuguese planning practice.

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The study of suburban morphology in CITTA

Miguel Serra, Paulo Pinho

CITTA – Research Centre for Territory, Transports and Environment

Faculty of Engineering, University of Oporto, alvim.serra@fe.up.pt, pcpinho@fe.up.pt

Phone/fax numbers: 00 351 225081903 - 00 351 225081486

This paper reports the work developed at CITTA regarding the issue of contemporary suburban morphology, using the Oporto Metropolitan Region as study territory. We have observed the evolution of the urban grids from five representative areas of the Oporto urban fringe, throughout the last fifty years, using a diversified methodological approach, combining diachronic cartographic redrawing with space syntax and street pattern analysis. Our findings provide evidence of different suburban growth patterns with different configurational outcomes (namely clear intelligibility inequalities between study areas), that are explainable by the morphological composition of their urban grids. Building on these results, we propose some recommendations for the spatial planning of these territories, aiming at the enhancement of their structural spatial properties.

Keywords: Suburban, morphology, Oporto, space syntax, intelligibility

1 Introduction

In Portugal, as elsewhere, extensive suburban development has produced new morphological patterns, with physical and spatial characteristics that are utterly different from those of the traditional city. Albeit urgently necessary, the spatial planning of these new urban areas seems like a herculean task, given the extreme awkwardness of their present morphology. In this paper, we describe and update the results of an on-going CITTA research program[3] addressing the issue of contemporary suburban form, using Oporto's[4] urban fringe as study object[5].

The main focus of urban morphology has been the historic or traditional city; studies approaching the form of today´s suburban areas are rather scarce. Some reasons for this relative lack of knowledge can be pointed out: the young age of these new urban environments, their extremely dynamic rates of transformation or their huge territorial scale (Stanilov 2004). But, above all these reasons, what truly hinders the morphological knowledge of contemporary suburban areas is the absence of the kind of order we used to indentify in the traditional city. By 'order' we do not mean geometric regularity but rather *structural coherence*, that is, the organic way whereby the elements[6] that compose urban form relate to each other. This system of relations, that was more or less the same for millennia, suffered profound changes in contemporary peripheral areas.

In traditional urban tissues, the relationships between those basic elements form a coherent morphological system, in which street and plot sub-systems are the fundamental structuring units, one being the complementary of the other. The street system is a continuous network of public space that gives access to all plots. These are organized in non-contiguous and discrete 'islands' of private space – or, more trivially, blocks. The side of the plot in contact with the street network is usually completely built, thus producing a strong correspondence between building, plot and street, endowing

[3] The research is funded by the FCT grant SFRH/BD/47204/2008.

[4] Oporto is the second Portuguese largest city, and the largest of the peninsular northwest.

[5] For an exhaustive, though less up-to-date, description of the whole research and see (Serra, 2008). Progress results can be found in (Serra, Pinho, 2009).

[6] Albert Levy (1999) defines the primary morphological urban elements as plots, buildings (or constructed spaces), streets and open spaces (urban spaces other than streets), definition that we follow herein.

the overall system with great continuity and legibility. Open spaces other than streets (squares, parks, gardens, courtyards, etc), correspond to moments of exception in the street system, and are located as a function of its structure. This kind of urban tissues have been extensively studied, and their morphologic characteristics and morphogenetic processes are now reasonably understood[7].

In contemporary suburban areas, that is, in the areas where today's city is being produced, the traditional relations between the basic elements of urban form have been profoundly altered. The elements themselves remain generally the same; what seems to have disappeared is the structural coherence they had before. The street network is now mainly composed by labyrinthine and narrow rural roads, mixed with patches of denser urban grids, without clear structural hierarchy. Here and there, new heavy-duty infra-structures (highways and motorways) following regional transportation logics, criss-cross this incipient local street network, changing drastically its accessibility patterns. Plots, usually agricultural fields that have become obsolete, are now just large areas where construction is (eventually) allowed. The structure of land tenure no longer has the organizing role that the traditional urban plot had over the built form system. Built forms no longer relate clearly to the street, many times not even to each other (Levy 1999).

The piece-meal basis of this new kind of urban development has produced an 'urbanscape' that is dispersed and discontinuous, structurally fractured and difficult to grasp. As early as 1965, Friedman and Miller had anticipated that the city of extensive metropolitan urbanization would "elude easy perception by the eye and will be difficult to rationalize in terms of a Euclidean geometry. It will be a large complex pattern which, unlike the traditional city, *will no longer be directly accessible to the senses*" (op. Cit., p. 319, our emphasis). Although 45 years have passed since these authors claimed that "the challenge to search for [new models of the peripheral city] confronts the planning profession with mounting urgency" (op. Cit. p.319), these models are yet to be found. The same claims can still be found in recent works that dwell on the same problem, such as (Levy 1999) and (Stanilov 2004).

Because we don't recognize this new city as something clearly 'urban', we tend to characterize it always by opposition to the city we know: 'the city with good form' *versus* 'the city without form'. This has produced a negative conceptual charge that hinders positive analysis, i.e. an analysis that doesn't depend on previous established paradigms or theoretical prejudices. The lexicon on the subject suggests this conceptual bias, in terms like "exploded city" (Spector, Landrieu et al. 1988), "splintering urbanism" (Graham and Marvin 2001) or "exurbia" (Berube, Singer et al. 2006). Álvaro Domingues (2006) sums up this issue quite well; in his words, we ought not see the diffuse city as a "perversion of the 'other' [city] (whatever it may be), but rather as another way of thinking the 'urban' and its form, which may have its costs, efficiencies and deficiencies, but that, above all, exists because it responds to a certain social context that, apparently, is quite widespread in many different geographies and cultures" (op. Cit., p. 29, our translation). This 'new urban', however, remains pretty much *terra incognita*, in what concerns their intrinsic morphological characteristics.

Morphologically, therefore, we could talk about a city we know, the city of traditional urban form, and another one that is strange to us, although much larger, the city of extensive urbanization, growing fast around the previous (Figure 1).

[7] For an overview of the urban morphology findings on traditional urban tissues see, for instance, (Moudon 1997) or (Whitehand 2001).

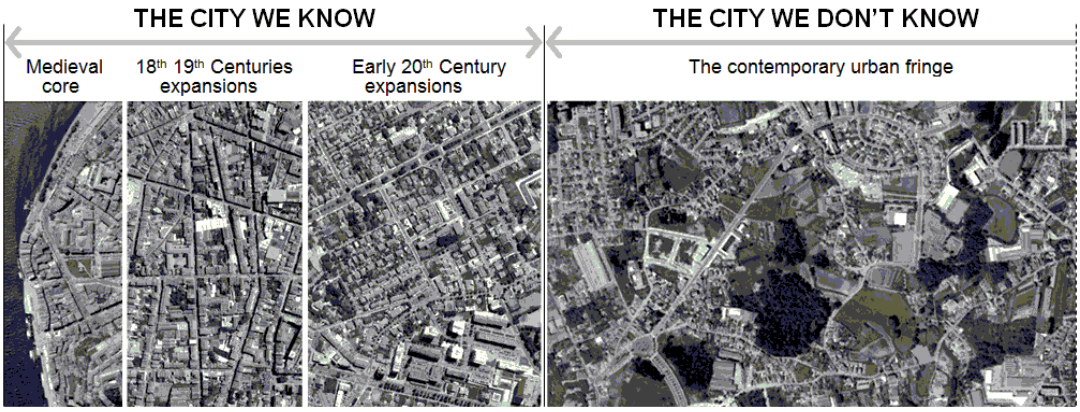


Figure 1. The city we know, and the city we do not.

We will propose that much of the conundrum created by contemporary suburban form lies in the fact that, until very recently, most of the existent analytical approaches were driven by *discursive techniques.* In the more generalist literature (Indovina 1990; Ascher 1995; Koolhas 1995) analysis tends to evolve around verbal concepts, rooted on a literary and even poetic discourse, in which the metaphor plays a fundamental role as a tool for description and conceptualization. This kind of methodology has given us strong perceptions of the phenomenological changes occurring in these new urban territories. These are, however, difficult to transpose to the planning practice and the technical output of such approaches is rather poor (Domingues 2009). Likewise, studies specifically morphological, as (Moudon 1998; Levy 1999; Stanilov 2002; Stanilov and Case-Sheer 2004), using more empirical and systematic methods, adopt verbal inductive reasoning to extract conclusions from their data. These works produced insights on the dynamics of suburban morphological change, but their outputs are fundamentally descriptive and their operability is narrow.

It is our opinion that we should not expect to obtain stringent explanations for suburban form through discursive processes. Nor should we expect the panoply of 'parascientific'[8] construction indexes and zoning regulations to be sufficient to promote morphological coherence and spatial legibility in places where there is no clear previous urban matrix. Very least should we hope that, in the absence of some kind of structural guidelines, will private initiative guarantee this by itself (see Figure 2).

Contemporary suburban areas have been said to be 'chaotic', 'without structure', 'fragmented' and 'illegible'. Most certainly, these are suitable adjectives to qualify some of the general physical and spatial characteristics of these territories. But they don't help much when one needs to think what to do about them. If these new urban areas are chaotic and unstructured, we need to know what kind of structure is missing, where and why; if they are fragmented and illegible, we need to be able to quantify the real impacts of such patterns on urban functioning. Above all, we need to understand objectively the new morphological processes and their dynamics, in order to find new ways of planning this periurban fabric, knowing what we want to transform and what we want to keep. If taken

[8] In fact, as (Domingues, 2009) refers, no one even discusses if these indicators are adjusted to the study's object or if its construction is truly scientific or not.

literally, these goals are beyond the reach of traditional discursive techniques of morphological analysis.

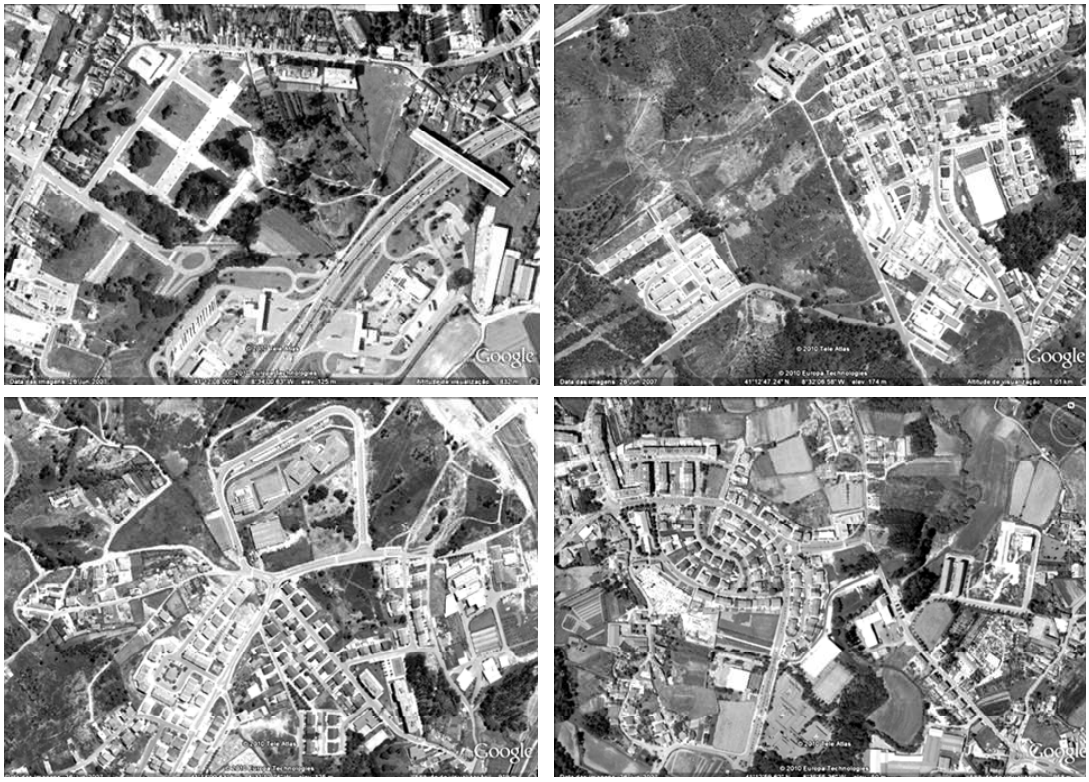


Figure 2. Private initiative allotments in Oporto's urban fringe. Note the individualistic and incoherent character of the several interventions, without any kind of strong global structure.

Here, we must make clear what is meant by *discursive* and *non-discursive* analysis techniques[9]. Discursive analysis uses verbal concepts in order to construct rational arguments about a certain object (in this case urban form). As such, its analytical outcomes are retrieved in the form of words, and only talk about what is conveyable by verbal concepts. Analysis is bounded by the scope of language. However, there are many phenomena that are non-discursive and for which there are no obvious verbal concepts capable of describing its characteristics[10]. In fact, the *structure* of urban spatial form is one of them. We easily say that a certain urban area 'is well structured' or is 'easily legible'; but, if asked to define precisely what we mean, we find a real difficulty in articulating a satisfactory answer. This is because urban spatial systems are very complex and their structural properties, although intuitively apprehendable, are not describable (at least not in a rigorous sense) by words: their nature is non-discursive. If we are to understand how cities are spatially structured and how that variable correlates with their functioning, we need non-discursive analysis techniques, that is, techniques that don't use discourse as a basis for morphological analysis.

[9] For an extensive discussion on this subject see (Hillier, 1996), p. 38-42.
[10] The objects of Mathematics and Physics, for instance, are predominantly non-discursive. This is the reason why these disciplines don't use discourse to explore them. History, on the contrary, is typically discursive, both as object and as discipline.

Since the seminal work of Lionel March and Philip Steadman (1971) the use of graph theory[11] has proved to be an efficient alternative to discourse, for the description of the morphological properties of architectural and urban form. Mário Krüger (1979) extended this approach further into the urban realm, modelling the relationships between built-form connectivity and urban spatial structure. These studies, among others carried out since then, contributed to the development of a new paradigm of urban form based on the concept of networks (or graphs), which has in the work of Bill Hillier (1984; 1996) and in his theory of *space syntax,* its more fertile and operative manifestations. More recently, and with relevance to this study, the work of Stephen Marshall (2005; 2009) brought this graph-based approach to the typological analysis of urban grids, providing new classification tools capable of avoiding the ambiguity and fuzziness characteristic of traditional classifications and making notable progresses towards an effective typological analysis of urban patterns.

The fundamental difference between these new morphological models and the traditional ones is the use of topology instead of geometry, as the main descriptor of urban form. Unlike geometry, which describes the absolute shape and scale of objects, topology only deals with the morphological properties of objects that remain invariable under *continuous deformations*, i.e. deformations like stretching and bending, which do not involve tearing the object in parts. In other words, from a topological point of view, what is important in an object is not its particular form, but rather the *intrinsic structure* of the form. As such, the network approach to urban morphology is more concerned in describing and analyzing the *structure* of urban form than its immediate geometric or visual qualities. Moreover, its outputs are largely quantitative, allowing for rigorous and systematic comparisons between the structures of different kinds of urban patterns.

This has an evident resonance with what we have said before, about the need to understand objectively the morphological shifts occurring in contemporary peripheral areas. Because of its non-discursive methods, thus aesthetically and ideologically neutral, the network approach to urban form seems to be a promising way of dealing with the morphological oddity of today´s peripheries, while avoiding the drawbacks of traditional morphological analysis when applied on that context. Here at CITTA, we have been following this path. In the next sections of this paper, we will expose the adopted methodology, our main previous findings and some new results of the on-going research.

2 Methodology

Our main objective of was to observe suburban growth in order to try to uncover the morphogenetic processes behind the apparent morphological disorder and structural randomness of these territories. We also sought to identify the specific morphological characteristics that made these urban areas so different from the traditional city and, apparently, so illegible and difficult to navigate.

We wanted to observe those processes at the micro-scale, but we also wanted to keep track of transversal phenomena across the urban fringe, in order to observe local and global trends. So we chose five study areas from Oporto's urban fringe and carried out a comparative study of them. They

[11] Graph theory is a branch of mathematics that provides a means of analysing the structure of relationships between elements. A graph is a set of discrete points joined by lines: this may be refered respectively as vertices and edges.

are the five civil parishes[12] with the highest urban grow rates in the last fifty years, from the five municipalities that surround the city of Oporto. Of course, parishes' areas are rather different as are they administrative limits, so we standardized them by defining a circular area (28, 3 Km^2) with 3 kilometers radius around each one. From now on, we will refer to this five areas[13] as A, B, C, D and E, as shown in Figure 3.

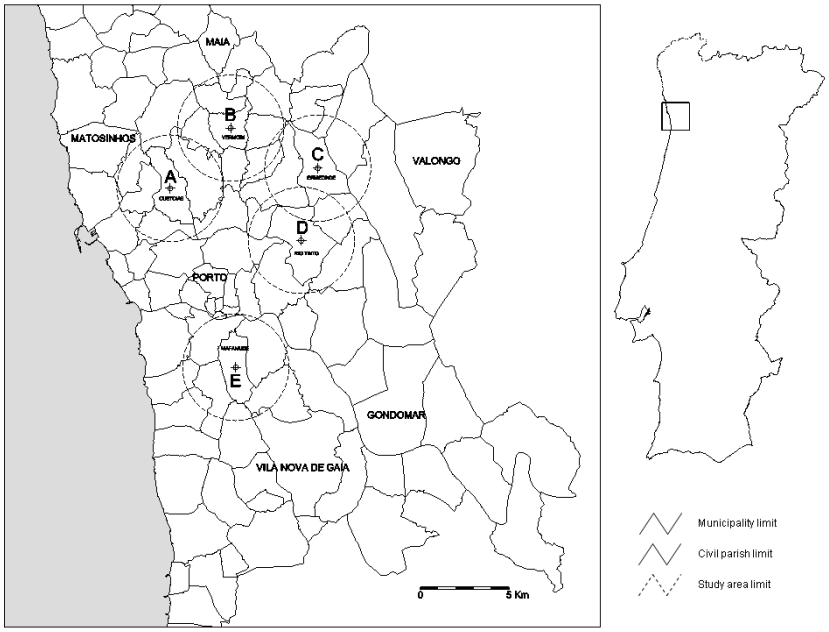


Figure 3. Study areas location on Oporto's metropolitan region.

Diachronic representations of urban form are extensively used for the observation of dynamic morphological processes. They allow comparison between different periods of urban development, turning clear the transformations between one period and the other. There are several methods to do this, from the simple observation and comparison of old maps to the more sophisticated use of GIS technologies to digitally superimpose cartographies from different periods. We used one of this methods, cartographic redrawing (Pinho and Oliveira 2009), in order to model the evolution of the street networks of the five study areas at four different periods, spanning the last fifty years of urban growth.

The option for studying exclusively the street networks, ignoring other aspects of urban form, has to do with practical and theoretical reasons. In practical terms, streets are much more reliable cartographic elements than individual buildings, i.e. its representation is less prone to error. Moreover, old cartographies usually show a gradual decrease in reliability towards the urban periphery (Koster 2003). Thus, in peripheral contexts, the cartographic redrawing of street systems is a more reliable exercise than the redrawing of other elements of urban form.

[12] The Portuguese system of territorial administration is divided, at the local level, in two tiers: the municipal level, and the civil parish level.
[13] The Portuguese names of the parishes are Custoias, Vermoim, Ermesinde, Rio Tinto and Mafamude, respectively.

Theoretically, if the street system is not the only element of urban form, it is certainly the largest and the one that holds all the others together in a coherent system. It has a topological property that sets it apart from all the remaining elements of urban form: it is mandatorily contiguous[14]. As Stephen Marshall (2009) notes, "this gives streets their significance for organizing urban layout, precisely because the streets all connect whereas the land parcels don't. […] In other words, the street network has a *strategic contiguity* relative to land plots." (Op. Cit. p.71, our emphasis). Streets are also urban structures far more 'perennial' than buildings, with higher resistance to change. Their impact on the evolution of urban form is therefore stronger and more relevant than that of buildings, as they act as a long-term constraint on subsequent changes (Whitehand 2001). Moreover, the morphological structure of street networks has been identified as the main determinant of urban movement flows[15]. Over the last two decades, innumerous studies emanating from the space syntax research field have provided evidence of this. In short, we could say that, today, the morphology of the street network seems far more important to urban function than the morphology of built forms.

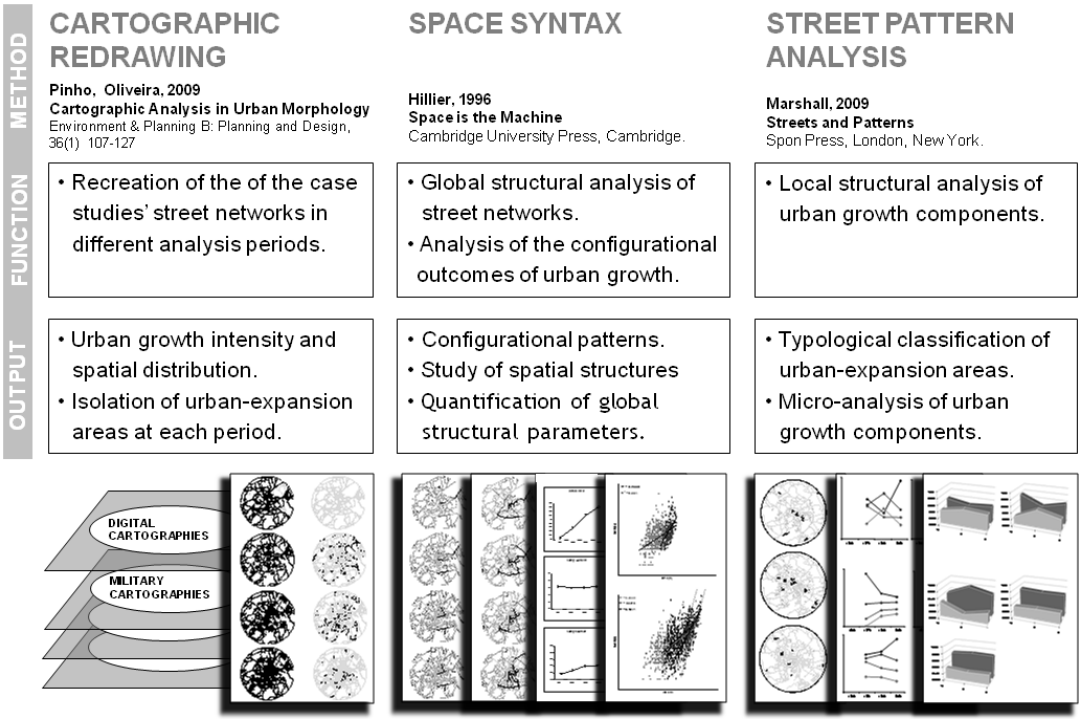


Figure 4. The research framework; each analysis technique was used for different research purposes with potentially complementary outputs.

Our research methodology was based on the concomitant use of three different analysis techniques: the aforementioned cartographic redrawing (Pinho and Oliveira 2009), space syntax (Hillier and

[14] Street networks are, by nature, contiguous networks, i.e. networks where there is only one component and every element is always connected to at least another one. There are no such things as streets where one can't access directly another street.

[15] For strong evidence of this fact see, for instance, (Penn et al., 1998; Hillier, Iida, 2005). For an extensive bibliography on the subject, please consult the Proceedings of the several Space Syntax Symposia, available at http://www.spacesyntax.org/symposia/index.asp.

Hanson 1984; Hillier 1996) and street pattern analysis (Marshall 2005). The idea behind this diversified research package was to explore suburban form through different 'analysis apparatus', whose outputs, although different, could provide complementary and synergic results (Figure 4).

Cartographic redrawing was used for the rigorous recreation of each case study's urban grid at each analysis period. These periods correspond to the publication dates of the cartographies used for that purpose, these dates being respectively 1950, 1975, 1995 and 2005. Hereafter, we will refer to these periods as 1P, 2P, 3P and 4P. The first three periods were described by digitalized paper maps[16] (scale 1:25 000), and the last by the current vectorial cartographies of each concerned municipality. The cartographic redrawing technique is, in itself, rather simple. It starts by the superimposition and georeferentiation, on a GIS platform, of a current vectorial map over a preceding raster map. Because the vectorial map is fully editable, it is possible to create a new version of it, subtracting all the elements that are not represented on the preceding map. By repeating this process with increasingly older maps, one is able to produce several 'snapshots' of the city form evolution. Moreover, current vectorial maps are much more precise than the old ones, making reasonable the assumption that, whenever differences are found between structures represented in both maps, one can trust and keep the current vectorial representation. Thus, it is not only possible to recreate several digital representations of the past planimetric form of the city, but also representations that are actually much more accurate than the existing ones.

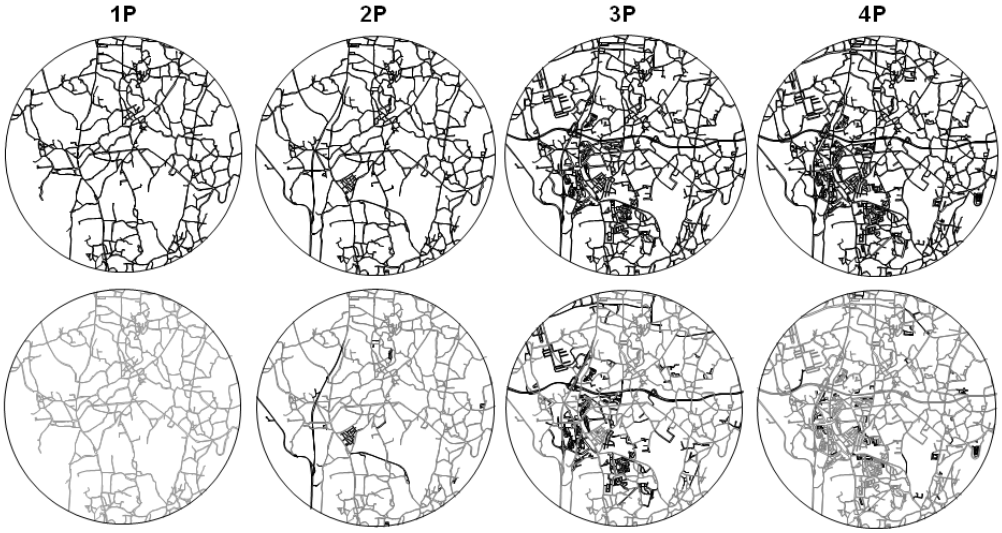


Figure 5. Example of the cartographic redrawing produced for each case study (here, case study B). Above, the grid in each period. Below, the respective urban-expansion areas.

Besides allowing for the recreation of the case study's urban grids, this method also presents an additional feature particularly important for this research. It allows for the rigorous isolation of urban-expansion areas, i.e. the set of all physical elements (streets, in this case) that were produced between one period and the subsequent. We have determined the intensity and the spatial distribution of urban growth by comparing these graphical sets between case studies and analysis

[16] Extracts from the Portuguese Military Map (edited by the Army Geographical Institute, IGE), covering the entire Portuguese territory.

periods. The cross-checking of that data with aerial photographs, also made possible its separation into the several individual interventions of each period, a procedure necessary to the subsequent study of their distinct morphological characteristics through street pattern analysis.

Space syntax was used to explore the overall morphological structure of the grids recreated by the previous technique, through their axial mapping. This is a way of converting the geometric complexity of urban space into a much simpler network of straight lines which, nonetheless, manages to capture its basic morphological structure. Axial maps (Hillier and Hanson 1984) are composed by the *minimum* set of line segments that are possible to draw over the open space system, such that every space[17] is at least crossed by one segment and every segment is at least connected to another one. Because it is the smallest of all the possible sets of lines constructed in this way, it is also composed by the *longest* lines that meet these conditions. In other words, an axial map can be said to represent a spatial system as the set of the longest lines of sight, or of straight movement, that the systems offers to a peripatetic observer. Once urban space is represented as an axial map, its topological structure (i.e. the simultaneous relations between all of its spatial elements), can be examined by means of graph, in which every line is represented as a vertex (or node) and every connection between lines as an edge linking those vertices (Figure 6).

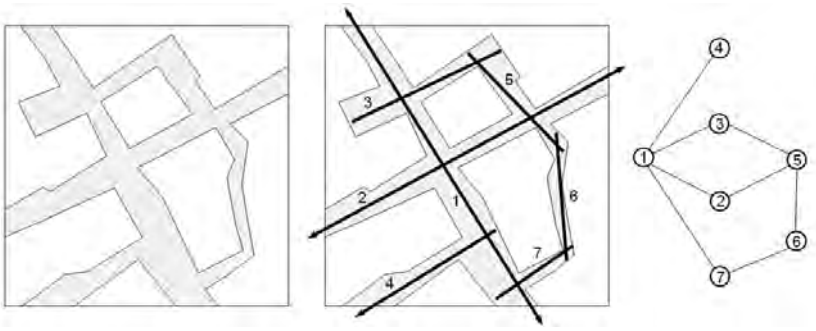


Figure 6. A fragment of a hypothetical street system (left), its axial line representation (middle) and the resulting axial graph (right).

Graphs have been used since a long time in the analysis of transport networks, including road networks. However, there is a crucial difference between the elements that are represented by the graph in this kind of analysis and those represented in syntactic analysis. In the case of transportation networks, the vertices are nodal points of the network (airports, train stations, road junctions), and the lines of movement between them are represented by edges. This form of representation suits the analysis of airline networks, or road networks when regarded at low resolution, where nodes are significant points of terminus and interchange. However, this convention is less effective for networks in which the movement channels themselves are the main focus of attention (as for the study of urban layouts). This can be illustrated by an example[18]. Although the layouts in Figure 7 would appear to represent quite different types in urban spatial terms, their conventional graph representations (junctions as nodes, streets as edges) can have exactly the same

[17] More precisely, every convex space. A convex space is such, that any line connecting two points of its perimeter, never intersects that perimeter. In other words, it is a space where any pair of its points are always visible from each other. It is considered in space syntax as the basic two-dimensional spatial unit.
[18] The example is taken from (Marshall, 2005).

topology (being represented by the same graph with the same number of links and nodes). Therefore, graph-theoretical indicators cannot express the particular form of the two lay-outs, which is exactly what would matter to the study of their morphology. However, if both layouts are first represented as axial maps and then converted into graphs, we can see as the syntactic representation successfully distinguishes these as different structures (Marshall 2005).

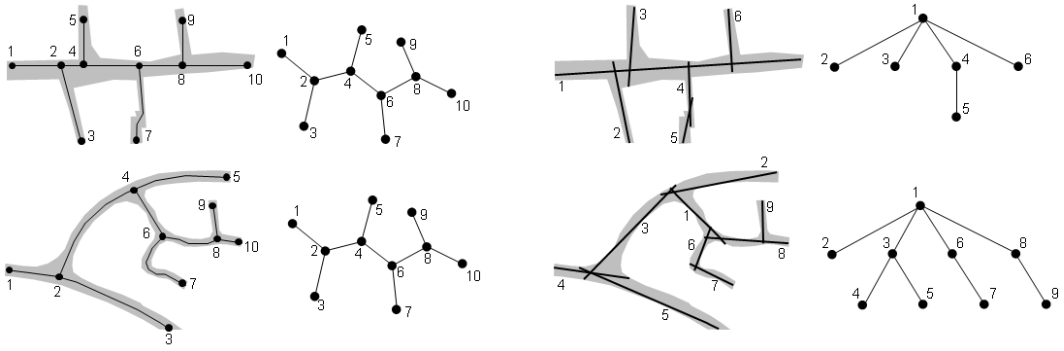


Figure 7. Two different street lay-outs, modelled with conventional graph representation of road networks (left) and with space syntax's axial representation (right). Adapted from Marshall, 2005.

By using axial lines as vertices, we are in fact encoding a pattern *of spatial relations* into the graph, because axial lines are one-dimensional representations of spaces (that are consistent insofar unobstructed sight and straight movement are possible along that line). Ultimately, what is being represented in the graph is the minimum number of changes of visual axis, or the minimum number of deviations from straight movement, that one must take to go from any point in the system to any other. Clearly, these are properties that are determined by the system's specific morphology. Yet, what is relevant to these properties is not the system's local form, but rather how its form is globally structured, i.e. how all its spaces relate to all the others, *simultaneously*. These simultaneous relations in a spatial system are what space syntax calls *spatial configuration*[19], and are exactly what the axial graph allows us to determine. In fact, defining how a vertex is located in relation to all the others is a common procedure in network analysis. Only, in this context, we do not talk about Euclidian distances, but rather topological ones. What is measured is the number of vertices one must pass in order to reach another one. This is called *depth* in space syntax. Calculating the depth of each vertex to all the others and summing up these topological distances, we obtain the vertex *total depth*, a measure of how deep that vertex is, *in relation to the system as a whole*. A small number indicates that the vertex (or the axial space) is *shallow*, i.e. on average, it is topologically close (or accessible) from the whole system. A high number indicates that it is *deep*, i.e. topologically distant and little accessible from all the others vertices. The total depth of a space is, therefore, a global measure and expresses an extrinsic property of that space: how it is embedded in the overall structure of the system. It is possible, of course, to compute this value for all the spaces, thereby obtaining a numerical quantification of the global accessibility of each one and, thus, the position of each one in the accessibility hierarchy of the system. But we can also represent this in a graphic manner, by ranking the axial lines accordingly to the values of their corresponding vertices (usually

[19] The configuration of a spatial system is a non-discursive morphological property.

using a color or thickness scale) on the axial map. This operation turns visible the structure of spatial accessibility of the street network, otherwise concealed in the much less visual patterns of mathematical values (Figure 8).

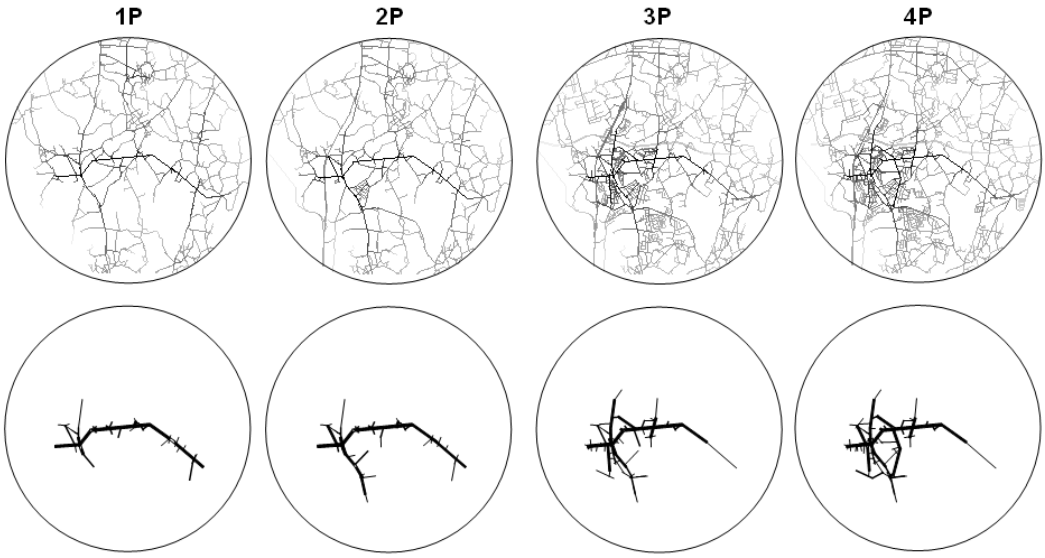


Figure 8. Example of the graphic representation of configurational patterns. Here, the evolution of global integration on case study C. Above, the general pattern. Below, a set of the most globally integrated spaces (here, the 10% most integrated), also called 'integration core'.

Space syntax uses several of such topological accessibility measures to explore the morphological structure of urban grids and its relation with urban socio-spatial phenomena, such as the spatial distribution of urban functions, the intensity or the type of spatial occupancy. Because of the largely quantitative nature of its analysis, its results are easy to compare statically with urban functional quantifications, such as land-uses, urban densities or movement flows. Particularly in the case of movement, the correlations have been found to be very significant[20], turning clear the role of urban form as explicative variable of the distribution of urban movement flows. At the light of this conjecture, the functional patterning that we observe in cities becomes an emergent phenomenon driven by movement: the product of the dynamics of a myriad of individual location decisions that seek (or avoid) urban movement flows, which are themselves dictated by the morphology of the street network (Hillier 1996). This fundamental relationship between the form of urban space and movement seems exists at the level of the global urban structure, and not so much at the level of local urban areas. And even more surprisingly, what seem to matter are not the total geometric properties of urban spatial form, but rather its deep topological structure.

Another major finding of the space syntax programme was the discovery of an additional structural property of spatial systems, be they cities or mazes, which seems to condition human spatial cognition and navigation abilities. Space syntax calls it *intelligibility,* or the degree of accordance between the local and the global structures of urban space, as expressed by the statiscal

[20] The measure known as integration (a normalized and generalized version of the mean depth measure) proved to explain up to 60% of the spatial differences in pedestrian movement rates and over 70% of those in vehicular movement rates (Penn *et. al.*, 1998)

correlation between local and global topological measures. The argument is as follows. When we navigate urban space, we are not only gathering information about the local spatial structure that we are perceiving directly, but we are also making assumptions about how that local structure is positioned on a more global dimension, which properties we cannot locally grasp. We do this by following consistent variations in the information available locally, which can give us clues about the global importance of each local area (e.g., the presence or absence of people or the prevalence of the different urban uses). As mentioned before, these are characteristics that are determined mainly by the way urban space is globally structured. It follows from this, that if the correlation between the two spatial levels is low, that kind of assumption will no longer be true, because global information will no longer be available in the local dimension. Locally important spaces will have no global relevance, and vice-versa. This conjecture has been extensively explored in empirical studies, with results showing that the parameter of syntactic intelligibility is a reliable indicator of the degree navigability, or cognitive appropriability, of a determined spatial system (Penn 2001). Also, this parameter has a particular importance to the present study for, as mentioned before, one of the most disturbing aspects of contemporary suburban areas, are their disrupted and labyrinthine urban grids.

We have made a broad syntactic research of each study area in each analysis period, using several kinds of analytical procedures, including integration pattern analysis, intelligibility analysis and the quantification of several syntactic structural measures. The evolution along time of the results of these analytical procedures, allowed us to draw conclusions about the configurational impacts of the urban growth patterns modeled by cartographic redrawing. These are global impacts, measured as variations on the global structure of the studied grids, whose effects we can estimate at the light of space syntax theory. And yet, as we have seen before, urban growth is not a global spatial phenomenon (happening everywhere and at the same time), but a rather local and discrete one, composed by many individual interventions (the ones isolated before) occurring at some moment in time. As such, the configurational outcomes of urban growth are also *emergent effects*, arising from local transformations of the grids occurring in a discrete manner. These are, for the most part, non-programmed interventions, varying in size and spatial distribution.

The next analysis technique, street pattern analysis, was used to clarify this relationship between these micro-components of urban growth, constructing the grids along time, and the emergent global effects that they produce, which have an impact on the global functioning of the area as a whole. We used some of the several analytical techniques proposed by Stephen Marshall (2005) in his book “Streets & Patterns”, to classify and quantify the micro-morphology of grid types. For simplicity, we have called these techniques ‘street pattern analysis’ (based on the title of the book and on its more recurrent concepts)[21]. The advantage of these new analytical tools is that they use a topological approach to grid typology, so producing results that are consistent with those of space syntax.

Stephen Marshall’s book is mainly concerned with two fundamental questions: how to classify street pattern types in a consistent and systematic way and how to distinguish quantitatively their particular morphological characteristics. Altogether, the book introduces a vast analytical framework

[21] We should stress, however, that this is just a personal choice and that nowhere in the book the author refers to his methods using that expression.

that goes far beyond the use that we give it here**.** But the general purposes of following some of its methods were the same: to classify the individual urban interventions identified by cartographic redrawing and to quantify some of their morphological characteristics.

As mentioned before, the cross-checking of the graphic set of urban-expansion areas of each period with current aerial photographs made possible the further individualization of this set, by comparing the morphology and visual characteristics of the built space (as type and color of roofing, architectural characteristics, etc). Suburban development happens much more by the addition of new structures than by the erasure of old ones, thus, in the current photographs, all the spatial structures of the earliest period are present, associated with buildings that are much older than that. So, the individuality of further developments is easy to distinguish.

Given the formal diversity of each individual intervention, their classification would have to be simple, yet sufficiently comprehensive. In his book, Marshall dwells on the problem of morphological classification of urban lay-outs, reaching an integrated taxonomy of street patterns based on their topological configurations. We have looked at two basic topological properties mentioned therein: the internal configuration of each individual intervention and the external configurational relationships it establishes with the previous grid. Internally, expansions were classified as linear or cellular and externally, as connective or tributary, making a total of four possible combinations (Figure 9).

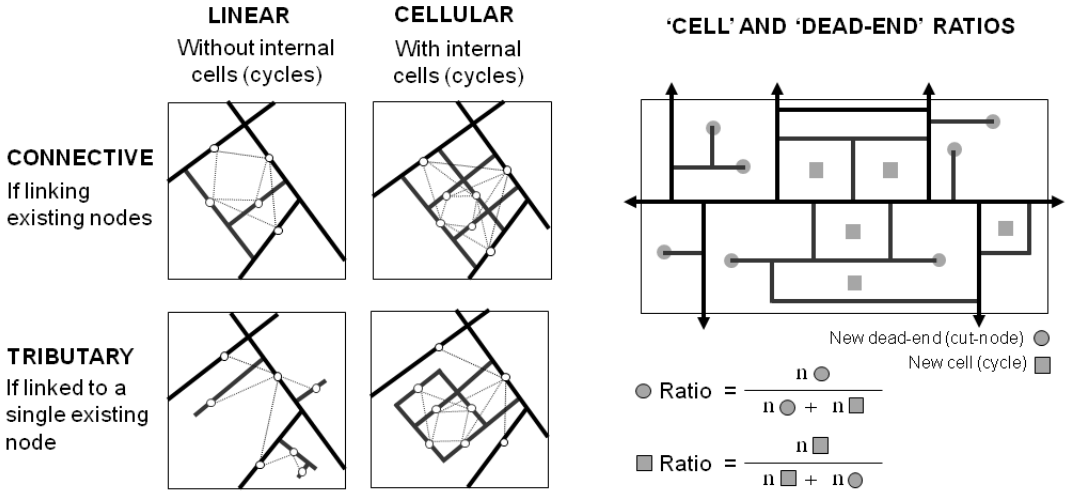


Figure 9. The morpho-typological classification system of the individual grid interventions (left). The 'cell' and 'cul' ratios, as defined by (Marshall 2005) (right).

Linear expansions don't contain cycles, that is, they are simple nodes, or sequences of nodes. Cellular expansions contain internal cycles. Connective expansions link existing nodes, thus creating new cycles. Tributary expansions link themselves to just one existing node, without creation of new external cycles. For each analysis period, we classified as such each identified individual intervention and made an accounting of their relative quantities.

The internal characteristics of each intervention (linear or cellular) are rather easy to establish. Externally, however, most interventions are not so purely connective or tributary, although this

criterion was shown to be effective if used with some degree of freedom[22]. To cope with this possible bias we used another method proposed by Marshall in his book. This author defines two simple morphological parameters for measuring street pattern configurations. Given the number of internal 'cells' (graph cycles) and 'culs-de-sac' (graph cut-nodes) in a planar graph representation of a street network, it is possible to establish a 'cell ratio' and a 'cul ratio', as proportions of the total number of internal cycles and cut-nodes. In a pure tributary lay-out (a tree, without cycles) the cul ratio will be one and the cell ratio will be zero. Conversely, in a pure cellular grid (without cut-nodes) the cull ratio will be zero and the cell ratio will be one. More generally, in real life mixed situations, the values will vary, the sum of both also being one (Marshall 2005). We used the same basic principle, though with slight modifications (Figure 9). We were interested in quantifying the morphological composition of each growth period (and not of each individual intervention), as represented by the set of its urban expansion areas. The idea was to obtain global values for the growth pattern in each analysis period, representative of how much of it was 'connective' and how much was 'tributary'. These values would serve as morphological indicators *per se* and also as benchmark values to control the typological quantification explained before. For the set of all urban-expansion areas in each analysis period, we counted (on the axial map) the total number of new cycles and new cut-nodes created[23]. With these values, we calculated the two ratios mentioned before, only now reflecting the morphological composition of each period's total urban growth.

This incursion into street pattern analysis was intended to complement with a finer grained analysis, the exploration of the global structure of the street networks provided by space syntax. We used the three analysis techniques in a sequential and systematic way, on the five case studies. The data produced was then analyzed comparatively. In the next section of the paper, we will review the results of each analysis techniques and explore their potential complementary outputs.

3 Results

The three analysis techniques adopted, for each case study at each analysis period, produced a huge amount of data, which was reported in an exhaustive manner elsewhere (Serra 2008). Also, previous results of this research have already been published once (Serra and Pinho 2009). Therefore, in order to avoid repetitions and for the sake of pertinence, we will present here our previous results and some new data in a more selective and critical manner.

Our general finding was the evidence of clearly differentiated patterns of morphological change between the study areas. These differences were not expected, at least not in a so marked way, because all case studies are located within a 10 Km radius from the center of Oporto and locally are considered as similar nearby suburbs. However, the results of the several analysis techniques showed a clear differentiation of the case studies in two groups, with distinct morphological characteristics and evolution patterns. As we shall see, not only are the results of each technique

[22] For instance, some cellular interventions have an extremely tributary character (and as such were classified), showing many cycles isolated from the surrounding network, even though they are externally connected with two existing nodes and not just one. In the same way, although creating new links in the network, some connective interventions can come with some tributary appendices.

[23] But not counting previous cycles, e.g. if a connective intervention divides a former single cycle into three cycles, the count of the new cycles will be two. Also, we have only counted new cycles with more than three nodes, for cycles with length three are mostly trivial cycles, i.e. typically caused by the manner and convention by which axial maps are drawn and not by actual grid conditions.

consistent, but they also reinforce each other, showing that, in spite of their seemingly uniform disarray, we should not look at these territories as devoid of morphological differentiation.

The street networks of the first period of analysis (1P), as represented by the redrawn maps, show a relative low street density and a prevalent pattern of sinuous and narrow roads, with large non-public spatial islands, characteristic of rural road networks. These are the original spatial matrices over which urban growth will occur. With the exception of case studies D and E[24], which already show at 1P some small grid condensations of urban characteristics (much smaller and more regular spatial islands with greater road density), all the other case studies show that general pattern (Figure 10).

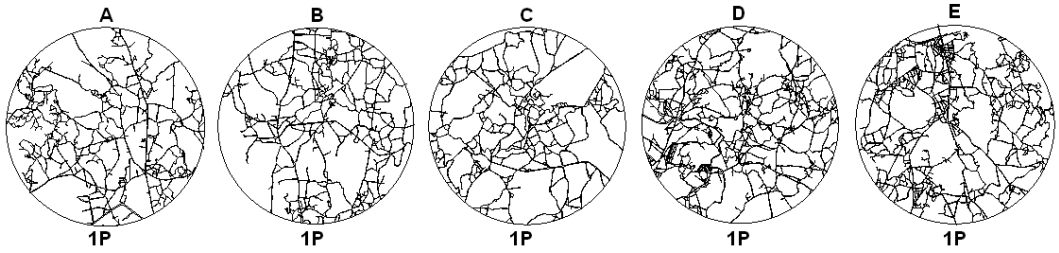


Figure 10. The street networks at 1P.

We have measured urban growth intensity by comparing the number of axial lines describing the redrawn street networks of each period, which is proportional to road density. Starting from different density levels (with density decreasing with increasing distance from the central city), all case studies show the same growth rate, with a maximum intensity phase[25] between 2P and 3P. Most of the transformations that the grids have undergone happen during this period.

An urban growth compacity index (measuring its concentration) was constructed by counting the individualized grid interventions of each period contained within a circle with half the study area[26], centered therein. This number was then expressed as a proportion of the total number of grid interventions in each period. For values above 50%, urban growth was considered concentrated; for values below that threshold, dispersed. The results show a clear differentiation in the spatial distribution of grid expansions. This is not constant along time. There are periods of concentration and others of dispersion in the same study area. However, during the period when urban growth is more intense (2P/3P), case studies A, B and C show a clearly concentrated pattern, while case studies D and E, a strongly dispersed one (Figure 11).

[24] These case studies are there nearest to the central city, and thus had an earlier urban development.
[25] Corresponding to the urbanistic boom which Portuguese cities suffered between the 70' and the 90'.
[26] Radius = 1,5 Km; area = 7,1 Km^2

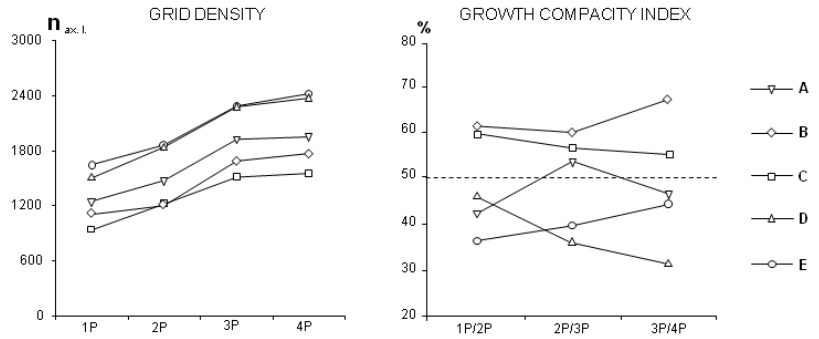


Figure 11. Evolution of grid density and growth compacity index.

Looking at the final period grids, it is possible to discern some of the effects of such differentiation in growth patterns (Figure 13). Case studies B and C (and, to a certain degree, also A), evolved from dominantly rural grids to grids characterized by a dense, urban central core, and a sparse and still rural surrounding area. In these cases, distinction between urban and rural components is rather clear. However, case studies D and E evolve into a kind of hybrid grid, with no clear distinction between rural and urban components (Figure 12).

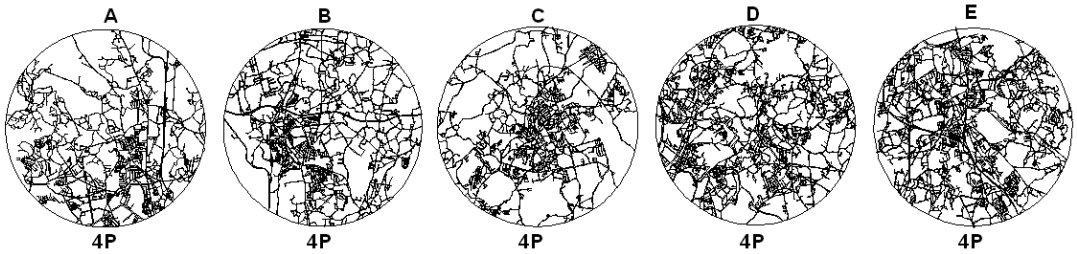


Figure 12. The street networks at 4P.

The space syntax results, in addition to providing new findings, showed that these differences between case studies were also present at the configurational level. At 1P, the initial rural grids showed integration patterns characterized by general segregation (low integration values), meaning low movement permeability and low general accessibility (Figure 13). Moreover, there are very few integration inequalities, i.e. hierarchical differentiations between grid spaces. Except for case study E, which shows a centre with some structure at this phase, the other initial grids are dominated by a few integrated long lines, corresponding to more linearised road structures (which are, for the most part, segments of old radial roads linking northern and southern towns to Oporto).

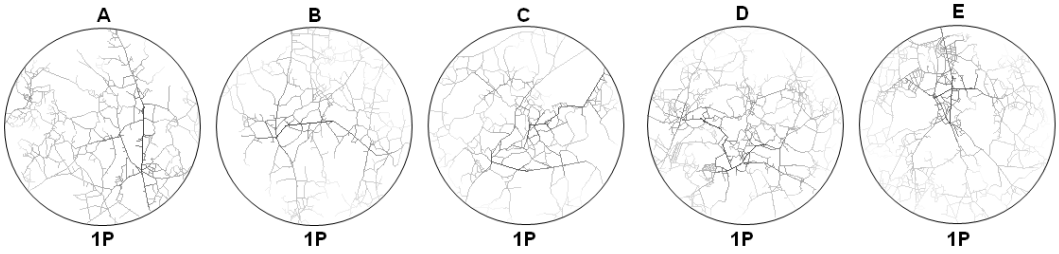


Figure 13. The global integration patterns at 1P.

In practical terms, this implies that movement would tend to be dispersed evenly in the network, becoming rarified. The topology of the rural grid do not favors any particular route structure, apart from a few more integrated spaces with distinct morphological characteristics (more linear). This seems to be exactly the contrary to what happens in urban street networks. There, a complex structure of more integrated routes, usually radiating from the urban centre and carrying most of movement flows (thus, attracting movement dependent functions) form a kind of super-grid, allowing easy access from the periphery towards the centre of the system and vice-versa. In the interstices of this core network, lie more quiet and less integrated spaces, yet with easy access to it (Hillier and Vaughan 2007). Our results show that the initial rural grids totally lack this kind of structural organization, which is the hallmark of functional urban environments. Therefore, that particular kind of structure will have to be *constructed* along time by urban growth, whether in a planned or unplanned way.

Looking at the final global integrations patterns (Figure 14), we can see case that the case studies in which concentrated growth was dominant (B, C and to a lesser extent also A), produced cohesive urban zones with complex integration cores and clear spatial hierarchies. While in the cases were dispersed growth prevailed (D and E) we observed the stagnation, or even the dilution, of previous spatial hierarchies and a clear loss of structural differentiation between grid spaces. In spite of the intense grid transformations, and even if mean integration values kept increasing along time in all cases, in case studies D and E the dispersed growth pattern was not able to alter significantly the undifferentiated spatial character of the initial rural grids.

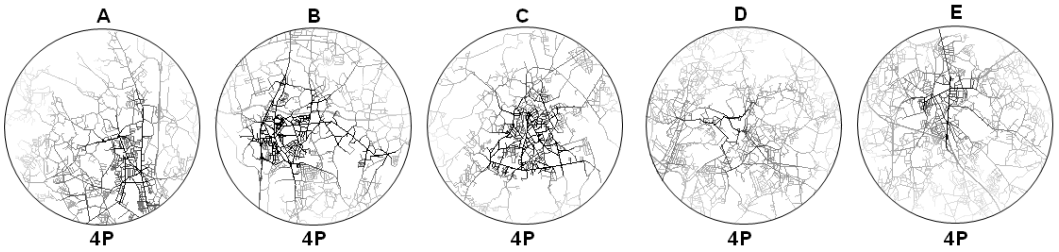


Figure 14. The global integration patterns at 4P.

The numerical quantification, in each period, of nine syntactic variables describing different global structural properties, showed other interesting patterns of morphological evolution. These have been described extensively elsewhere (Serra and Pinho 2009), so here we will just stick to the most

relevant results. As mentioned before, the structural property known as syntactic intelligibility, as proved to be a reliable indicator of a spatial system's navigability by humans. This property is central in the space syntax theory of the city, being claimed as an explanation for the morphological regularities that have been identified in cities all over the globe in the more varied cultural contexts (Hillier 2001). As such, it is also of the utmost importance to this work, because suburban contemporary areas have been qualified not only as 'labyrinthine', but also as 'non urban' (at least when compared to the traditional city).

The evolution of the intelligibility values of the case studies showed an unexpected, yet very relevant result. We have quantified the values for *global intelligibility* and *scale synergy*, these being the correlation coefficients (R^2) between the values of connectivity and global integration and between local and global integration, respectively. Both are correlations between the local and global properties of space. The evolution of these values for each case study is expressed in the charts of Figure 15. A profound difference regarding the evolution of the systems' syntactic intelligibility is noticeable, as case studies A, B, and C present increasing intelligibility values, while case studies D and E, show a sharp decrease during the period of most intense growth. The initial values are all low and close to each other, adding low intelligibility to the rural grid characteristics identified before. However, in case studies A, B and C, urban development manages to invert this situation and to raise the values considerably. Rather, in case studies D and E, in spite of an initial increase and the continuous and intense growth, the values end up at the initial level.

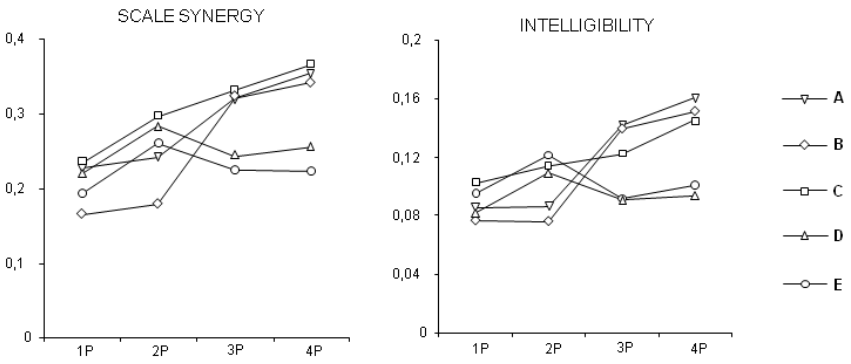


Figure 15. The evolution of scale synergy and global intelligibility values.

Such a differentiated behaviour means that there are qualitative differences in the morphological construction processes of the studied grids. If suburban contemporary areas are marked by their labyrinthine character, these results show that some of the case studies were losing that character and becoming more intelligible along time, while others were getting worse. Likewise, some had a true urban development process, increasing the intelligibility of the previous rural grid; while the others have grown into something different, perhaps less urban, with an intelligibility level similar to that of the rural grid, even if much more denser and developed.

It is important to stress that these results refer to the global structure of the street networks emerging from urban growth, which is fundamentally a local process. Therefore, the results are also describing *emergent global effects*, arising from discrete individual interventions acting at the local

scale through time. In other words, the morphological causes for these effects must be sought at a lower level, that of the micro-components of urban growth.

And, in fact, what seems to be producing these intelligibility differences are the typologies that, in each period, contribute to grid construction. Figure 16 shows the results of the quantification of these typologies, compared with the evolution of the intelligibility and synergy values for each case study. Again, the division of the study areas in two groups is rather evident. In the first group (A, B and C), connective expansions are always prevalent over the tributary ones. However, in the second group (D and E) during the period of most intense growth, the tributary types overcome connective ones. One can say that the first group has a permanent connective grid construction, while in the second group grid construction becomes predominantly tributary during the period when most of the grid is produced. This seems to have a clear relation with the evolution of the system's intelligibility. As we can see from the charts in the middle and lower rows Figure 17, it is exactly during the period of most intense growth, when tributary forms overcome connective ones (case studies D and E), that the values of intelligibility and scale synergy plunge. In other words, there seems to be a direct correspondence between the prevalence of tributary forms and intelligibility decrease.

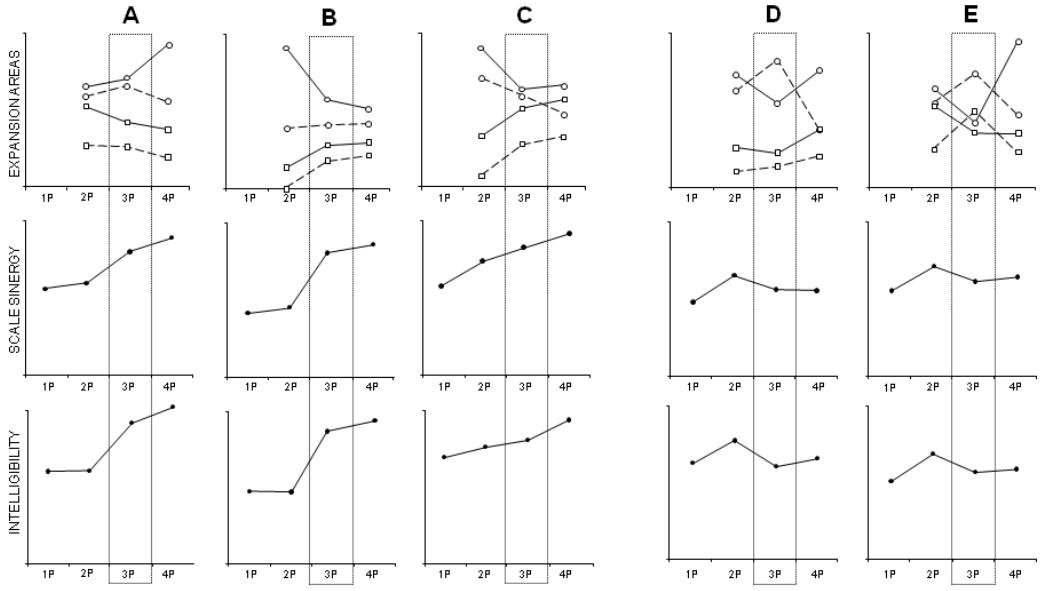


Figure 16. The relation between grid morphological types and intelligibility.

The quantification of the two ratios explained before, measuring the relative proportions of new cycles and new-cut nodes in the urban growth of each period, is consentaneous with the previous results. In case studies A, B and C the creation of new cycles is clearly prevalent over the creation of new cut-nodes, while in case studies D and E, the relation between the two ratios is more balanced. Moreover, in these cases, during the period of most intense growth, the creation of new cut-nodes surpasses the creation of new cycles. In addition to confirming the typological quantification data, these results show us that the case studies of the first group were getting more

cyclic (or more grid-like) along time, while the second group was getting acyclic (or more tree-like), specially at 2P/3P (Figure 18).

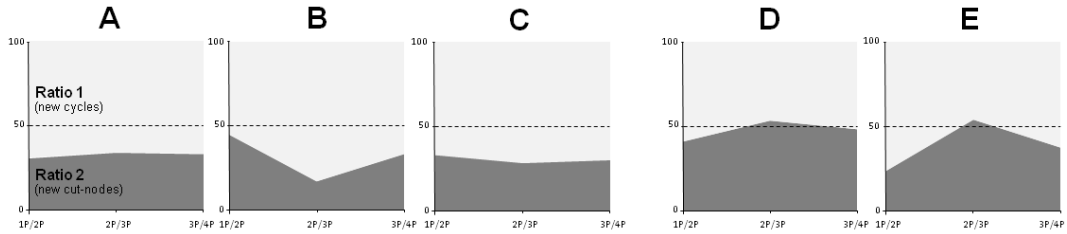


Figure 17. Quantification of new cycles and new cut-nodes ratios.

The values of these two ratios have provided further evidence of this strong relation between grid typo-morphologies and syntactic intelligibility. They are clearly correlated with the variation of intelligibility values (global intelligibility and scale synergy), that is, the value of each period subtracted by the value of the previous period. In Figure 18, we show the correlation with Ratio 1, that is, the ratio of new-cycle creation, showing that the more cyclic a grid gets the more intelligible it becomes. Of course, because both ratios are complementary, the correlation with Ratio 2 would be the same, only negative.

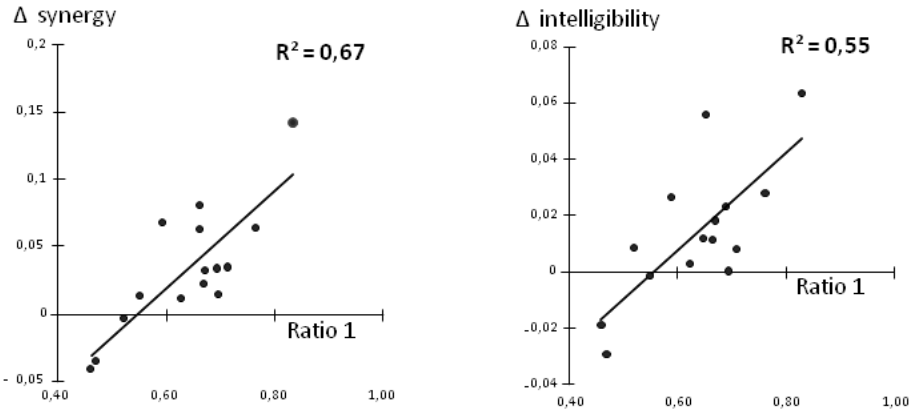


Figure 18. Correlation between Ratio 1 and intelligibility variation values.

Throughout this last section we have seen how the adopted methodology was able to produce a different morphological picture of suburban development, one that is not based on its odd superficial characteristics but rather on its deep structural organization. These results seem important, because they clarify the relationship between the local processes that constructed these grids along time, which are (for the most part) non-programmed individual interventions, and the emergent global effects that they produce, which have an impact on the global functioning of the areas as a whole.

4 Conclusions

Contemporary suburban areas present an analytic challenge to urban morphology. Seen through the lenses of classical morphological theories they seem a perversion of 'good city form', hopelessly disjointed and nonsensical. This critical bias has conducted to a general paucity of knowledge on what concerns their objective morphological characteristics, and to excessive generalizations of their potential flaws. We need to invert this state of affairs, exploring new analytical techniques and methodologies, capable of coping with the formal complexity of today's suburban areas. This work has provided a step in that direction.

Our findings provided evidence of different suburban growth patterns with different configurational outcomes, namely clear intelligibility inequalities between the study areas. Although they can be felt on the several studied environments, these morphological differences exist at a deep and structural level of urban spatial form, and their formal identification is inaccessible to traditional analysis techniques. Nonetheless, they ought to be taken into account when deciding how to intervene there. Thus, a general output of this research, is the recognition of space syntax as a highly relevant tool for the study of contemporary suburban morphology, producing results capable of informing in a more reasoned way the planning practice in these areas.

Albeit determinant to the functioning of the studied areas, for the reasons mentioned before, these configurational differences refer to their global spatial structure. Obviously, these global structures did not come into being all at once, but were instead constructed over time by urban growth. As such, they are also emergent structures produced by many local interventions (promoted by private initiative, for the most part), following their own local logics.

Cities are problems of organized complexity, as Jane Jacobs (1961) first stated in a such enlightened way. They are complex systems by nature, made of many parts in dynamic interaction, leading to the emergence of structures that are not properties of those individual parts. This is particularly so in regarding to the development of urban form, as we have seen. But looking at today's suburban areas, the question that arises is: how can we handle, if not in a 'haussmanian' manner (today not very popular), such uncontrolled and apparently unpredictable processes?

Complexity science (Waldrop 1992) has shown that it is sometimes possible to generate ordered patterns emergently or, in other words, to produce order that is not planned[27]. In recent years, this has been brought to the urban theoretical field with very promising results (Batty 2007). As Michael Batty puts it, "the challenge is to dig below the surface and detect the processes that generate what we see" (Op. Cit. p.4). Stephen Marshall (2009) has been occupied in translating these findings to the urban practical agenda, exploring how we could use the understanding of emergence and self-organization to assist the generation of urban spatial lay-out, that is, how could we use local rules (instead of imposing a pre-defined macro structure) in order to achieve desired global patterns. In this work, we have also made a contribution in this sense, in demonstrating the existence of a strong relation mediating the local morphological properties of the micro-components of urban growth, and the global structure of the street systems, produced by them over time.

We have seen how areas where urban growth was predominantly dispersed and non-connective evolved into hybrid grids with low intelligibility values. And we have also seen that

[27] In fact, nature has been showing this since ever.

concentrated and connective growth led to urban and intelligible grids. If we take syntactic intelligibility as an urban quality *per se*, as space syntax's theoretical *acquis* does, it becomes clear that our results point some clues to how we could plan suburban areas from the bottom-up, i.e. creating regulations at the very local level that would have positive impacts at the global level. In fact, both concentration and pattern prescription are parameters not difficult to introduce in public policies. The first, moreover, is already currently pursued in many situations. The second not so much, because the debate on the qualitative properties of urban patterns has been producing, until recently, rather inoperative conclusions. However, as Marshall (2005) argues and we have tried to show, this is not necessarily so. Our results point to the possibility of establishing basic morphological prescriptions for patterns of urban grids that, if generally followed, would lead to the emergence of intelligible urban systems. The patterns that we are talking about are defined at the lowest level of their morphology, that of their inner and outer topological relations. This avoids the difficulties in implementation that morphological prescriptions suffer, unless they are compulsorily implemented under a general master-plan. To promote a predominantly connective grid construction, shunning the tributary type, would not be difficult, both through planning instruments, and through the collaboration with agents of urban change. Therefore, as a technical output of this research, we would recommend that public policies should add to their concerns on urban dispersion, those on urban connectivity at the micro-scale.

Gone are the days when planning practice intended to control each variable of an urban system and to capture the solution on a blueprint. The excessive positivism of such stance was quickly recognized, and planning theory became more interested in the planning process itself, with the indirect effect of relegating urban form to a secondary role, as an uncontrollable variable (or even irrelevant) of the urban phenomenon. This then changed, when the debate on urban sustainability gave a new impulse to the study of city form. Perhaps now we should start thinking that, after all, the blueprint could even not be needed; for 'good city form' would emerge by itself, if only we could understand clearly, and thus promote, the processes that give rise to it.

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Part 2. Planning and Environmental Assessment

Urban form and daily travel; non-motorised transport in Trondheim examined by combining space syntax and GIS-based methods

Bendik Manum, **Denis Voisin**

Norwegian University of Science and Technology, Department of Architecture and Fine Art, Trondheim, Norway bendik.manum@ntnu.no Phone: 00 47 73595057

Norwegian University of Science and Technology, Department of Energy and Process Engineering, Trondheim, Norway denisv@stud.ntnu.no Phone: 00 47 73598950

During recent years, approaches ranging from preventive medicine to carbon emission cut have shed critical light on our car-dependant societies and pointed out a need for focusing on non-motorised transportation. This paper is based on a research project related to future development of the Brøset-area in the city of Trondheim, Norway, and presents methods of analyses as well as results concerning urban form correlates of daily travel, particularly focusing on walking and biking. By comparing the results of space syntax analyses with empirical data of peoples' daily travel routes, this research project illustrates the potential of the recently developed space syntax parameters "choice" and "angular change". Further on, by combining space syntax methods with GIS within the frame of the Place Syntax software, we illustrate how complex aspects of urban form such as peoples' accessibility to daily destination can be analysed and made operational to real planning and design. Finally, we are carrying out a statistical modelling looking for correlations between daily travels of 5000 peoples in Trondheim and a set of urban form variables that according to recent research should be decisive to daily travel behaviour. Thanks to extensive surveys provided by the local authorities of Trondheim, socio-economic and others confounding factors are also taken into account. In addition to present useful methods of analyses, our study shed light on how different aspect of urban physiognomy influences amount of non-motorised daily transportation as well as peoples travel routes.

Keywords: urban form; space syntax; travel behaviour; walking; biking

1 Introduction

Non-motorised transportation is the oldest and most basic form of transport and compared to other modes of transportation it is advantageous for numerous reasons; it has positive impact on health, it causes no pollution, it requires no fuel but normal nutrition, it has negligible amount of accidents (unless being exposed for motorised vehicles!), and last but not least: non-motorised transport are the modes of transport associated with cities that are attractive in terms of culture, retail and diversity of urban daily life. Litman (2009) criticises that transportation seems to be ranked by speed; the faster the transport the more important it is. He argues that the situation is the opposite where it comes to urban life; due to "amount of exposure" to street environment caused by the low speed of walking, walking is superior to other modes of transportation when it comes to provide potential for commerce and activity in the cities. Despite the advantages mentioned above, non-motorised transportation is a field with short history of research or scholarly knowledge. Even today, most planning and design concerned with transportation is about catering for obstacle-free movement for the private car and supplementing this with public transportation in the situations where private cars are not useful. Interest in non-motorised transportation has been about handling conflicts against motorised transport, rather than about walking and cycling's potential for replacing and reducing amount of motorised transportation. However, based on approaches ranging from preventive medicine (Brennan Ramirez et al. 2006) to pollution and carbon emission cut, criticism of our car-dependant societies has increased and non-motorised transportation has become of larger interest. This interest

is a background for the ongoing research project “Brøset, towards carbon neutral settlements” in the city of Trondheim, Norway, - a research project on which this paper is based.

After describing the overall methodology, this paper consists of three main parts. The first part explains some new space syntax based tools for modelling and analysing urban form, the second compares results of these analyses with empirical data of peoples’ real travels, whereas the third part presents methods and some results from a statistical study of urban form correlates to modes of daily travel. By this, we hope to contribute to methodological development within this research field of urban form and transportation as well as to provide some explicit knowledge about urban form and non-motorised transportation.

2 Background

2.1 Urban form and transportation

A basic issue within the evolving interest in non-motorised transport is what makes people walk and cycle, - or seen from an architectural or urban design point of view: how do we plan and design cities where people walk and cycle more than what is usual in cities planned and built during the last century? A consequence of non-motorised transportation being a new field of scholarly interest is that the knowledge is rapidly developing rather than being well established and fixed. This implies that statements of relevant research are diverse and some time contradictory. Cervero & Kockelman (1997) examined how walking is related to “the 3Ds: Density, diversity, and design”, whereas Lee & Moudon (2006) argue that “several of the variables commonly believed to be important for walking were not significant” and entitled their paper “The 3Ds+R” where they have replaced “diversity and design” from Cervero and Kockerman’s paper by “destination and distance” and where the added “R” represents “route to destinations”. They characterise “route” by the parameters “block size” / “length of sidewalks” and by “directness” to important destinations such as grocery stores, schools and eating/drinking-places. Before going into the methodology and details of the research on urban form and transportation, it is important to remember that non-motorised transportation is not one phenomenon. As pointed out by for instance Schlossberg et al. (2006), biking and walking must in many cases be handled as two phenomenons. This is due to basic differences of the two; cycling distances can be much longer that walking distances whereas walking is far more robust than cycling concerning the quality of pavement/street-surface, steep terrain and the geometry of curves and crossings. Going more into detail, there are also different perspectives on cycling Haake (2009) and Forester (1992) argue that separate cycling lanes are unsafe and that cyclists should operate in the traffic almost as if they were motor vehicles, whereas Pucher and Buehler (2009) point out that cyclists are of very different kinds and that very different kinds of layout are therefore needed. In our ongoing research we examine differences between modes of non-motorised transport, whereas in this paper we only focus on a selection of overall results.

Regardless of the fact that non-motorised transportation is of different kinds, there are some aspects related to urban planning and urban form that most researchers consider important (Thomsen and Manum, 2009). Among these are “population density”, “land-use mix”, accessibility to daily destinations such as school or retail, and basic features of the “street-network” such as “street connectivity” or “grid-density”. (Brennan Ramirez et al. (2006), Lee and Moudon (2006) and

Schlossberg et al. (2006)). This paper deals in particular with modelling and analysing the parameters of the street-network that according to research should be relevant for amount of non-motorised transportation.

2.2 Space syntax as a tool for studying urban form and modes of transportation

Space syntax is a field of architectural research where useful methods for studying spatial configurations have been derived from a consistent theoretical framework. Fundamental in the development of space syntax is the work of Bill Hillier and Julienne Hanson at the Bartlett, University College London (Hillier and Hanson (1984), Hanson (1998) and Hillier (1996)). Extensive studies have shown that analyses by space syntax methods correlate convincingly to numerous aspects of complex phenomenon taking place in urban space, phenomenon ranging from amount of different kinds of traffic, location of retail or frequency of burglary. Pedestrian movements but also cycling are modes of transport where space syntax methods are particularly useful (Hiller (1996, p.164), Hillier and Iida (2005) and Raford, Chiaradia and Gil (2007)).

Concerning space syntax theory and methods, this paper focuses on the application and development carried out in our research project. For those not being familiar to space syntax, some further reading would be useful. About historical development as well as recent state of space syntax research, see for instance Hillier and Vaughan (2007). For a summary of basic theory and methods, see for instance Manum (2006, p.66–81). If being interested in particular issues or details of the extensive amount and variety of research carried out within the field of space syntax, see the proceedings of the biannual space syntax symposia where the two most recent are http://www.spacesyntaxistanbul.itu.edu.tr/papers.htm or http://www.sss7.org/Proceedings.html.

A basic kind of space syntax analyses is the “axial-line analyses” that consist in analysing “axial-maps” where urban space is modelled by straight lines that either are connected or not connected. Until recently, “axial-line” has been the kind of spatial syntax modelling and “integration” has been the space syntax parameter usually applied in space syntax analyses of urban space in the cases where movement or traffic are the issues of interest. Integration calculated within different “radii” has shown to correlate to different kinds of movement (van Nes, 2002). This is partly due to the fact that space syntax integration captures distance as “number of changing direction of movement” and not as metric distance. For car traffic, “global integration” is the usually applied parameter (calculating “axial steps” between all axial lines in a particular model). For pedestrian movements, “local integration” shows the highest correlation (calculating axial steps only between axial lines that are within distance of 3 or 5 intersections from each other). Additional to “integration”, the parameter called “choice” has been developed. Whereas “integration” describes the distance (in terms of axial steps) from one element to all others, “choice” (also termed “betweenness”) describes to what extent a particular line is part of the shortest route between other elements (Hillier and Iida (2005), Turner (2007) and Hillier (2009)). In parallel to the introduction of the parameter “choice” there have been developed space syntax tools that handle “spatial distance” in a more advanced way than what is the case for axial-lines (being either connected or not). Turner (2001, 2005 and 2007) has developed the parameter “angular change” in combination with “segment-analyses”. In segment analyses, the basic spatial element is the straight line from one intersection/junction to the next and the space syntax

distance between intersecting elements (line-segments) are calculated in accordance to the angle between the lines. According to Raford et al. (2007) space syntax analyses calculating “segment angular change” correspond well to bicycle traffic. More explicitly, they found that continuity in terms of “angular minimisation” is essential for a good bicycle-route.

The space syntax analyses in the research described in this paper includes calculating both “integration” (radius 6) with an axial map and “choice” with a segment map. Basic space syntax is about “configurational properties” of space, - leaving out all other properties of space for instance land use. As we will describe more closely in the section about methods, our research do not consist only in such basic space syntax analyses but also includes analyses that combine space syntax and GIS. This is a part of our research where the consultants Tobias Nordström and Alexander Ståhle (Spacescape, Sweden) have contributed substantially.

2.3 The Place Syntax tool and “attraction accessibility”

Place Syntax combines the space syntax concepts for modelling urban space as cognitive environment, i.e. topological axial line distance, with conventional descriptions of attractions / destinations into a “combined accessibility analysis model” which is the Place Syntax software. Axial distance correlates better with observed pedestrian movement than walking distance in meters or with straight-line distance in meters. By introducing the axial line as a distance unit in detailed GIS-based attraction-accessibility analysis the Place Syntax tool capture essential features of urban form as cognitive environments. The Place Syntax tool is particularly useful for predicting movement in urban areas where the distributions of densities and buildings are uneven.

2.4 The research project

The research project “Brøset, towards carbon neutral settlement” is about urban development of the Brøset area in the city of Trondheim and is funded by the Norwegian Research Council. It is chaired by NTNU, The Norwegian University of Science and Technology and is carried out by an interdisciplinary group of researchers, from departments of industrial ecology, architecture and planning, engineering as well as from social sciences. There is also a close co-operation with Trondheim municipality, who is in charge of planning the Brøset area. More explicitly, this paper is based on the transport-part of the Brøset research project, a part that focuses on examining urban form’s potential for reducing carbon emissions from transportation. Some basic issues in this respect are how to reduce the amount of transportation and by what means transport is carried out. We have particularly focused on urban forms potential for increasing the share of daily travel carried out by non-motorised transportation. More information about the Brøset-project, including more details about the “transport and urban form”-part of the research project, can be found at http://brozed.wordpress.com/.

After examining what features of urban form that according to research should be relevant for the amount of non-motorised transportations, we have carried out three kinds of studies. The first was to interview people about their daily travel. This included registering the actual routes of peoples’ main daily travel. The second was to carry out a series of space syntax and GIS analyses of parameters that according to research should be important for walking and biking. This is the part of

work done in collaboration with the consultants Spacescape. Finally, we are carrying out a statistical study looking for correlates between numerous urban form parameters and peoples' actual travel behaviour. Some of the results of these studies can be found at the Brøset web-site referred above. Based on these studies, we have the possibility of comparing analyses and empirical data. The next sections describe this more in detail.

3 Methods

3.1 The space syntax and GIS-analyses

An important part of our research has been carried out in collaboration with the consultants Spacescape (Sweden) and with the local authorities of Trondheim. Thanks to the Trondheim municipality's GIS-data that includes detailed information about 5000 peoples' daily travel and Spacescape's competence in analyses combining space syntax and GIS, our research project has been an arena for developing spatial analyses by means of the software Place Syntax (Ståhle, Marcus and Karlström, 2005). Based on Trondheim municipality's GIS-road-map and "orthophoto" in high resolution, Spacescape made a detailed axial-map of all streets and paths for walking- and biking in the entire city of Trondheim. Then, they carried out space syntax analyses as well as Place Syntax analyses combining space syntax and GIS-data. The aim of the space syntax analyses was to reveal potential (and problems) of the street-network, whereas the aim of the Place Syntax analyses was to calculate a series of parameters describing accessibility to destinations that according to research should be important for people choice of mode of transport. The space syntax analyses consisted in analyses of the street network in itself, calculated by "axial integration" with a radius of 6 axial steps to capture pedestrian movement potential as well as "segment angular choice" with a radius of 5 000 metres to capture bicycle routes. The Place Syntax analyses examined accessibility to density of residents and to strategic destinations such as schools, kindergartens and workplaces. In these Place Syntax analyses distance was measured in airline distance as well as network distance in metres and axial steps (changes of direction).

3.2 Comparing analyses, intended bicycle routes and real bicycle routes

The field of planning and transportation mostly deals with how "mode" and "amount" of transportation relate to residential density and location of workplaces and other "destinations". Trondheim municipality's data about peoples' daily travel was obtained thanks to a survey carried out in 2001-2003 (Vågane, 2006). In Trondheim as well as in most other cities, we know little about actual routes that people choose. Therefore, we have carried out a survey identifying peoples' "actual routes" of travel. We did one questionnaire-based survey where the respondents were people working in or nearby Trondheim city centre, - asking for where they lived, how they travelled and which route they choose from home to work (Knudsen, Gabrielsen and Håland, 2008). The results were drawn on a map, giving a "squid-like-image" describing real bicycle routes to (and from) the centre of Trondheim (see figure 2). We did a similar study at the Brøset area, visiting people at home and registering their route of travel to work, study or other "main daily destination" (Karlsnes, Straume and Manum, 2009). These "actual route maps" provide empirical data that is useful for being compared with "intended

bicycle routes" as described by "bicycle route map" of the local authorities of Trondheim. The "intended routes" (the red lines in figure 1) are of numerous kinds: some are well designed separate bicycle lanes, some are streets suited for cycling due to little car traffic, and some are streets or paths that by different reasons are not much used by cyclists. By comparing "actual route maps" with "intended bicycle routes" we can provide information about the usefulness of the intended bicycle routes in Trondheim.

Space syntax analysis is a way of revealing "potential performance" of the urban space (Marcus, 2000). To what extent this potential is managed depends on numerous issues on street level such as amount of car traffic, quality of the road-surface, obstacles in terms of crossings, slope and other issues not captured by the space syntax model (the axial- or the segment-map) or the space syntax calculation. In our case, where we have modelled a segment-map of bicycle-route-network and calculated space syntax parameters that should be relevant for cycling (Raford et al., 2007), the results should illustrate the potential for bicycle traffic along the line-segments in the model. By comparing these results with "intended route map" and with "actual route map", we should be able to shed light on the applicability of the space syntax analyses.

3.3 Statistical analyses of urban form correlates to modes of transportation

In addition to comparing analyses and empirical data as described in previous section, we are doing a statistical analysis looking for correlations between the accessibility-parameters as found by the Place Syntax analyses and extensive empirical data of Trondheim population's real daily travel. The first part of our work presented here focus on daily choice of travel modes to go to work over the year while we are currently working on single and chained trips to a dozen of destinations.

In order to examine patterns in details, we have chosen to integrate numerous urban form measures at a rather disaggregated level. Socio-economic data are also used at a disaggregated level. The methodology, inspired by Lee and Moudon (2006), who also handled a large set of urban form measures, consists in variable screening and grouping before logit multinomial regression. Two analyses are performed independently for socio-economic / travel characteristics measures (1st Model), and urban form measures (2nd Model) alone which are then put together to build a third complete model and derive their respective influences (Stead's methodology, 2001).

Based on the transport survey data, we computed our dependant variable describing daily travel habits to work with four modalities: walking 3 days a week or more (11.8%), cycling 3 days a week or more (24%), using public transport 3 days a week or more (8.9%) and driving 3 days a week or more (55.3%). Origins (home) and destination (work) addresses were recorded on a "Grunnkrets" level. Grunnkrets are small administrative area-units of Trondheim. Consequently, people living in the same Grunnkrets were assigned to the same address (the geometrical average address of the Grunnkrets), implying that their urban environment is assumed to be identical. This approximation constitutes an uncertainty that will be reduced when data registered at parcel level will be available, hopefully during 2010. Travel duration and distance from home to work were integrated as travel characteristics. Travels performed within one Grunnkrets, which is the case for people working and living within in one Grunnkrets, were set with constant values based on Grunnkrets average size and correlation optimization; typically 200 meters.

Socio-economic measures concern gender, age, occupation, incomes, household size and cars accessibility. Several variables attached to work description were collected (total worked hours per week, work schedule, workplace or type of parking). Urban form data were extracted from MapInfo using Place Syntax and space syntax (previously described) and were provided at both parcel and Grunnkrets levels. Measures characterize both workplace location and home place location and are mostly distances in meters and axial steps to a panel of destinations, number of accessible daily destinations, densities, block sizes or lengths of lane types (some are log-transformed). A handful of computed indicators to characterize spatial accessibility (integration and choice previously described) or building morphology are also integrated. Finally, 199 variables are used to characterize a location: 147 from network measures and 52 from airline measures. It should be noticed that we put airline and network measures in competition together in the same model. As we are interested in different transportation modes which have each a specific distance scale we used five size of buffer regarding network measures (1 km, 1km and 6 Axial Steps, 3km, 3km and 6 Axial Steps, 5 km) and two regarding airline measures (1 km, 3 km). Moreover we introduced the distance in axial steps to a closest destination and used it also to define new type of buffers. Complete urban form characteristics for both workplace and home place were available for 2000 respondents as well as few socio-economic data were missing. Regarding travels to work analysis, we took into account only people who were working more than 30 hours per week and were therefore going to work every day. Finally 980 respondents constitute the sample. Environmental missing data were mostly concerning people living in remote suburbs who were much more subject to car travels independently from district characteristics.

To build the first model socio-economic variables were forced in the model while travel characteristics variables were selected through a backward stepwise process (entrance with p value under 0.1 and exit with p value higher than 0.1).

To build the second model we tested first variables for their bivariate association with the dependant variable (Pearson coefficient). Due to the very large sample size only those significant at the 0.01 level were further considered. Secondly we grouped variables on the basis of bivariate inter-correlation coefficients. We considered the different categories of variables (distances, number of accessible daily destinations, areas, densities, length, slope, time, spatial accessibility indicators...) independently and we focused for each variable category on competition between buffer sizes, network and airline measurements and finally variables within the same category. Variables with inter-correlation coefficient higher than 0.7 were put together and represented by an unique variable chosen for its stronger correlation with the dependant variable. Finally we checked remaining variables for any unexpected correlation until no more correlation higher than 0.9 were found. Number of daily destinations, densities, length of lane types, block size and slope were more often close related than expected. Then we performed the logit multinomial regression including intercept and backward stepwise modelling. Variables enter and stay in the model with p value under 0.1. To build the third model travel characteristic and socio-economic variables coming from the first model were forced into the model while applying the same backward stepwise modelling process for the environmental variables selected after the grouping process.

4 Results

4.1 Theory and practice; results from comparing space syntax analyses, intended cycle-routes and peoples' real cycling

Figure 1 shows the results of the space syntax analyses calculating "segment angular choice" of Trondheim, whereas the red lines show "intended bicycle routes" (according to the planning authorities of Trondheim) on the same map. What we see, is that the space syntax analyses, which is a purely mathematical calculation of configurational properties of the street- and path-network, corresponds very well to "intended bicycle routes" as well as to where people cycle. Looking more closely, we see several places in Trondheim where the three maps do not correspond.

Point 1 in figure 2 is Fjordgata, a street much used by cyclist but neither marked by the intended cycling routes (red lines in figure 1) nor captured by the space syntax analyses (figure 1). The reason for cycling in Fjordgata is its location at north edge of the city centre, implying that there are no crossing streets from north into street. Therefore, different from the Olav Trygvassons gate that according to space syntax analyses and municipal intentions should be the cycle-route, Fjordgata provide an "obstacle-free" cycle distance of about 500 meters. Since this kind of information is not present in the space syntax modelling or analyses, it is not surprising that space syntax results do not captured it. Concerning intended routes, the results show that intentions about people choice of route are of little use if not knowing and taking into account people's reasons for selecting their routes.

At the point marked 2, neither the space syntax nor the intended route corresponds to actual cycling. The reason is that the terrain is very steep. This is not captured by the space syntax analyses since slope is not a feature present in the analyses. Concerning intended routes, these must be based on understanding of peoples' preferences. Crossing streets as well as slopes are examples of features highly important for peoples' cycle routes without necessarily being taken into account when planning formal bicycle routes.

Point 3 is Erling Skakkes gate, a street where space syntax analyses and real cycling corresponds but that is not present in the "intended routes". This street being preferred by cyclist shows the importance of route directness / least angular change, - a feature that is capture by the space syntax analyses but not taken into account by the planning of formal bicycle routes.

Point 4 shows how the heavily trafficked Elgeseter gate is not chosen by cyclist. Instead, they choose parallel streets since these are as direct to their destination. This phenomenon of choosing parallel streets in cases of heavy traffic is captured in the intended bicycle routes but only partly in the space syntax analyses.

In conclusion, our study shows that space syntax analyses in terms of least angle segment analyses within a metric radius is a very useful tool for predicting bicycle routes. However, no analyses can capture features not being present in the input. Therefore, since slopes and heavy traffic are obstacles that influence cycling habits but not captured by space syntax analyses, these parameters need to be taking into account by other means than space syntax tools.

4.2 Combing space syntax and GIS analyses of Trondheim and an example of applying these analyses in real urban planning of the Brøset area

An essential part of our analyses has been to provide knowledge about accessibility from residents (based on GIS-data about real residents located at real addresses) to the “destinations” relevant for non-motorised transportation. Figure 3 is a map showing accessibility to schools, in the sense that the scale from red to blue represents good to low access. Access is measured as number of schools within 1 km distance along walking/cycling network. The figure shows that the accessibility from the Brøset area to schools is not good. Figure 4 illustrate the space syntax spatial integration of the street-network (lines coloured red to blue, red being much integrated), density of residents (area coloured red to blue, red implying many people within short distance). Finally, the dots show the location of grocery shops (large dots are several shops, large shops, shopping centres, whereas small dots are small single shops). The figure show that the area around Brøset is characterised by low residential density, the street network is not well integrated and there are few grocery shops. The table in figure 5 shows accessibility from the Brøset area compared to the centre of Trondheim and to Trondheim on average. In the results presented in this figure, accessibility is calculated in different ways (distance to destinations, supply of destinations and spatial integration). The accessibility value is then compared with the average value of all areas within 5 km from the city centre. What we see is that schools and retail are not easily accessible from the Brøset area. According to Lee and Moudon (2006), access to school and retail are among the most important parameters for achieving a high rate of walking and cycling. Therefore, aiming at “carbon neutral settlement” at Brøset, the area’s accessibility to these destinations should be improved. This can be done by including school and shops in the Brøset-project or by adding/improving the walking and biking street-/path-network so that the access from Brøset to existing destinations in the surrounding areas becomes better.

Concerning the bicycle route-network, figure 5 show that the “intersection-density” or “grid density” is very low around Brøset. This implies that the street network should be completed by adding new streets or paths and by upgrading some of the existing ones. An explicit proposal for doing so is shown in figure 5.

These proposals concerning accessibility and street-network are results of the research by Spacescape (2009) and will be guidelines for further planning and design of the Brøset area. The methods of analyses shown here will be applied in order to evaluate the proposal for urban design in the urban development project at Brøset.

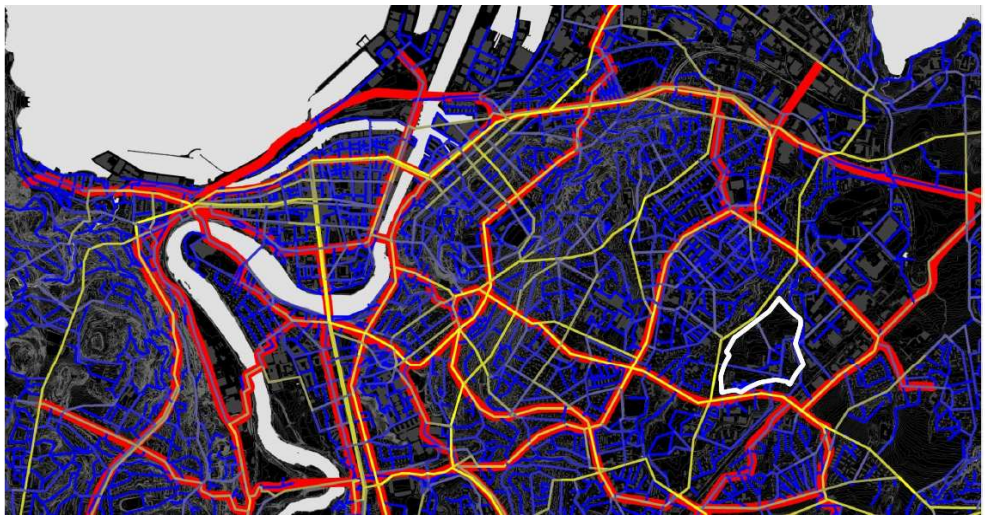


Figure 1. Space syntax analyses illustrating "continuity" of the bicycle network ("segment angular change, choice, buffer radius 5000 meters") Yellow: high continuity, blue: low continuity. Red lines show bicycle routes as intended by the local authorities of Trondheim. Source: Spacescape, 2009.

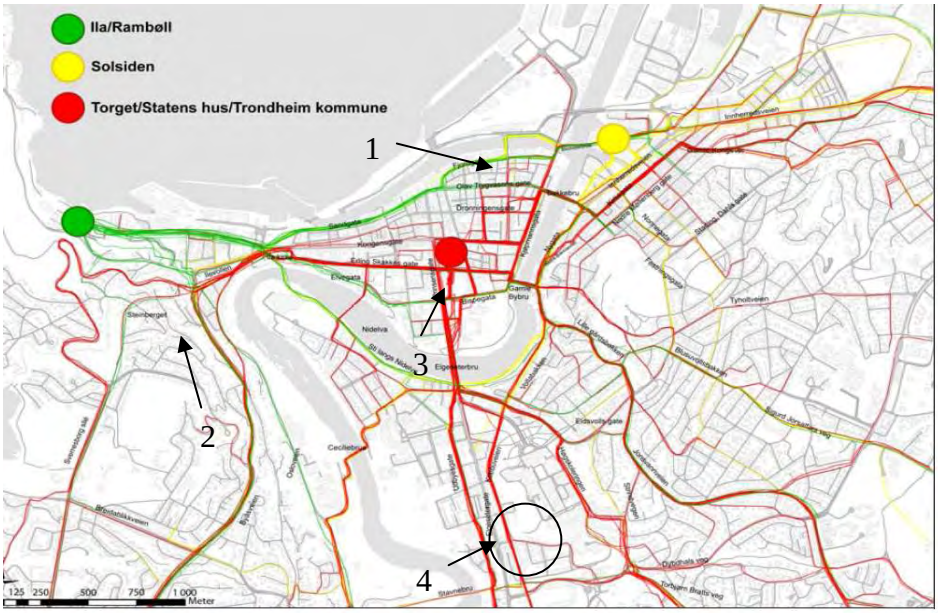


Figure 2. Real cycling routes to (and from) Trondheim city centre. Coloured dots show the workplaces where the survey was carried out. Corresponding coloured lines show the respondents actual cycling routes from home (Numbers mark points commented in the main text).

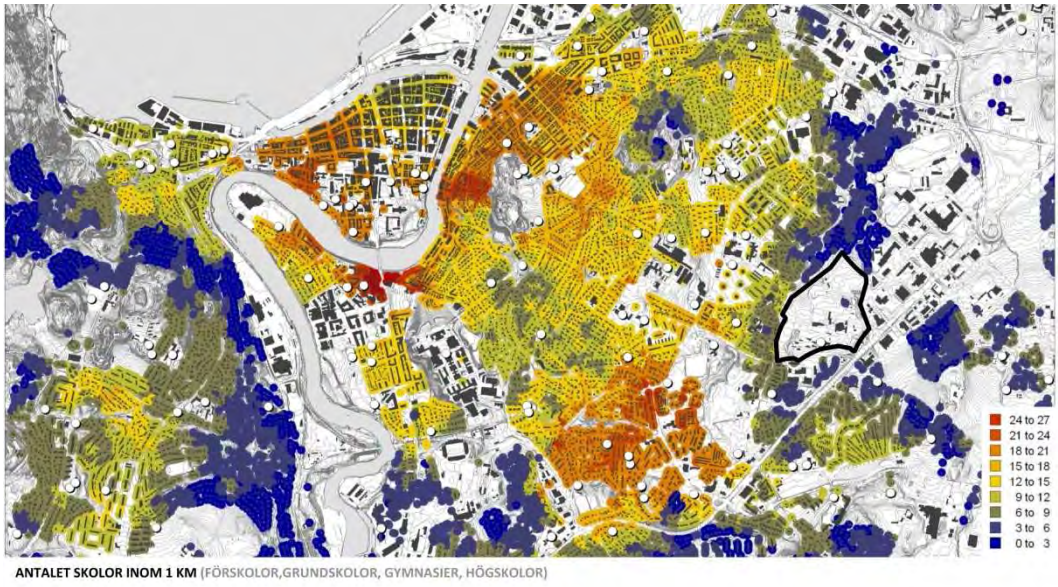


Figure 3. Accessibility to schools (kinder gardens, primary schools, high schools and universities within 1 km distance along walking/cycling-street-network). Souce: Spacescape, 2009.

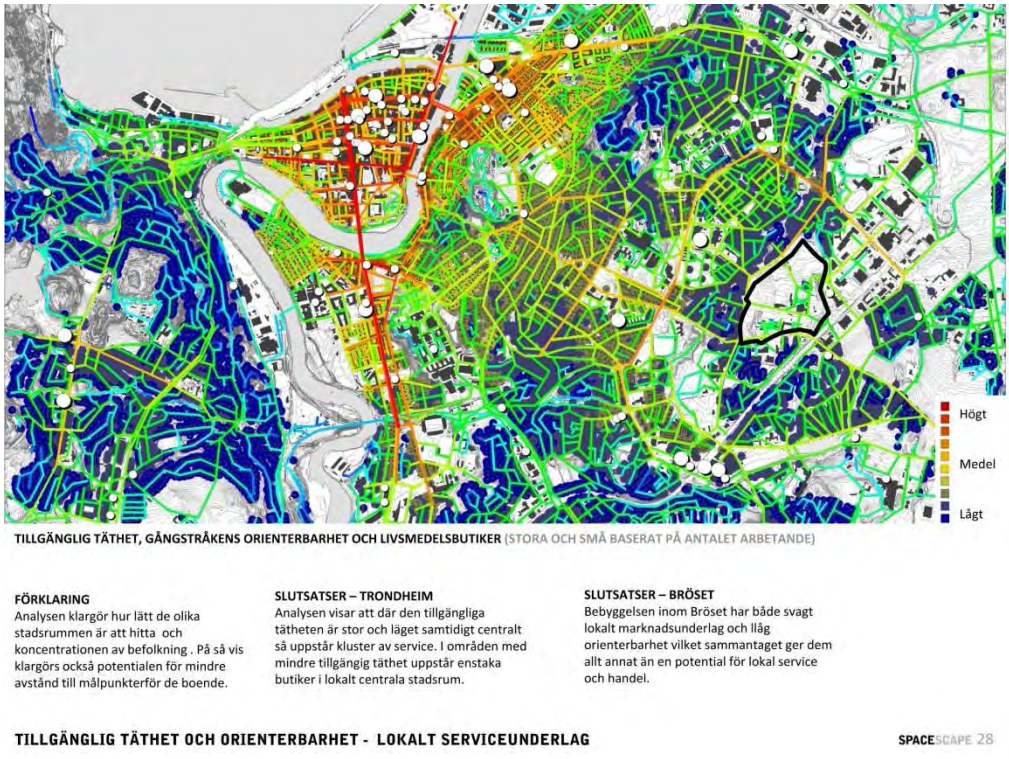


Figure 4. Spatial integration (radius 6) of streets (red being highly integrated), density of residents from each point (orange/red implying many people within short distance) and the location of grocery shops (large dots are several shops, large shops, shopping centres, whereas small dots are small single shops). Source: Spacescape, 2009.

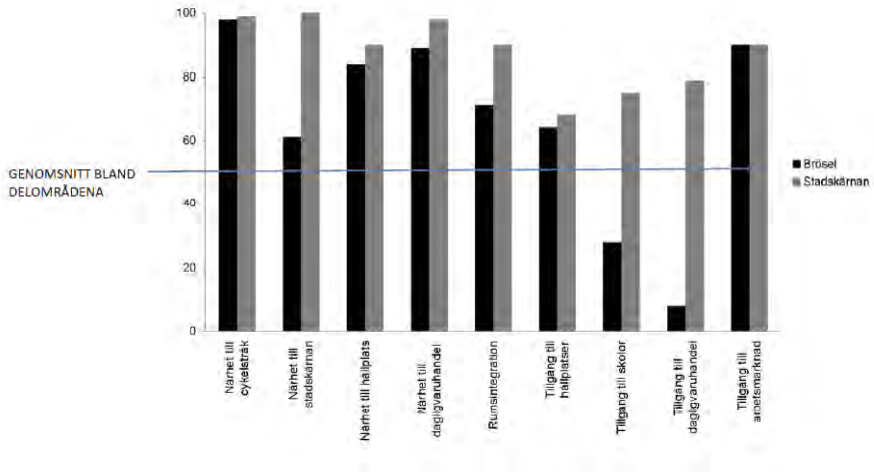
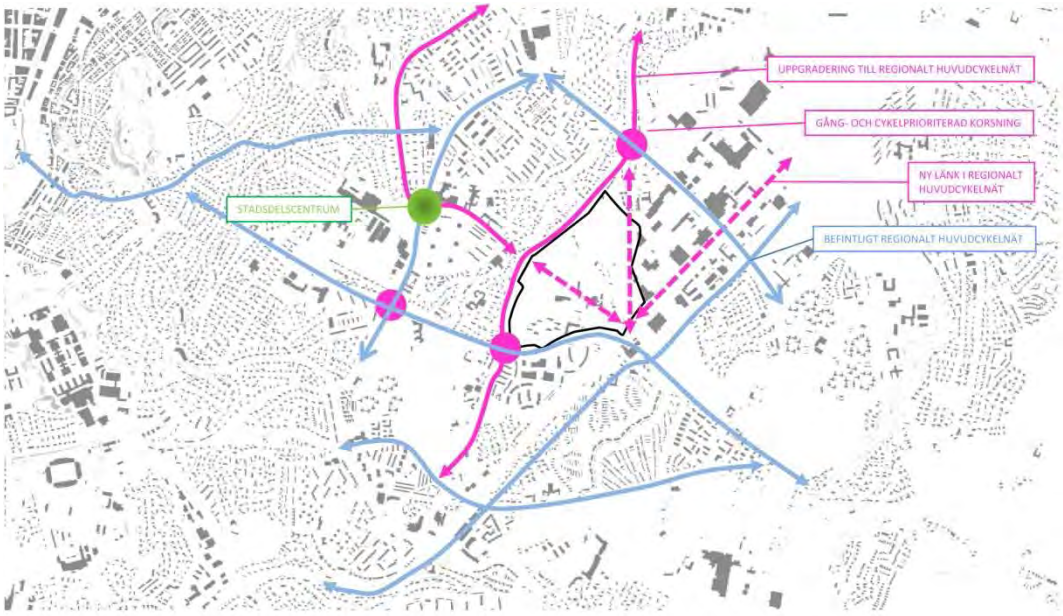


Figure 5. Accessibility to difference destinations, from Brøset compared to city centre and to Trondheim within 5 km from the city centre on average. Source: Spacescape, 2009.



Strukturskissen illustrerar de mest strategiska gång- och cykelstråken idag (blå) tillsammans med nya huvudstråk i Bröset (lila) vilka knyter samman programområdet med omgivningen. På så vis kan en överlagring av både regionala och lokala rörelser ske inom Bröset. Detta kan öka det lokala marknadsunderlaget för handel, bidra till gemensamma mötesplatser och öka den upplevda närheten till omgivande vardags-målpunkter, vilket i sig kan bidra till att uppmuntra fler till att röra sig till fots eller med cykel. De nya länkarna inom Bröset ger centrala lägen där verksamheter beroende av tillgänglighet och genomströmning kan lokaliseras. I fall en rumslig variation eftersträvas inom programområdet kan ett mer uppbrutet lokalt nät av stråk komplettera huvudstråken.

STRUKTURSKISS PÅ GÅNG-CYKELNÄT FÖR MAXIMAL TILLGÄNGLIGHET TILL BRÖSET

SPACESCAPE 31

Figure 6. Proposal for improved bicycle-network in the Brøset area. Blue : important existing routes Cyan: new routes. Source: Spacescape, 2009.

4.3 Statistical analyses of urban form correlates to modes of transportation

This statistical analysis provided a lot of interesting results. We will present the main patterns and focus on results related to distance measurements and spatial accessibility concepts as described in the methodology section.

The few socio-economic variables we forced in the model are significant, especially and not surprisingly the car availability, the number of cars owned by the household and the total number of persons in the household with a p value<0.001. Car availability and number of cars play a similar role and strongly decrease the probability to walk and cycle relatively to drive and even more strongly the probability to use public transportation. The total number of persons per household has a more equivocal influence: the more people in a household, the less probable they will walk but the more probable they will cycle relatively to drive. An explanation could be the Norwegian habit to drop off their children to nursery or school on the way to work either by bike or by car rather than walk with. Incomes per person as well as total household incomes appear to be not significant and show no clear patterns about walking and cycling. This may due to the high average income in Norway where everybody can afford a car. The relative price of gasoline is also lower than in others countries. Concerning travel variables, driving time and distance from home to work, grouped together, are the second most important factor, after car accessibility, to explain people travel habits in the 3rd model. Finally the first model shows a R^2 = 0,430 (Nagelkerke) while 2nd model has a R^2 equal to 0.325 (Nagelkerke) and 3rd model has a R^2 equal to 0.609 (Nagelkerke). Accordingly to Stead (2001), this means that urban form characteristics can explain directly between 18% and 32% of the variance of the dependant variable (people travel habits to work) whereas socio-economic and distance to work together can explain between 28% and 43%.

Table 1. 3rd Model: highly significant urban form variables (p value <0.05)

3rd Model	Khi-2	Signif.
Number of destinations within 3km Air (around Work)	13,0	,005
Number of Nurseries within 1km_Air (around Work)	10,2	,017
Time to City Center by Bus (from Work)	18,4	,000
Number of High Prox. destinations within 3km 6 Axial Steps (around Work)	9,9	,019
Closest green area (from Home)	10,9	,012
Average block size within 1km 6 Ax (around Home)	10,4	,015
Closest cycle lane (from Work)	10,9	,013
Maximal Spatial Integration (for Work)	10,6	,014
Sloppy kilometers within 3km 6Axial steps (around Work)	29,7	,000
Density employment within 3km (around Home)	34,2	,000
Density population within 3km 6Ax (around Home)	9,4	,025
Length bus lanes within 3km_Air (around Work)	10,9	,012

Not surprisingly, employment densities, population density around home and average block size appear to be important factors and follow patterns pointed out by previous research (Saelens, (2003), Lee and Moudon (2006) and Milakis et al. (2008)). The time distance (by bus) from work to city center is also one of the key factors while some other factors are a bit strange. For instance the higher the total number of steep kilometers, the more probable people will walk, cycle or use bus compared to drive. This paradox may be explained by the specific topography of Trondheim where a high number reflects a strategic location in the "valley" close to the city center.

Coming back to the Brøset project, it is interesting to compare the Brøset area to an average Grunnkrets of Trondheim and to the city center, considering urban form characteristics. For instance, what are the differences in probabilities for a person to walk, cycle or use public transport on a daily basis relatively to drive to work depending on his residence location, all others parameters being equal? If we take into account only the most significant urban form characteristics around home location (p value <0.05), we retain: closest distance to a green area, average block size within 1 km and 6 axial steps, density of employment within 3 km and density of population within 3 km and 6 axial steps. Moreover, we assumed that urban form characteristics explain 25% (in fact 18% to 30% as described previously) of the individual people's choice. Results are presented on the figure 7 below, where probabilities for city center are arbitrary set to 1 for the example.

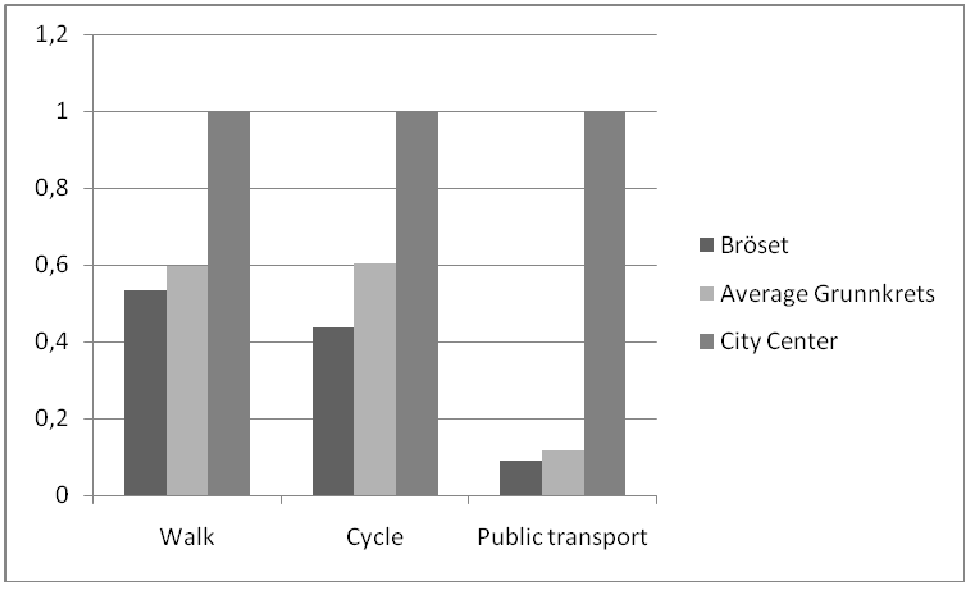


Figure 7. Relative probability to walk / cycle / use public transport to work depending on residence location.

If, for instance, a resident in the city center has the same probability to walk or cycle as drive daily to work; in Brøset he has respectively 47% and 60% less chances to walk or cycle than drive (independently from socio-economic factors, distance to work and work location). Regarding walking this is near the same for a resident in an average Grunnkrets of Trondheim whereas regarding cycling he has few more chances to daily cycle to work than in Brøset. These are preliminary results

but they point out the real effect of accessibility problems (described in the part 4.2) on people choices and that the carbon neutral objective for the Brøset project is a challenge.

Another important result is the influence of the "workplace maximal spatial integration", which is a way to characterize the accessibility. Within our sample this factor ranges from 1 (minimal integration) to 2.2 (maximal integration). Figure 8 illustrates the strong link between "maximal spatial integration at work" and share of non-motorised transportation for daily travels to work. Moreover, accounting for others confounding factors (after multinomial logit regression), an increase by 1 of maximal spatial integration at work increases walking and cycling probabilities relatively to driving probability respectively 18 and 5 times. In our case spatial integration seems to be a better way to measure accessibility than choice which was much less correlated with the dependant variables. Accordingly to Hillier (2009), this may be due to the local scale being more important than global scale concerning non-motorised transportation (see 2.2). It's also interesting to notice that spatial integration of the work location seems to be more important than the spatial integration of the home location to explain people travel habits. The reason may be that average block size can better explain people choices than spatial integration around home.

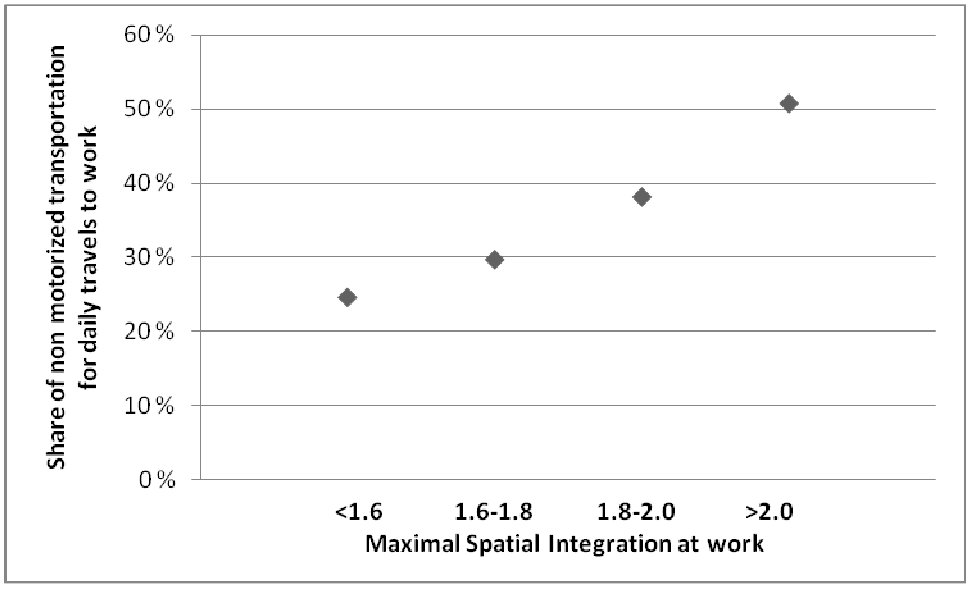


Figure 8. Maximal Spatial Integration (radius 6) at work and share of non-motorised transportation.

Nevertheless, results from grouping process are as interesting as the final results. Concerning distances to the closest daily destination we looked first for correlation between network distances measured in meters, axial steps or axial steps*meters. Strong correlation was found for both home and work location. Regarding home location, distances in axial steps were much more correlated with the dependant variable while for the work location the pattern was less clear and few distances in meters were kept depending on the destination. Finally, for short distances, distances in axial steps explain people's daily choices of transportation to work much more than distances in network meters do. Consequently, in our case, when it comes to measure closest distance to daily destinations, axial

steps should be preferred. Further work is needed to examine this pattern for longer distances. For instance, it could be done by comparing correlation with people's daily choices of travel mode, for home to work distances depending on measures in network meters or in axial steps. Results are expected to be complex and methods for computing these two parameters in a "single distance indicator" would be useful. Further elaborations on space syntax based parameters, which capture human cognition of distance much better than merely metric distance does, will improve correlates with travel habits (Hillier, 2009). The one we have tried in this work, meters multiplied by axial steps, doesn't appear as a good one as was less correlated with the dependant variable than the simple network meters, and far less than only axial steps.

Subsequently, axial steps are relevant way to define buffers especially those of high proximity and to account for people subjective perception of distances in buffer definition. In fact concerning number of accessible daily destinations, we looked first for competition between buffer sizes. For each destination, measures corresponding to the five network buffer size were highly correlated to one another and two measures instead of five were sufficient. Concerning home location, two profiles were revealed. Some "high proximity daily destinations" (us stops, nursery, sport equipments, parks and stops) were highly correlated with the dependant variable for the 3 km and 6 axial steps buffer, whereas "medium proximity daily destination" (school, gymnasium, universities, works, groceries, and eating and drinking places) were much more correlated at the 3 km buffer size. Variables within those groups were also strongly correlated to each other. This structure was still present but less clear for airline measures. Regarding the work location those two groups merged in one became one for network measurements and the 3 km and 6 axial steps buffer was the best for all facilities. Once again this was less visible for airline measures.

Consequently, everyday destinations (on the way to work) can be split in two groups: high subjective proximity destinations (best correlation for a buffer size < 3 kilometres and 6 axial steps) and medium subjective proximity destinations (best correlation for a buffer size > 3 kilometres and 6 axial steps). For all variables taken into account, three kilometres appears to be a threshold distance to characterize home location as well as work location when it comes to explain travel habits. Regarding small buffers, by adding an axial steps constraint to a classic distance constraint (in network meters) to our buffer, we improved the explanation of the dependant variable a lot. Even though 3 km seems to be a surprising long distance, the 3 km and 6 axial steps buffer is often the best scale to capture high proximity equipment variation within an area among the buffer sizes we tested. This is partly explained by the 3 kilometres and 6 axial steps buffer size which is closer to the 1km or 1 km and 6 axial steps than the 3 kilometres buffers. Axial steps constraint is the limiting factor. This means that we might have missed the optimum distance constraint (between 1 and 3 network kilometres). Concerning the axial steps constraint we used only 6 as a default setting. However, now that the importance of this factor on buffer sizes definitions is identified we should look at these issues more in detail, for instance with constraints of 6, 8, 10 or 12 axial steps for buffers definition.

Finally, our results have confirmed the superiority of network meters on airline meters to capture people distances appreciations. Network measurements are more efficient than airline measurements for almost all the variables. Lee and Moudon (2006), for instance, has found different

patterns (about number of accessible destinations) when it comes to explain people walking distances Their result might be due to a too small buffer size definition which falsely emphasized airline buffers significance compared to network buffers. Still, number of accessible destinations within buffer defined with airline meters can stay in the final model, even if they are less correlated with the dependant variable, because they are not highly correlated with any other measures contrary to most of the number of accessible destinations within buffer defined with networks meters.

5 Conclusion

Our research has consisted in comparing a wide range of information concerning urban form and peoples' daily travel in the city of Trondheim, aiming at providing general knowledge as well as to contribute in planning the urban development at the Brøset area in Trondheim.

By comparing space syntax analyses with peoples' real travels, we have illustrated how the parameter "segment angular choice" convincingly corresponds to the complex phenomenon of which specific route people chose to cycle. At several places in Trondheim we see that this space syntax analysis capture cyclists' preference for continuous and "angle-minimised" routes much better than the intended bicycle routes of Trondheim do. This illustrates how space syntax provides powerful tools for planning well functioning bicycle route network. Our guideline for planning and design of the Brøset area is an example in this respect.

The Place Syntax analyses provided a large set of data about urban form characteristics. According to our statistical analysis, some of them such as employment and population around home and maximal spatial integration at work location are very significant to explain daily travel to work habits. Furthermore, the statistical analysis indicate that axial steps are the parameter that best correlates short distances (to the closest daily destination) to daily travel to work habits; far better than metric distance or distance computed as metric distance multiplied by axial steps distance. Axial steps are also revealed as essential component for origin and destination areas description. By adding an axial steps constraint to a classic metric constraint for buffer definition we improved significantly measurements correlation with daily travel to work habits. Finally, our statistical analysis shows that the space syntax and Place Syntax analyses not only correlate to choice of travel routes but also explain choice of travel modes, which is a step further toward sustainable planning. From the work carried out so far, we see several subjects that we look forward to examine more closely. One is to look at non work trips as well as chained trips; a second is to optimize the Place Syntax analysis by going further into distance measuring, buffers defining and the computing of accessibility indicators. We also look forward to apply our model of analyses on results of the ongoing transport survey that is based an exact addresses (parcel) rather than aggregate areas. This will surely improve the ability to explain peoples' travel habits.

A basis for the development of space syntax theory and methodology is the comparisons of empirical data and calculations with new parameters. Our result that spatial integration explain work-surroundings' influence on travel habits well, whereas density and average block size are better for explaining the influence of home surroundings, is an issue that should be examined more closely. This result might have parallels to the finding of Raford et al. (2007) that individual's routes and aggregated routes correspond differently to configurational aspects of the urban space. Furthermore,

our results indicate that Hillier's concept of to-movement (to be distinguished from "through-movement", Hillier and Iida (2005, p. 556)) can be distinguished into "to-" and "from-movements", - in the sense that travel-mode between A and B depends on A or B being the starting point. Our methodological framework of combining space syntax and GIS data within the Place Syntax tool is well suited for elaborating these issues.

In conclusion, Trondheim's extensive GIS based information about the city, its residents and their travels has provided a unique basis not only for carrying out analyses that are operational for actual planning but also for developing the Place Syntax tool. Our study has been carried out on GIS-data made for general purposes. Providing GIS data aiming more specifically at being basis for this kind of analyses should substantially improve knowledge about urban form's influence on daily travels. Such knowledge would benefit other and more overall issues such as reducing carbon emissions and improving health.

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Are the fairs for all? Movement and accessibility in the open-air markets of Caruaru (PE) and Campina Grande (PB).

Gustavo Miranda, Circe Monteiro

Departamento de Arquitetura e Urbanismo

LATTICE/UFPE – Laboratório de Tecnologias de Investigação da Cidade

Faculdade do Vale do Ipojuca – FAVIP e Universidade Federal de Pernambuco – UFPE,

arqgustavomiranda@hotmail.com, monteiro.circe@gmail.com

Phone/fax numbers: 00 55 81 2126 8311

The open-air markets are part of the life of the city, specially the ones in the Northeast of Brazil, as they keep an intimate and symbiotic connection between them, through the occupation of the urban space, the colours and the diversity of products, the human relationships and the cultural richness. This work aims to analyze the interfaces of trade with the cities, taking as case studies two of the most representative examples, the open-air market of Caruaru (feira de Caruaru) and Campina Grande (feira de Campina Grande). There are several aspects that can be investigated in a study on open-air markets, yet the configurational aspects of these spaces (or their spatial patterns) are often neglected. The closest studies to investigations of this nature were made by Azinzadeh (2003) and Nejad (2005) in Iranian bazaars. So, the lack of researches on use patterns of informal trade in urban areas has provided a springboard for the development of this work. In these markets, if fuller or emptier, the different atmospheres allow different types of movement patterns, favoring a constant process of change in the space. For a contribution to enhancing the framework of existing research on this theme in particular, this paper has addressed this issue based on the concepts of accessibility and movement - two variables that are closely linked and present in any discussion of patterns of space occupation by the open-air markets.

Keywords: open-air markets, Caruaru, Campina Grande, movement, accessibility

There are several aspects that can be investigated in any study on free markets, yet the configurational aspects of these spaces (or their spatial patterns) are almost always neglected. A review of the literature revealed that the studies that come closest to the investigations of this nature were conducted by Azinzadeh (2003) and Nejad (2005) on bazaars in Iran. Aside from these, little or nothing has been published. Such a shortage of research into patterns of informal commerce in the occupation of urban space prompted this study to be undertaken.

Thus, with a view to contributing to the existing investigations into this line of research in particular, this issue is addressed based on concepts of accessibility and movement - two variables that are closely linked and present in any discussion on the patterns of occupation of space, but which, in isolation, only partly explain this dynamic.

On taking the markets of Caruaru and Campina Grande as a case study, it was found that accessibility occurs in different ways and is peculiar to each case. Although independent of existing uses, because movement happens on account of the local road network, some factors influence the natural movement that exists in both markets, such as the presence of magnets which attract a flow of people and different movements.

Moreover, the diversity found in a street market also favors a constant process of mutation, certain rules of disposition in space, size, materials, etc., but it also responds to conditions encountered day by day. Whether fuller or emptier, the different atmospheres in the markets allow

different types of patterns of movement. Therefore, this paper seeks to identify whether the patterns of spatial occupation of the Campina Grande and Caruaru markets follow the same pattern, based on the topological concept of accessibility.

Movement and flow in markets: logic within the occupied space

Each of the two markets discussed here has a very singular spatial layout: one is within a convex area and apart from the central and original urban fabric of the town; the other is still in the same grid that constituted the urban formation. However, both were once arranged along the grid of the towns, resulting in very different processes of space occupation, but ones that compete at some points in common, such as the emergence of similar conflicts or even of linking up market and town.

To do so, this part will deal exclusively with street markets in urban areas. The objective is to gauge the accessibility and movement within the areas occupied by these markets, using Space Syntax as the main instrument.

It is divided into three parts. (1) The first seeks to show the occupancy of the markets of Caruaru and Campina Grande in the town centres and how the urban relationships turned out between them until they suffered municipal interventions, at different times. (2) The second refers to the interventions themselves, where a moment of transition was necessary to adapt to the changes undergone by the street markets in their spatialities. (3) And in the third, we shall seek to show that the inner space of the open-air markets has its own dynamics, with different results, especially on account of how it is placed in the urban fabric.

Therefore, we sought to develop an analysis of the spatial dynamics of each market, internally and externally to them both, by observing their patterns of accessibility and movement, but without failing to take into account that this type of commerce trade has peculiarities, observed *in loco*, which should be added to the theories applied, i.e., by associating the observation of the local phenomena with Space Syntax techniques.

The town centers of markets

Town centers are usually the places with greatest global accessibility in the entire system. In many of these areas, street markets have been situated, and thus received a strong flow of people generated by the natural movement of the urban fabric, as per Hillier (1999). And in Caruaru and Campina Grande this was no different.

Each of the historical-geographical centers analyzed in this paper comprises a “live center” [28] (Hillier, 1999) of the town. Syntactically, this center is at the most integrated point in the system, i.e., easy access to it allows the areas nearby to be directly irrigated and the other areas indirectly so, so as to bring users to these areas. Therefore, this is where the major retailers in the town are located as this location increases the possibility of sales and it is where the large majority of bus lines converge, a reflection of the association between the population´s need to move about and the high level of global integration.

In Caruaru, where global integration is high in the town center, the value of system integration drops from this center to the edges (Figure 1), extending from the north bank of the river Ipojuca until Avenida Agamenon Magalhães meets the BR-104 highway. Until 1992, the Caruaru market was located in this center, displayed a linear structure, followed the shape of the roads, and occupied about 20 streets and alleys, an area of 22,760m2.

As to the axial system of Campina Grande, it has a good level of global accessibility, with a value of maximum global integration at 1.3583, while in Caruaru this is 1.3063. The most accessible area forms the nucleus of global integration, which has a dual form of "fishbone", where two of the main avenues are the "backbone" and the transversal street axes form the spines (Figure 2 - details 1 and 2).

And it was in these centers that both the Caruaru and Campina Grande street markets were to be found for many years, and in them they took advantage of the great flow and movement of people brought about by the urban fabric through the good level of global accessibility that the systems have.

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[28] The author calls this “live centrality”. In his study, Hillier explains that this “living center” means the element of centrality which is led by retail trade, markets, catering and entertainment, and other activities which benefit unusually from movement. The argument is confined to the live center because the spatial processes governing live centrality appear to invoke spatial requirements over and above those related to other central functions such as administration, office work, employment or religion. (Hillier, 1999).

[ii] Interface can be regarded in this study as a synonym of “relationship”.

[iii] This relationship of neighborliness was maintained by the Town Hall in accordance with the physical proximity of the stalls even when they operated in the city center, through interviews and registrations. Many of these traders worked side by side for many years before being transferred definitively to the May 18 Park, in the new configuration of the Caruaru Market in 1992. As Rodrigues (1992b) states in the "transfer the human factor was prioritized. From the start of the project, there was a concern to maintain the relationship of neighborliness of the merchants [some had lasted for more than 30 years] and to give value, by place of each point of sale."

[iv] The ‘full’ elements are the stalls and the ‘empty’ elements, the spaces between them.

[v] This is associated with the process known as cohesion. This term was borrowed from human geography to understand that, on account of the economic force generated in commerce, there is a trend in the retail sector for "stores of the same type to cluster, although they do not maintain business with each other”, thus forming a set that creates attraction for the consumer who, being interested in a particular product will have alternatives to choose from" (Corrêa, 1979)

[vi] The process of invasion-succession is defined by Correa (1979) as being associated, above all, with the residential issue, although it may affect tertiary and industrial activities. In the case of areas near the business center, where the deterioration of buildings is greater, the fact is added that the locally central activities not only prompted the departure of the high-income population, but also its spatial expansion starting from the center creates for property owners the option of waiting for land to be revalued, so as then to sell the residence or land to firms that require a central location. The implication of the invasion-succession process is in the mutable character of the residential areas that constitute a city.

[vii] This segment emerged in the '60s, acting in the market of low cost popular products, based on the use of remnants from cottonwear (textile – helanca in Portuguese) coming from the industries of the south (sul in Portuguese) of Brazil, which gave rise to the name Sulanca in Portuguese (by interpretation, Flea Market in English, which is the term used in the English version of this article).

[viii] The high or low season are periods when market traders tend to have a variation in the sales of their products. Thus, for them, the high season takes place in the festivities of St. John (in June) and at the end of the year (December). All other markets are considered low season.

[ix] The number of people employed for this calculation was an average of 50 thousand, on a Flea Market day.

This is why the Caruaru street market could grow and expand, thus increasing even more the great flow of people and capital to the town, and the total number of traders reached five thousand.

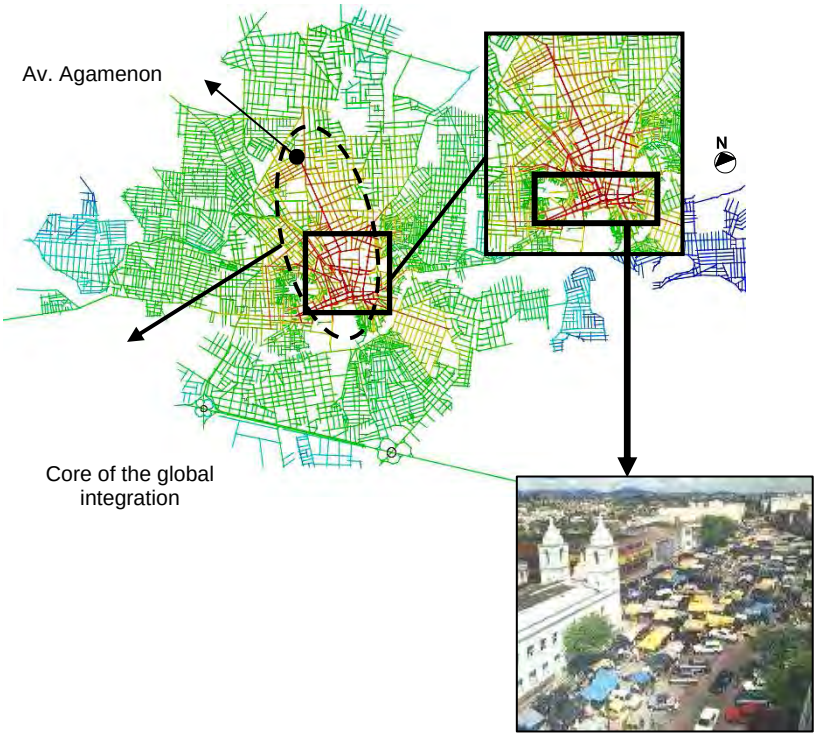


Figure 1: Integração global de Caruaru, em1992, com destaque para a área ocupada pela feira no tecido urbano.

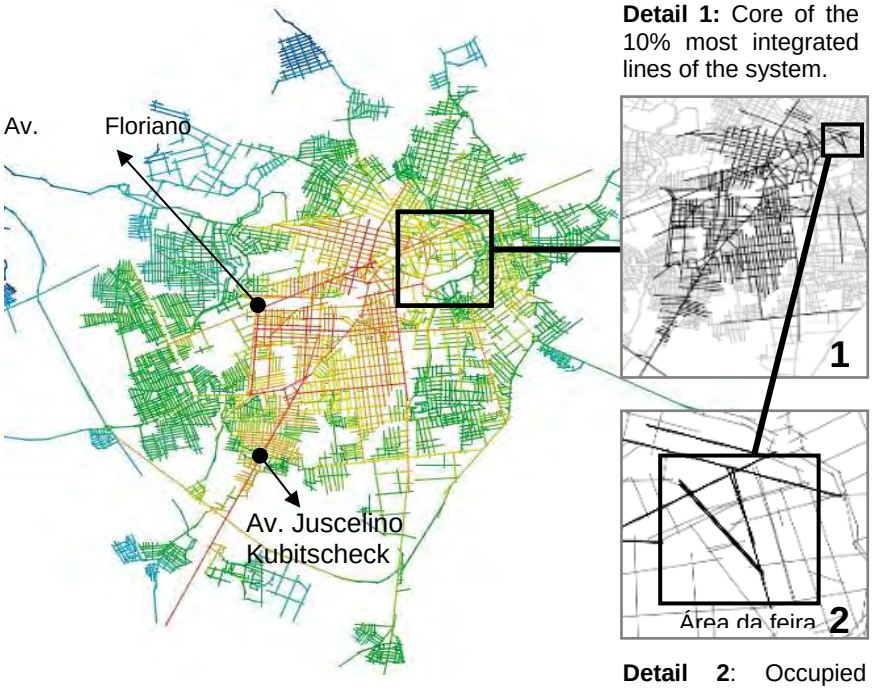


Figure 2: Global integration of Campina Grande.

Detail 1: Core of the 10% most integrated lines of the system.

Detail 2: Occupied area by the market in the core of integration

However, over time, there were serious consequences brought out by this spatiality, such as a constant increase in the number of conflicts – traffic jams, a slump in mobility and the quality of the infrastructure needed to run the market. was no different in the case of the Campina Grande market. After having been for many years located in the town center (Figures 3 and 4) and taking advantage of the movement of people inherent to these areas, the presence of the market began to bring about more bother than benefit, due to the increase in the number of traders and users in this space, which resulted in the growth of the dimension of conflict, such as the lack of mobility and cleanliness, for example.

There the market continued to be set out along the urban fabric, arranged in streets a little farther away from the site it had occupied until the mid-1980s, close to where it is today. In short, it was transferred in order to move the problems that were typical of this lay-out away from the center, i.e., it was thought that by moving this informal commerce away from the center, the conflicts would disappear.

In Caruaru, thought began to be given to relocating the market to another more suitable space for its operation. Unlike what happened with the street market in Campina Grande, of the various spaces considered for the relocation of the one in Caruaru, the only one which had the spatial facilities to receive it was an area near the center on the south bank of the river Ipojuca, later named May 18 Park.

So even although the two markets were urban benchmarks for the towns and were in town centers that have a strength and momentum of their own, some cases of conflict emerged in the growth and development of the street markets of Campina Grande and Caruaru that needed to be resolved at the earliest opportunity. Thus there was a need to think about ways to solve the main problems arising from their presence in the central urban space.





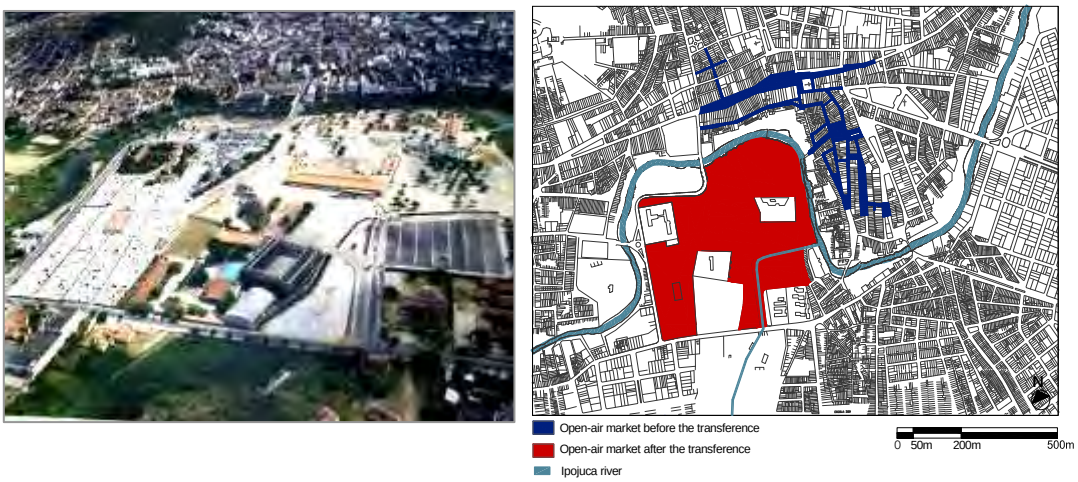
Figures 3 and 4: Market in Campina Grande in the beggining of the 20th Century where today is the Rua Maciel Pinheiro and in the downtown, in 1979. Sources: Historical Museum of Campina Grande and Jornal Diário da Borborema, respectively.

Different phases of transition: change and permanence

With the emergence of conflicts in the Caruaru and Campina Grande markets, several actions had to be taken by the municipal governments, especially with regard to mobility in the centers, since the flow and movement in this space were extremely badly affected, exactly because of the positioning of the stalls in the urban fabric.

Thus, in Caruaru, the lack of space for expansion, traffic jams, and the lack of infrastructure led to a discussion of what the best way would be to reorganize the street market and bring back those people who had stopped shopping in these places. All this also led to restructuring the town center so it could "breathe" and get all its inherent vigor back, besides moving the site of the market to an area near this central zone. Great care was taken to maintain the interface ii between the market and the town, something which is important for the existence of this informal commerce.

The new area went on to house the market of Caruaru, which had 1,861 stalls and about 4,000 traders at the time of the transfer in 1992. The Park was about six times larger, being about 154,440m2 (Rodrigues, 1992) (Figures 5 and 6), arousing such curiosity that Rodrigues (1993) described this site as a "new theater", due to the pulling power of the space.



Figures 5 and 6. May 18 Park in 1992 and comparative map with the market still in the centre of the city and after at May 18 Park (1992). Source: Jornal Vanguarda

This new area was given full facilities and support for users and traders was given to this area, by providing it with the necessary infrastructure such as water and sewage, toilets, sidewalks and paths between stalls, facilitating both pedestrians to move around and access for emergency services. In this project, something that was preserved was the relationship of neighborliness between the traders [iii] from the most different areas (some had been neighbors for more than 30 years), by marking out the areas according to what had been the case in the center. (Figure 7)

In Campina Grande, the same motives can be applied to the need for intervention by the municipal government. However, one of the main reasons was to be found in siting part of the market in front of a large supermarket, which directly influenced decision-making in the Town Hall. Thus, a stretch of informal commerce was prohibited from taking place on Avenida Marechal Floriano Peixoto, one of the main roads of the town which has a good level of global and local integration.

There was no transfer of activities from the Campina Grande market as in Caruaru, but its restricted functioning in an area with a low value of integration favored, without a shadow of doubt, the fall in the number of traders (Table 1) and diminished the flow of users and capital.

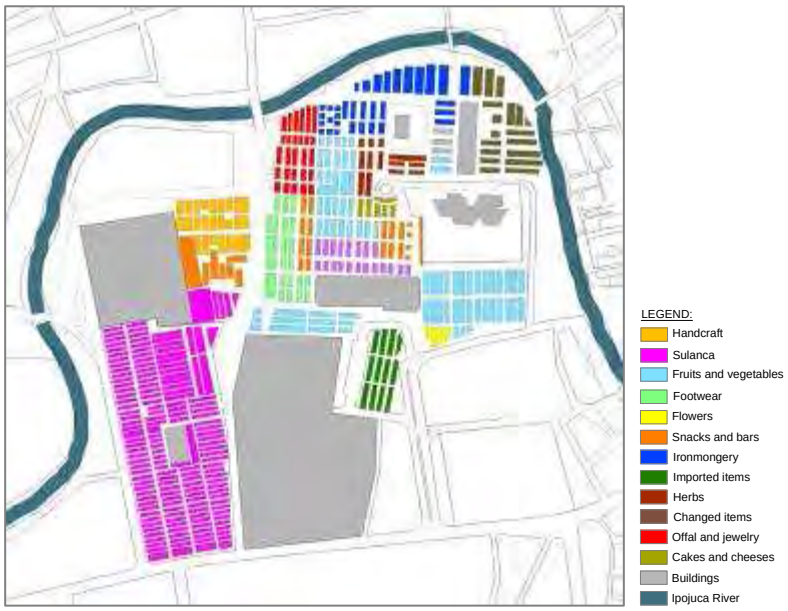


Figure 7: Displacement of the market in Caruaru after the transference to the May 18 Park in 1992.

Table 1: Number of traders and stalls in 1985, 2003 and 2008

CAMPINA GRANDE MARKET - NUMBER OF TRADERS AND STALLS		
Year	**# of traders**	**# of stalls**
*1985**	≅ 5000	2400
*2003***	3414	1500
*2008***	1876	≅1000

Sources:* Gazeta do Sertão, 1985; **COSTA, 2003; ** Administration of the Central Market - Sec. of Urban Services. Period from 22/08/2008 - Register of the sellers located in the central market of Campina Grande.

Thus, whether by relocating these two markets or not, the main intention of the intervention in the central spaces was to improve the market-town relationship and it was, to some extent, imposed by the complications arising from there being such trading in the centers of Campina Grande and Caruaru. But also, the interventions had an effect on the internal space with the passage of time, and this modified the dynamics of the functioning of both markets.

Integration and movement within the markets of Caruaru and Campina Grande

Integration and movement are characteristics of space and are closely linked, because movement only exists if a certain area is very accessible. Its cycle is established by the configuration of the road network, which shapes areas with higher and lower concentrations of flow (primary effect).

Hence we can conclude that if every market has movement and a large flow of people, this is because it is on a well-integrated site. This hypothesis is true in principle in Caruaru and Campina Grande, but it must be emphasized that the process is currently at the end of a cycle, as Medeiros says, because the functioning of such trading has already changed the configuration of both towns.

Syntactically, in Caruaru, although the market is not located in the nucleus of global integration of the town, the planned and orthogonal arrangement of the May 18 Park created another zone with weak global integration in the urban fabric, but one with high local integration, in addition to the existing integration on Avenida Agamenon Magalhães, one of the main avenues of the town (Figure 8). This means, in this case, that several internal areas of the Park, based on whether they were full or empty [iv], became points of movement and passage, starting with small lines that brought greater possibilities of accessing all the areas of the space.

Figure 10 highlights the local integration of the Caruaru market; the areas with greatest local accessibility are the north and west, with the middle also being very accessible. If the area of the market is highlighted and is correlated to the Figures below, the above hypothesis is confirmed, namely that the spatial pattern has a direct influence on the flow of users at certain points of the market, such as at Gates 1 and 11, for example. They have a good level of accessibility and flow of people, with a local syntactic value of 3.3821 and 3.2844, through which 134 and 58 people/min. circulate, respectively, on the busiest day of the week (Tuesdays, for Gate 1 and Saturdays for 11), as is shown by crossing the axial map with that of the count. (Figure 9)

On the other hand, this planned spatial configuration also brought with it low accessibility in some internal areas, i.e., there are several internal paths that do not have high local integration. This leads to what is observed today: the low use of some entire stretches of stalls, which adversely affects the market as a whole.

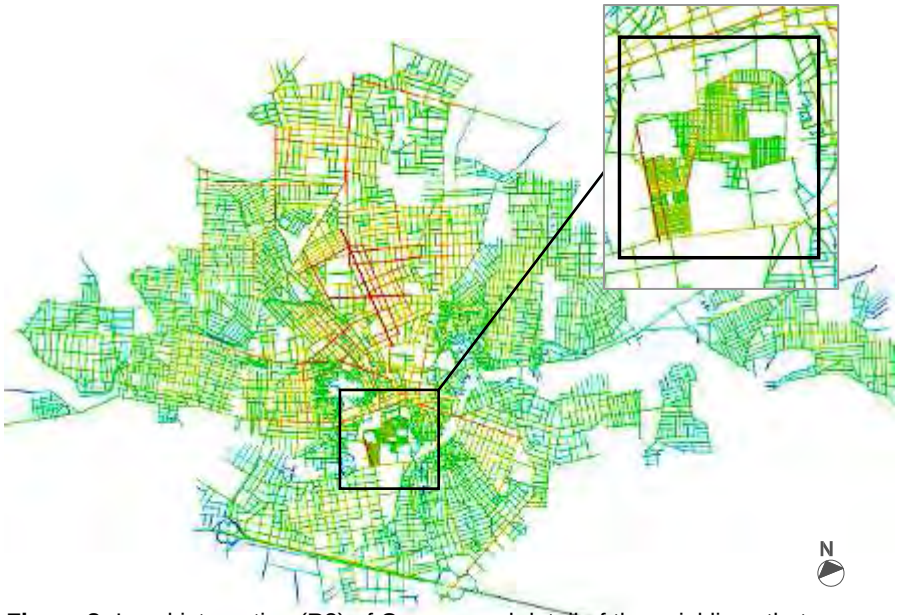


Figure 8: Local integration (R3) of Caruaru and detail of the axial lines that compose the Caruaru market – 2007.



Figure 9: Counting of people in the Caruaru open-air market on Saturdays – 7-9am.



Figure 10: Highlight to the less locally integrated areas of the open-air market of Caruaru.

As to such modification of use in primarily commercial spaces, Penn (2005) argues that the "grid of routes creates uneven flows of people in different segments." Thus, this inequality of flows creates places with larger and fewer opportunities for sellers to market their products. In the Caruaru market, the inequality of flows is such that many areas form underutilized pockets or even "dead" ones, due to the low use made of them, this also being noted through in loco observations associated with counts of people (Figures 10 and 11). This leads to reducing the value of the function of these

spaces due to the emergence of activities that are different from the original ones, such as deposits, brothels and “dwellings”. In this article, this process is called internal emptying, a result, among other reasons, of the weak internal movement of people, as mentioned above, and the departure of traders who go to trade on the streets around the market.

And as to local accessibility in the Campina Grande market, it has no such noteworthy feature. The streets that are tangential to it are the same ones which have good global and local integration, while the others around the fair do not have satisfactory local measures, as Figure 12 shows.

This figure also shows that the areas of greatest local integration are in the center and south, However, as noted at the side, the part of the grid where the market lies does not have this morphological characteristic, it being the case that the street with greatest local integration, Avenida Floriano Peixoto, is only tangential to the street market (Figure 12 - Gate 1). It has an integration value of 3.5379, being the 13th most integrated line locally of the whole system, which confirms the good flow of people measured at the count gates, through which 31 people/min. pass, while the average of the other ones is 18.25 people/min.

This morphological characteristic is aggravated by the layout of the stalls in the middle of the streets. In many places, they take up the sidewalks of the stores or even existing homes (Figure 13), with only two strips being left for pedestrians.

This generates significant reflections on mobility and a decrease in the speed of the flow of pedestrians and barrow-boys, thus causing a sort of "traffic jam" between the stalls.



Figure 11: Pictures representing the highlighted areas in the figure 13, showing the internal emptying of the open-air market of Caruaru, in 2009 Sources: Gustavo Miranda.
Legend:

1. Area with brothels;
2. Empty space between stalls;
3. Stalls without use in 5 of 6 week-days that the market is working;
4. Stalls without use in 5 of 6 week-days that the market is working;
5. Demolished stalls and others working as warehouse;
6. Stall working as a “dwelling”.

The urban grid of this zone of the town has also caused several areas in the market to emerge which have a low local integration value, many of which are underutilized. In this article, they are called "bubbles", as are the ones in the Caruaru market. They are characterized as being a little aside from the central market, because they have little movement (on the day of greatest flow, 15 people/min. passed through the site, a rate below that of other points in the same period) and as giving a greater sensation of insecurity than other parts of the market, as stated by 45.4% of the respondents who cited several areas as unsafe.

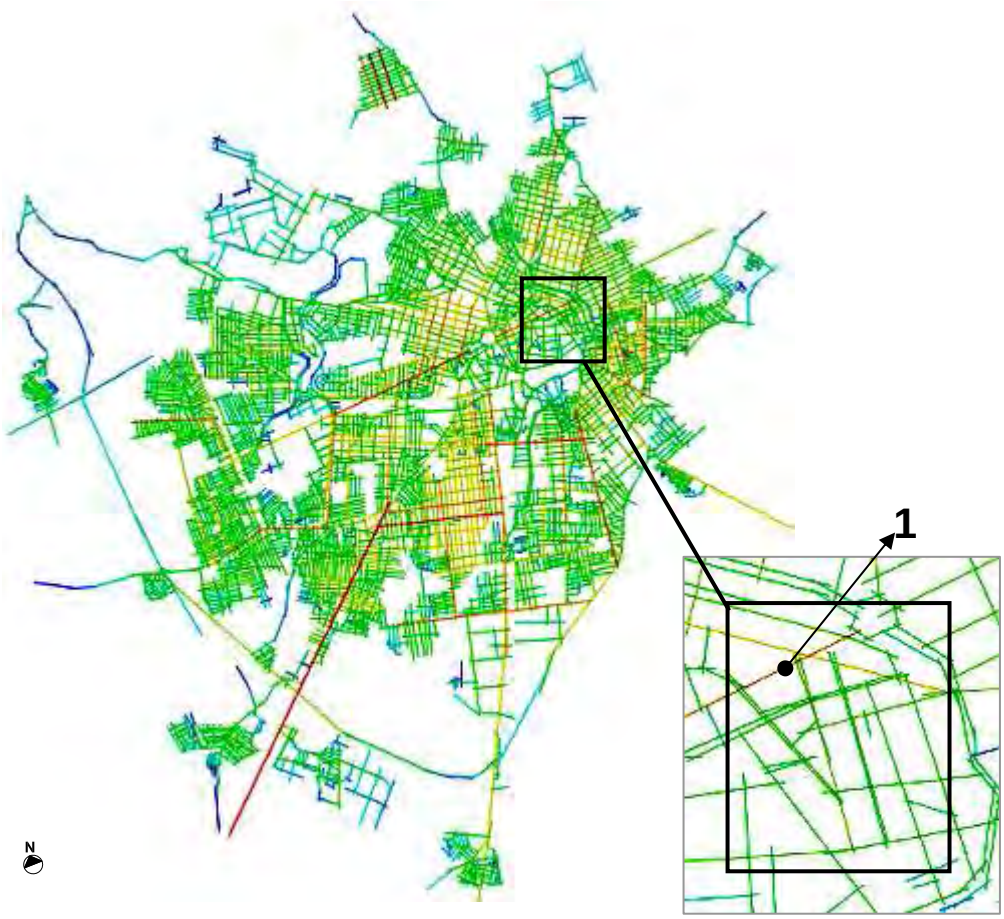


Figure 12. Local integration map (r3) of Campina Grande, highlighting gate 1.



Figure 13. Sidewalks occupied by stalls. Source: Gustavo Miranda, 2009.

However, not only the spatial configuration in itself explains all the causes of movement. The built environment – full and empty elements - may explain the whys of the type of movement in a particular area, as shown by Medeiros (2006). And in the Campina Grande market, this happens even more strongly, as recorded in the field observations, while lack of visual permeability is also considered a strong ally of the sensation of insecurity in some places and of segregation in others.
In the Campina Grande market, this happens in the areas behind the meat market, since it occupies an entire block, thus functioning as a physical and visual barrier for buyers and dividing the market into two, one to the north and the other to the south, this latter being the more segregated of the two (Figures 14 and 15).



Figures 14 and 15: Meat market hightlighted as a visual block in the surroundings of the Campina Grande open-air market. Sources: Google Earth and Gustavo Miranda, 2009.

These observations and this analysis show that in Caruaru and Campina Grande, the markets undergo processes of modification and adjustment to their internal structures, as consequences of spatial influences that they have suffered over time, in a convex area or even if arranged along the urban fabric. Therefore, the analysis of local integration has become relevant to understanding the use of the internal area of the markets but this is also associated with field observations and counts at the gates.

A check was therefore made that in Caruaru there had been a significant alteration over the years in the rhythm of movement in the internal area of the market, which generated a process of internal emptying, whereas in the Campina Grande market, the very fabric of the town in which it was located led to a gradual decrease the number of people and the underuse of some stretches of this informal trading.

Thus, this confirms what spatial syntax already predicted in the first analyses, namely, there is not a standard result of occupation of the territory by the markets studied but rather this happens in different ways, resulting from the association between urban form and the activities taking place within and around these markets.

Movement and patterns of use of the markets: participant´s observations

The dynamics of street markets take place due to the association of different factors, whether they be spatial, economic or cultural, that influence the generation of movement to and in these areas. And

the use of the land, based on what was argued above, also establishes a direct relationship with movement, mainly by virtue of the outreach of these markets, thus influencing the way that attraction to these spaces will present itself.

To understand the association of movement/patterns of use, it was necessary to undertake more detailed field observations on the functioning and dynamics of the markets studied, by associating them with the use of counting people at "gates" into and out of these markets.

This resulted in confirming assumptions raised even at the survey of the literature stage. Everything was submitted to the issue of accessibility, movement and use of space, whether internal or external to the market. Thus, in the period of observations, it was unequivocally found that the Caruaru market has a large weekly dynamic, because of its regional and national outreach, with the flea market (*'sulanca'* in Portuguese) having an economic strength that stands out from the others.

As to the market in Campina Grande, its dynamic is more restricted to the town and the neighboring places, without having one sector that stands out from the others, but with a typical market functioning, which still follows the urban layout. But both markets have conflicts and situations that only hamper the functioning of trading and that reinforce the need for a closer look, as shown below in the various observations made on the markets of Caruaru and Campina Grande.

Observation of participant: week-end

When the Campina Grande market gains most movement



Figure 16: Extra line of barracks on Saturdays in Campina Grande. Source: Gustavo Miranda, 2009



Figure 17: Child working as a barrow-boy in the Campina Grande open-air market. Source: Gustavo Miranda, 2009.

In Campina Grande, the weekend in the market revealed something that was expected beforehand: the increase in the number of vendors and stalls at the fair. Many of them formed a third row in areas where there were already two, considerably reducing mobility at Gates 3, 19 and 22, for example (Figure 16).

Another factor that contributed to the difficulty in walking through the market was the barrow-boys. Shouting "watch out – this is heavy!" or "watch out – there´s blood!", they wind through pedestrians no matter who is in front of them. But, however threatening this may be, happily the way they speak makes it quite funny. But for the traders it is not. They complain a lot about these barrow-boys (15%, at least, of the respondents complained about them) because there is a real excess of them in the market. It is almost impassable as the stalls are in the middle of the street, and even more so with these barrows in transit and upsetting the mobility of the customers.

What is not funny, but certainly degrading, is the fact of children doing this heavy work, which begins at dawn on a school-free Saturday. At this time, there are boys of up to no more than 10 years old carrying goods to help support the household (Figure 17).

The announcement of products and the competition between stallholders was visible and audible. While one shouted at the top of his lungs, "40 bananas for one real," another neighbor, so as not to fall behind and lose custom, shouted louder, three times in a row "50 bananas for one real." But it is not only them. Others make themselves heard in the best and loudest possible way so as to advertise their products to the four winds.

Most vendors at the Campina Grande market pay no taxes whatsoever. According to information received from the director of the central market, only 80 to 90 of them pay the land use fee, currently $5.00 to $10.00. He complained that, without this fee, the benefits for the market are few. This explains why very often during our walks through the market, traders were wary, wondering if the study was some kind of inspection.

Thus, in this market, Saturday is the busiest day of the week, as shown below in Figure 18. On this day, people from other towns and from the region use the day to come and shop, as well as to meet up with acquaintances and to sell their products.

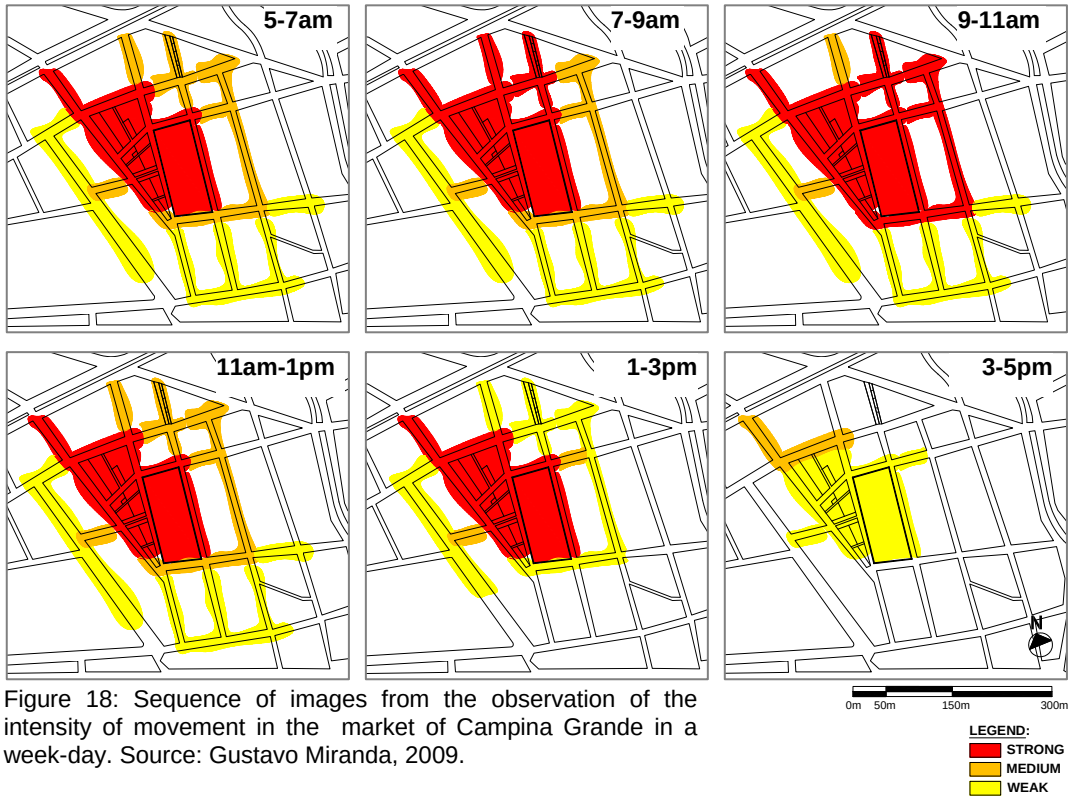


Figure 18: Sequence of images from the observation of the intensity of movement in the market of Campina Grande in a week-day. Source: Gustavo Miranda, 2009.

Intense movement inside the Caruaru market

Intense movement of people. This was registered in the Caruaru Market at all times of observation on the Saturday, since the market does not function on Sundays, and the count of users reflected this. The availability of parking near the House of Culture is largely responsible for this, for the flow of users was great from early on, especially next to the meat market, through the gates of which 20 people/min on average (area 2) passed. Motorbikes, cars, buses, "Toyotas" (mini-buses), in short, every kind of vehicle has easy access to this area of the market, bringing in the residents of the nearby steadings and towns to "stock up from the fair" and take back groceries for the entire week, especially by taking their business to the fruit and vegetable market. However, at other points far from the accessible areas, not a single person passed by, generating a sensation of insecurity, such as at Gates 5 and 10, in the area marked 1 (Figures 19 and 20).

However, during the morning, the number of people gradually increased in the direction of center-market, via the access routes both from the center and the market, which is reflected in the increase of the flow in most of the gates, especially in the north and south areas of the May 18 Park. But from mid-day, the sense of movement is reversed since the stores are closing, as are the stalls, as shown by the blue arrows in Figure 21.

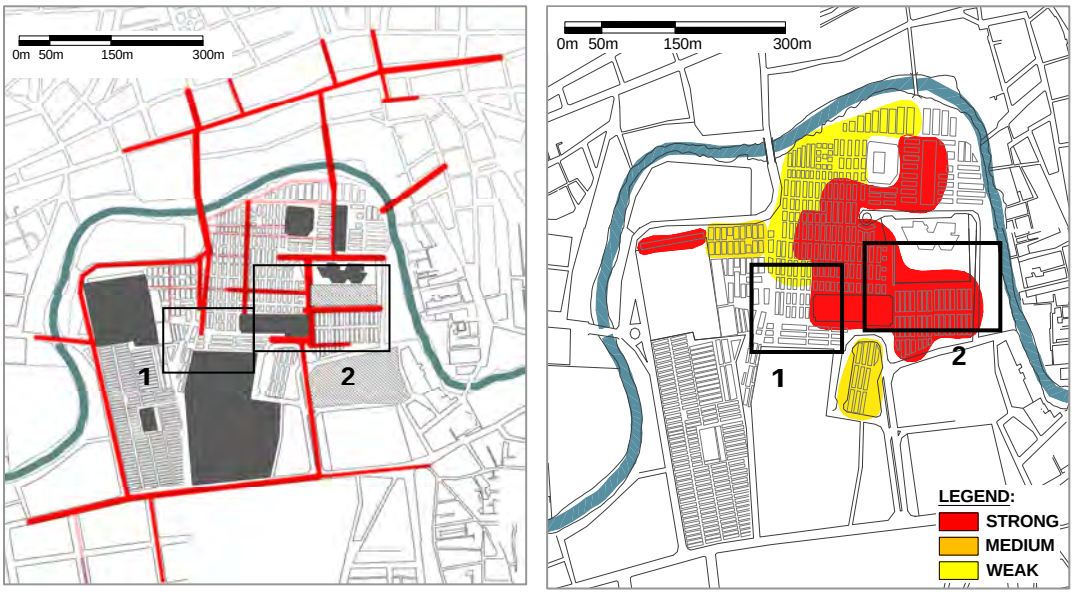


Figure 19: People counting map on Saturdays (7-9am), highlighting the areas 1 and 2.
Figure 20: Map with the observation of the movement dynamics in the same period of the previous one.

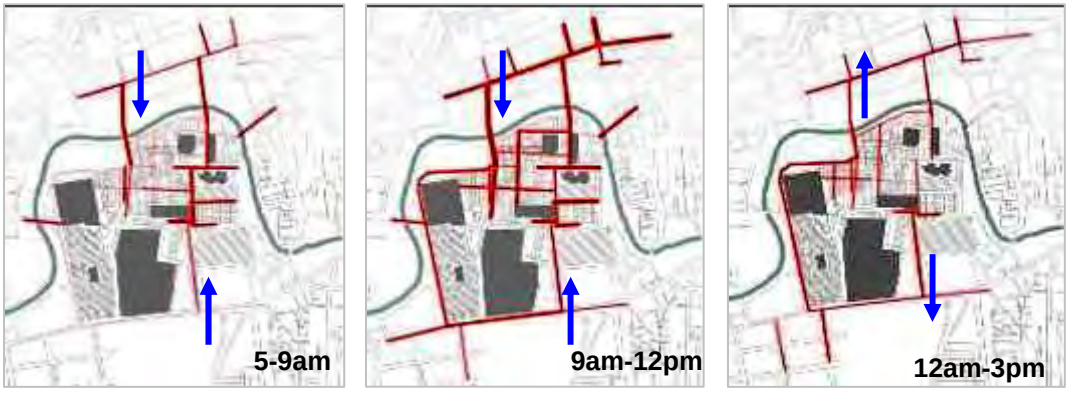


Figure 21: Indication of the flow of people in different periods on Satudays (blue arrows).

Observation by the participant: during the week

This observation period concentrated, both in the Campina Grande market and that of Caruaru, on the attention paid to these informal markets on weekdays. There was the tendency that, in this period of observation and count, the dynamics of functioning in both markets differed greatly from that of weekend days, when the movement and flow of people are considered strong. And this trend was confirmed, with the exception of Tuesdays in Caruaru, when the flea market takes place, this being examined in detail later in the article.

Weak but constant movement in the Campina Grande market

In the Campina Grande market, on some weekdays, observations were made from morning till late afternoon. From early on, stallholders were working, selling greens and vegetables at the main entrance and inside the market, but fewer than normal since it is not a period with a great movement of buyers. However, during the course of the day, the flow increased considerably, with certain stretches receiving an increase of over 100% in the number of people, such as at the main entrance to the market (Gate 2), jumping from 9 to 22 people/min, in the period from 5am to 7am to that of 7am to 9am, respectively (Figure 22 - Parts 3 and 4).

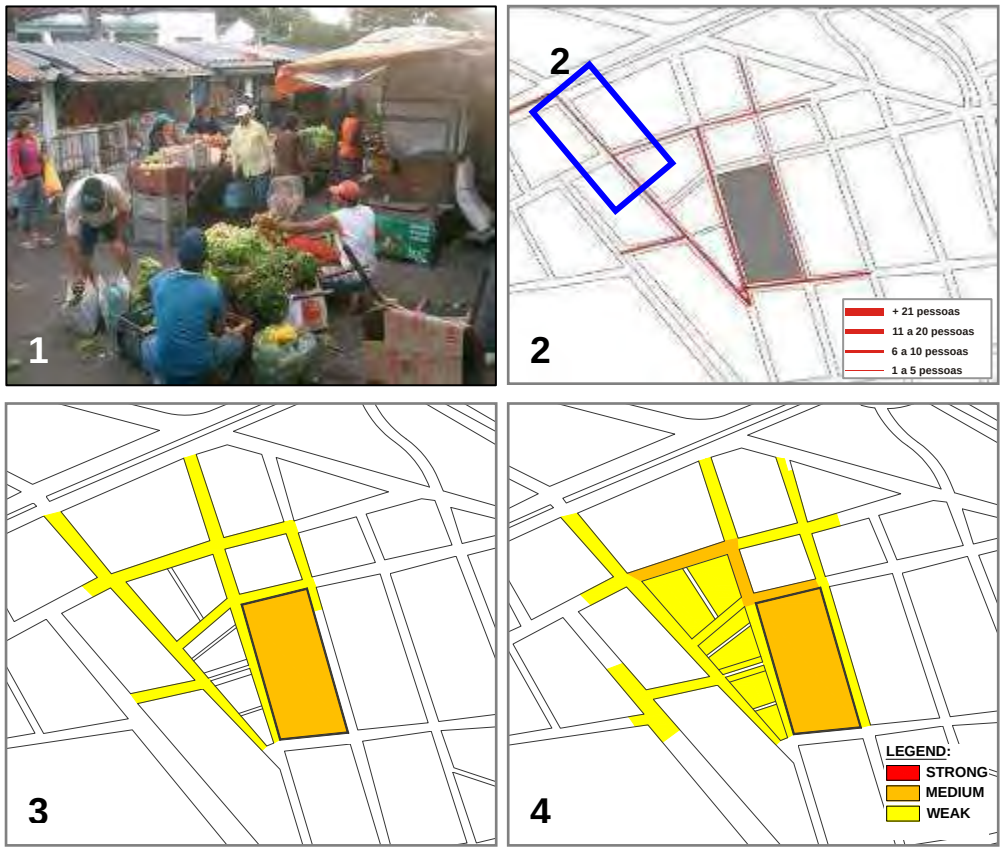


Figure 22: Image of the movement in the market of Campina Grande. (1) Marketers in one access of the open-air market; (2) gate 2 (11am-1pm) highlighted and the flow of people shown in image1; (3 and 4) maps with the flow of people in different periods parts of the market from 5am to 9am, during the week. Sources: Gustavo Miranda, 2009.

Throughout the day, another area that received an increase in the flow of people was the surroundings of the meat market, especially to the north and west. This is a reflection of existing uses

at the market, such as that of fruit and vegetables (north) and clothes, foodstuff and household utilities (west). These areas receive much of the flow of people during the day, for they have more drawing power than others elsewhere in the market. (Figure 23).

This internal use produces images very peculiar to the market, such as at some points of streets near the meat market, where there are women, often elderly ladies unpeeling beans quietly in front of passers-by (Figure 24), while their husbands and children sells bags with these beans, besides cassava, grapes, lettuce, etc.

As to regular commerce around the market, this basically consists of activities related to the market, such as for example, min-markets, bars and snack bars. Others, such as various dwellings which remain on the streets occupied by the market, try to stay there, this being a problem since one of the major problems they face is that many of these sidewalks are taken up with merchandise or stalls in front of these buildings, and this reduces the mobility of those who live there (Figure 25).

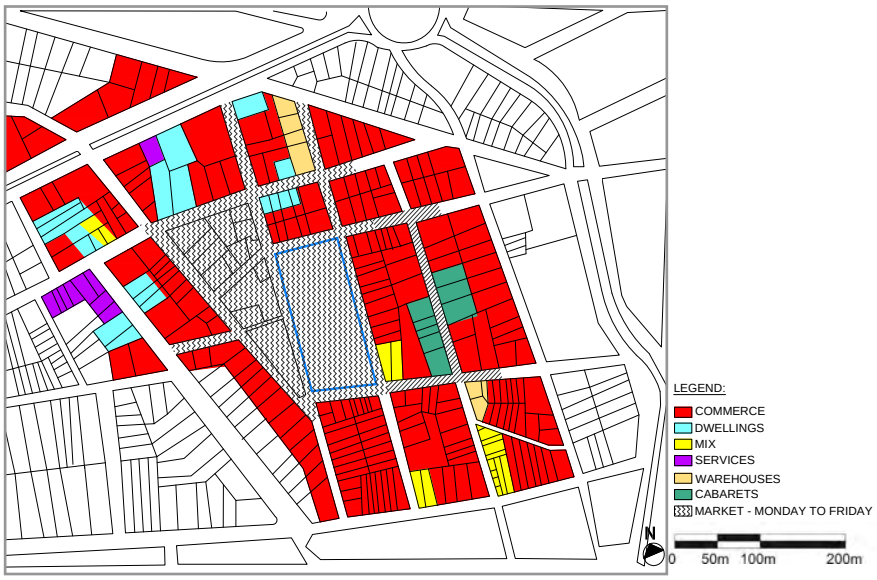


Figure 23: internal land use of the Campina Grande market.



Figure 24. Elderly lady unpeeling beans quietly in front of passers-by. (Gustavo Miranda, 2008)

Figure 25. Market stall in front of a house in Campina Grande. (Gustavo Miranda, 2009)

Another well-established use in the vicinity of the market is that by storerooms and warehouses for the deposit of merchandise sold at wholesale, both to stallholders and to the formal retail commerce sector. For the market, the existence of this use does not contribute to a significant flow of people in the area, because it is not an activity that generates much movement of people, caused by specializing in this area, i.e., there is not a diversity of uses that might attract more people and increase the movement of people in this area, thus reducing the existing temporality.

Likewise, there are those activities that indirectly take advantage of the commercial symbiosis between formality and informality, such as brothels or "cabaret" spots (Figures 26 and 27), red-light areas, which serve the public who go to sell/buy in the space of the market. According to the Director General of the fair, Aguinaldo Batista, in the '60s and '70s, when there were no nightclubs in the town, these places were visited a lot by rich people in the region, but this does not happen today because drug users and drunks are the most likely characters to be found in these places.





Figures 26 and 27: Brothels in the same street of the market of living animals.Source: Gustavo Miranda, 2009.

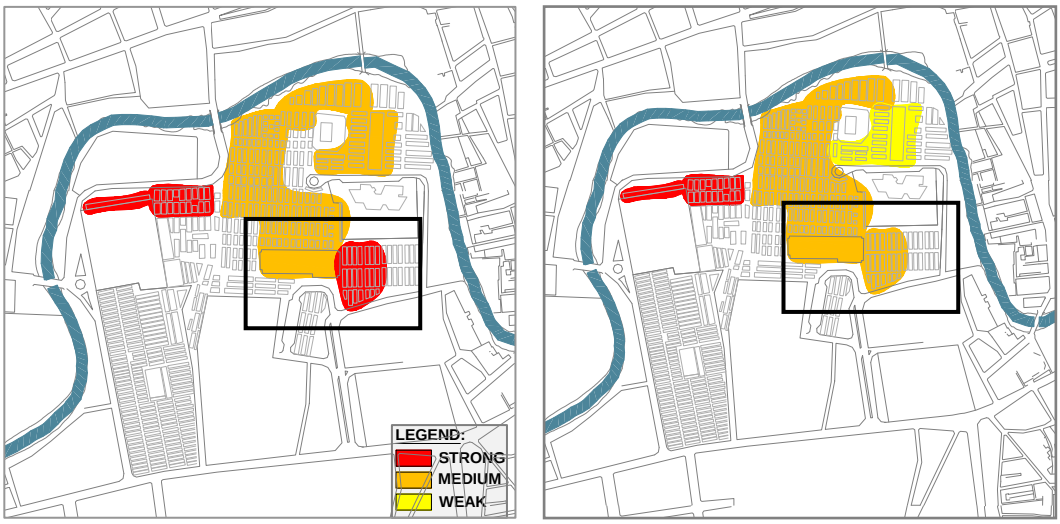
All this contributes to the south/east areas of the market being one of the most segregated, not only because of the configuration of the grid, but also because of the existing uses and the feeling of insecurity generated, which causes people to avoid walking through them, thus becoming only a place to park and to sell goods wholesale.

Week-days in the Caruaru market: of little movement to the apex with the flea-market

The beginning of the week in the Caruaru market did not have a high presence of people in many of the areas, even in those in which there was great movement on Saturday, such as in the east area of the fair, beside the flower sector and the meat market (area highlighted - Figures 28 and 29), since on these sides there is easy access for both vehicles and pedestrians. If these empirical data are put alongside those checked previously by means of space syntax, it is confirmed that there really is a direct relationship between the functioning of certain parts of the Caruaru market and the degree of topological accessibility to them, at least during the week.

During this period, basically the same markets as on Saturday functioned, but some of them had fewer stallholders and buyers, such as those of handicrafts, fruit and vegetables and flowers, for example. In the first of these, there was a threefold drop in movement, on Monday; in the second, by 50%; and in the last, it is almost eight times lower in relation to the count on Saturday.

On continuing to walk through the fair late in the afternoon so as to conduct the counts, a different movement was noted near the flea market area, which caught our attention. Many of the owners of the stalls which had remained closed for the whole week began to set up for the flea market, which would only take place as from 3 o´clock in the morning on the following day. There was the arrival of mini-buses with materials, the setting up of tents, the cleaning of stalls, the sweeping of streets, the arrangement of racks and display cases and unpacking of merchandise, in short, everything that a trader can do to organize his sales was done.



Figures 28 and 29: Average of the intensity of people in the market of Caruaru during the week, from 11am to 1pm. Source: Gustavo Miranda, 2009.

Observation by the participant: the spatial dynamics of the flea market

In this phase, the observation *in loco* was conducted on the specific day of the flea market, in Caruaru. The Tuesday was nothing like the other days of observation, as there was much more movement and there was a larger number of traders and users within the periods used for observation. The flow of people that began on Monday afternoon increased a great deal during the early hours of dawn. The setting up of the stalls was not just limited to the fixed ones but there were also collapsible ones, brought in from the "graveyards of stalls" (Figures 30 and 31) from midnight by porters who set them up at various points, as in the market of imported goods, in front of the arts and crafts market and flea market, and took up one of lanes for vehicles, thus causing a lot of disturbance to traffic from dawn.



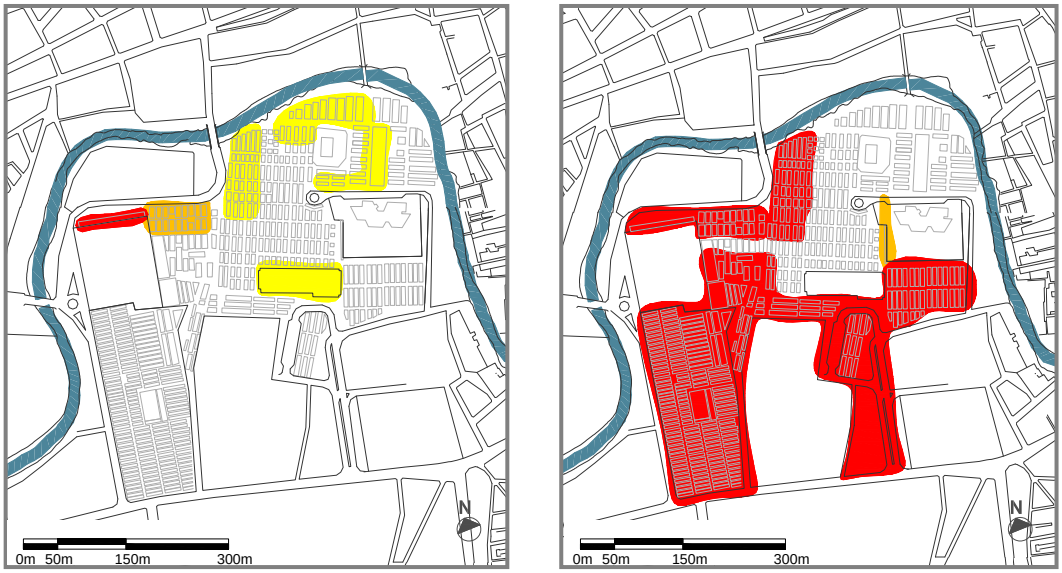
Figures 30 and 31. Cemetery of wood stalls. In other part of the market metal stalls being fixed. Source: Gustavo Miranda

It was still early morning when the market began. And it was the 5th largest Flea Market of the year (Fathers' Day), according to the President of the Association of the Flea Market Stallholders of Caruaru, coming behind only the markets that took place before Christmas, New Year, Mothers' Day and the St John's Festival. Any one of them has the power to attract more than 100 thousand people per market between vendors and customers, in a relatively short period of 8 hours of operation.

In the hours in which the market was held, it became clear that the enormous movement and the vast flow of people (up to a maximum of 147 people/min in the vicinity of the market, and 172 within the Flea Market, at the height of the count, from 9am to 11am) occurred along the edges of May 18 Park and in the streets close to it, because of the trading in clothes and related articles.

Thus, the power of attraction or the "magnet" that this market exercises is so strong that it significantly alters the internal balance represented on the map by stains (Figures 32 and 33), thus shifting much of the functioning of the interior of the market to the west /southwest edge of the Park, which causes many shopkeepers to put their goods in the middle of other sectors, which make the activities clash. (Figure 34 and 35)

Mondays 3 – 5pm **Tuesdays 5-7am**



Figures 32 and 33: Observation maps showing the change in the intensity of use of the space of the May 18 Park, during the period before and after the Flea Market, on early Mondays. Source: Gustavo Miranda, 2009.



Figuras 34 and 35: Flea market stalls in front of the handcraft ones. Source: Gustavo Miranda, 2009.

Additionally, this “magnet” role of the Flea Market has caused many upsets and changes to the streets in the immediate surroundings. The changes contribute to one point in common, the transformation of the use of the buildings that flank May 18 Park, which stop being dwellings and turn into stores that sell products related to the Flea Market (a process of invasion-succession vi). However, the symbiosis between formal and informal commerce also brings good fruit, such as that of generating jobs, especially for the former, which depends heavily on the existence of the clothes market and the force it has to attract buyers (Figure 36).

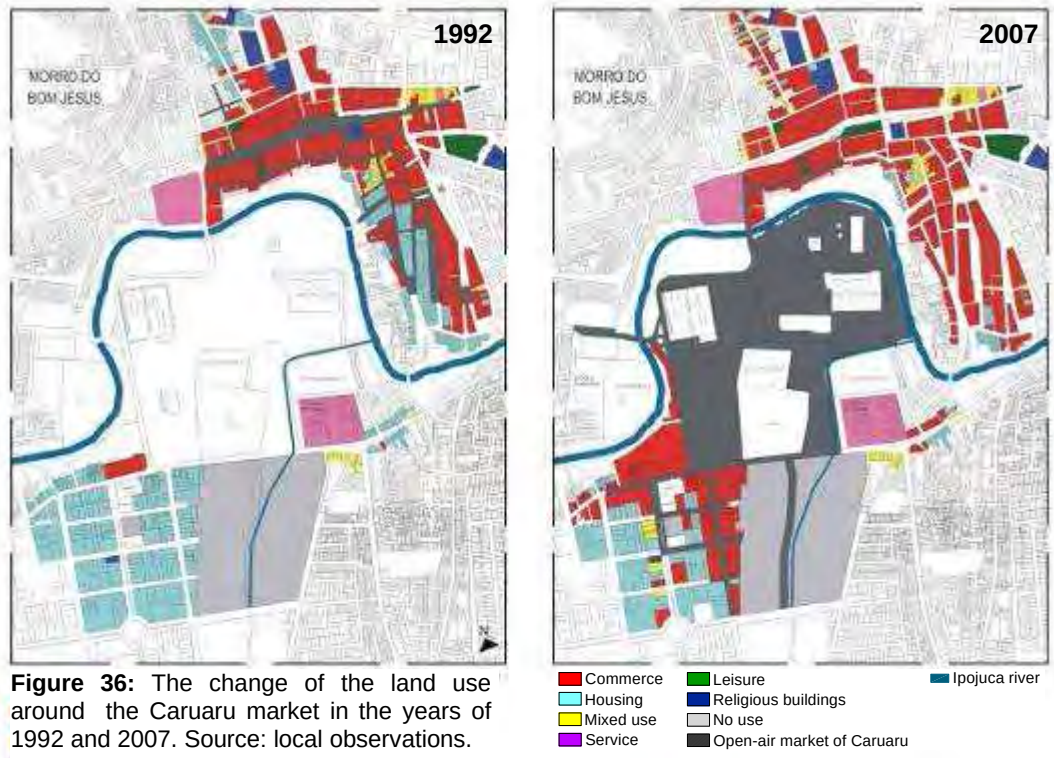


Figure 36: The change of the land use around the Caruaru market in the years of 1992 and 2007. Source: local observations.

Yet, the disturbances have a greater impact, since they affect the lives of thousands of people passing through this area, from dawn, when the streets are taken over by hundreds of stalls and thousands of people, thus slowing down the flow of vehicles and causing traffic jams, besides the internal emptying process already mentioned.



Figure 37: Comparasion between two different moments in a same flea market área, without or with users. Source: Gustavo Miranda, 2009.



Figure 38: Comparison between two different moments in a same flea market área, without or with users. Source: Gustavo Miranda, 2009.

Another upset is the lack of occupation of the flea market in May 18 Park during the week because it functions for only 9 hours a week, which means less than 25% of a working week, thus leaving this space idle for long periods, in comparison with other days of observation. Thus, it is easy to observe this difference in the use of the area when the various observation moments are placed together, from 5 am to 5 pm, as in the earlier maps. This constant and the high seasonality leads to a sharp fall in maintaining a neighborhood-watch-type surveillance and to the emergence during the week of criminal actions, such as assaults, homicides and drug trafficking in the area, which are reported daily by the local media. (Figures 37 and 38)

Therefore, why not provide a rotation of use of the idle Flea Market space by introducing options that would diminish this seasonality, besides finding a more sustainable use for the hundreds of stalls which are shut for most of the week? An example of this dynamic in the use of space can be found within the market itself. Behind the *Casa da Cultura* (Culture House) there is a space, already cited in the observation of Saturday, which receives the fruit and vegetables market by using collapsible stalls, which thus leave a space which, on Tuesdays, is occupied by dozens of stalls selling clothes.

Thus, the operation of the market itself responds to issues such as these, without the need for large radical changes, but simply respecting the territoriality and the existing commercial infrastructure, which reflects the type of commerce that is being built up. Therefore, all this ends up

by having a reflection and by being determining for the model of spatial occupation in the Caruaru and Campina Grande markets, besides the dynamic having been modified a long time ago of the relationship between this informal commerce and the town, whether in economics, in culture or even in the mode of management, but mainly, in the spatiality of these markets.

Two different spatial dynamics of the markets: *the market-thoroughfare and the market-patios*

Both the markets of Caruaru and Campina Grande are currently undergoing very singular processes of occupation of the urban space by informal commerce and which have been almost immediately reflected in the relationship of market-town. This, to some extent, has to do initially with the dynamics of trade, on account of the search for a greater number of sales and an increase in the income of those traders. Consequently, there is a spatial reflection, whether in the need to retake the street space or whether because of the need to survive, given the threats from the competition with formal commerce.

Thus, based on the observations taken in the filed through an analysis of the spatial occupation, it was possible to get two different forms of occupation, which will be put forward in two new morphological classifications for markets are

The understanding of the differentiation in the model of occupation of the urban space by the markets of Caruaru and Campina Grande was essential for them to be classified in this study as *market-thoroughfares* and *market-patios* (Miranda, 2009) (Figure 39).

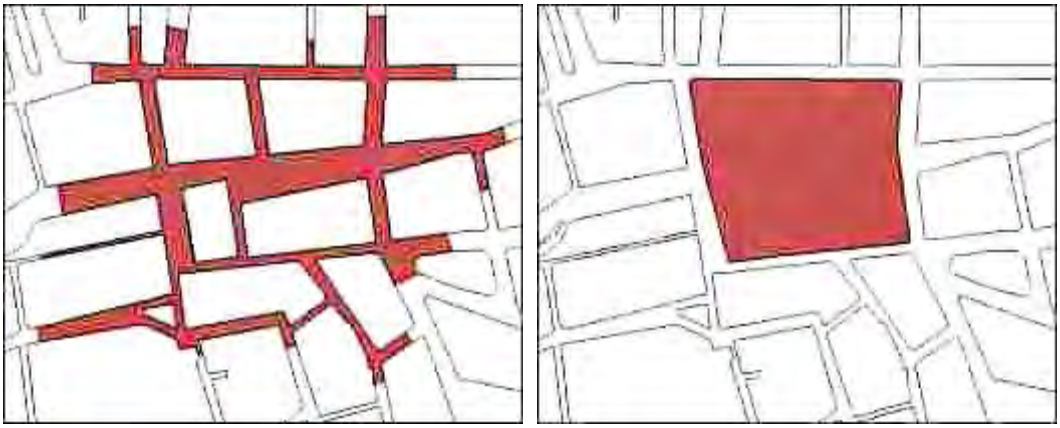


Figure 39: Sintesys of two different types of spatial occupation by open-air markets: the *market-thoroughfares and the market-patios.*

The *market-thoroughfares* are the best known as they are laid out in the very fabric of the town, regardless of the coverage they have, of whether they serve some neighborhood or have regional outreach, as is the case of the central market in Campina Grande. This type of market usually "asks to borrow" the space of the town in which it will be fixed, but it gives back to the town an urban dynamic that brings with it a large flow of people, various movements and strong economic life.

The number of examples such as these is undeniably greater than the other type of market, which has also been establishing itself as a new mode of setting out this commerce in towns. The *market-patio* type is characterized by being located in its own and planned area in which there is a special infrastructure: it is independent and has its own regulations so that it may take place in periods that are independent of the functioning of formal commerce. Normally, they are located in

areas on the borders of the center, since they are reflections of a new way of thinking, in which they are regarded as elements that are harmful to urban centrality, as happened with the Caruaru market.

This type of market has a different relationship with the space in which it is located, vis-à-vis the *market-thoroughfare*. The *market-patio* does not borrow the space in which it is located, but rather the latter becomes part of it, which leads to the other type of relationship of the user/ trader with the market and to the emergence of conflicts of dimensions that are totally different to those that occur in street markets, normally due to the management of these areas being relaxed.

Actions and reactions in the spatial dynamics of the markets

On examining the role of the urban fabric of each town in the functioning of the markets of Caruaru and Campina Grande, based on the analysis of the accessibility existing in both and how the spatial articulation between the informal forms of commerce and the territory take place, it was noted that, in one way or another, the markets studied demonstrate that they still have a permanent contact with the urban space of the towns. Examples that are easily seen are the occupation of the streets and the arrival of new traders in Caruaru or the departure of others with the weakening of the functions of the market, in Campina Grande.

However, one of the goals was also that of showing that an evolutionary process, whether of adaptation or even regression, is a way of reacting to an imminent need. And the markets of Caruaru and Campina Grande have undergone or are still undergoing such situations.

This became clear from the field observations and counts carried out, in which the dynamics of functioning is completely involved on account of the flow and movement of people. However, the presence of strong attractors (magnets) was also registered, such as commerce which has low prices and many similar activities being next to each other, which leads to a greater movement on some days, less on others, but one that is always there.

Thus, it became clear that this enhancement of functioning arises on account of the search for greater profitability and profits, the primary target of any commerce, but it brings with it many conflicts, such as the lack of use in some areas, low mobility in the space, difficult intelligibility and the sensation of insecurity, just to name a few.

Even with all this, it is noteworthy that both markets still have the power to generate movement patterns, to attract large flows of people, to receive new functions and to bring out the potential in the development of urban space. Therefore, the search for new ways of relating to the territory is concrete and clear from the moment the markets explore the urban space in the best way possible, since their actions are responses to a context of imminent needs.

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The Role of a Form-led Approach in the Expansion of Irish Towns: urban morphology tools for planning

Art McCormack

MosArt (Architects, Landscape Architects, Urban Designers), Wicklow, Ireland

art@mosart.ie

Telephone: 00 353 404 25777, Fax.: 00 353 404 25745

Irish towns have expanded at an unprecedented rate over the past fifty years. The suburbs with their diverse land use critically lack a coherent structure and spatial schema. This crisis results from life style and political influences but also to a large extent systemically due to planning that prioritises land use and infrastructure over form. A study was carried out on eight Irish towns into how a form-led approach to urban expansion in Ireland could engender improved urban planning. The study identifies four essential urban morphological determinants that can be used for description and analysis and also as tools for planning and design. These tools are the: *conceptual determinant*, concerning the essential layout type of the town; *physical determinant*, comprising landscape characteristics and the infrastructure of transportation; *organisational determinant*, focused on the sequential arrangement of tissues reflecting, density, intensity and land use; and *structural determinant,* involving five essential urban elements, namely, routes, nodes, edges, districts and landmarks. This paper focuses on two of the case study towns, outlining their rigorous analysis. Consistently this study demonstrated that, without having recourse to an underlying plan-based form, town suburbs lack coherence. Yet in each town examples of where the urban fabric contributes to morphological order were found, so providing the basis of a set of models for form-led planning. In conclusion, the study recognises the importance for decision makers of understanding urban form both two-dimensionally and three-dimensionally, including sequentially, at all of its levels, from the building/plot to the whole town scale, in order to achieve improved coherence of the urban fabric.

Keywords: urban morphology; urban form; form-led approach; urban planning and design; Irish town expansion, planning tools.

1 Introduction

A critical problem with contemporary urban form, particularly regarding town expansion in Ireland, is the paucity of a ‘coherent structure and spatial schema’ (Altman, 2007). These are matters in general at the heart of urban morphology as applied to planning (Maitland, 1984).

While studies have been carried out on changes in urban form in towns throughout Europe, including Irish towns (O’Connell, 2006, cited in Kealy and Simms, 2007), no work to date has been carried out on the form of recent and current urban expansion in Ireland. Rather morphological research has tended to be academic and historical in focus, without addressing the radical changes that have occurred in planning over the past century (Gauthier, 2005). This paper will look briefly at the history and morphological nature of Irish towns followed by a consideration of key problems pertaining to their growth and extension. It will, then, outline a case in support of a morphological approach as well as a method for realising this and will proceed with an analysis of two case study towns. The latter towns belong to a set of eight case studies analysed as part of a more detailed examination of the potential of urban morphology as a basis for the planning and design of town expansion in Ireland (McCormack, 2010a).

2 Background

2.1 Outline Development of Irish Towns up until the 18th Century

The origin of an Irish town is likely to have been sometime during the past 1,500 years, from one of the following eras: the Early Christian period (c. 800 to c. 950), the Vikings invasion (c. 800 to c. 950.), the Anglo-Norman invasion (c. 1170 to c. 1350), the Plantation and Georgian eras (16th, 17th centuries, respectively) and the Victorian period (19th century) (Bradley 1990, Whelan 1997, Kealy and Simms 2007, Dargan 1994, 1995, 1997, 1998, 2000, 2001). In most instances the form of the town bears evidence of the influence of its origins and the ensuing periods. Morphologically today many of these towns comprise a compact main street and core surrounded by an institutional fringe (Shaffrey, 1977; Lewis, 2001). However, as a result of depopulation due mostly to impoverishment and emigration, the growth of Irish towns was slow or stagnant from the time of the Great Famine in the mid-19th century up to the 1960's (Duffy, 2000). Since the 1960's almost all urban settlements have experienced significant growth, with unprecedented expansion occurring from the mid-1990's on (ibid.), especially during the delirium of the 'Celtic Tiger' economic boom (mid-1990's to 2008). The study of towns, upon which this paper is based, involved an analysis of contemporary urban form that has been created over the past fifty years through comparison with the period of stagnancy mentioned above which, for convenience, is regarded as an 'original' town.

2.2 Character of the Irish Town Suburb



Figure 1. Plan and photographic view of Kells, representative of the traditional Irish town with dense mixed use / commercial \core and minimal and relatively compact residential suburbs. Source Shaffrey, 1977.

In regard to form and legibility, the traditional town comprised a compact coherent core (Conzen, 1960, 2004a) with a modest residential ribbon extending outwards (Shaffrey, 1977) (Figure 1). In marked contrast to the relatively small fine-grained (proportion, pattern, direction) and fine-textured (complexity, density, size) fabric of the historic town, the physical structure and shape / pattern of the latter-day growth of Irish towns regarding suburbs, have been spatially loose, lacking coherence of form. This growth, reflecting a sprawl pattern typical throughout the western world, comprises housing estates as well as pavilion type buildings, for instance in extensive campus-style office and industrial developments, leisure centres, hotels, car sales units and institutional complexes. Such pavilions, whether isolated or clustered, are set in and surrounded by space rather than comprising buildings defining space.

This, therefore, reflects a fundamental morphological paradigm shift from the traditional compact town in which the links between the different elements (plot, street, constructed space and open space) formed a hierarchical system to one that is open and fragmented with autonomous and atomised elements which do not relate to each other (Levy, 1999, Carmona et al. 2003), comprising urban fabric that is criticised by Maitland (1984: 153) as ".. largely incoherent, hostile, unintelligible and inconsequential."

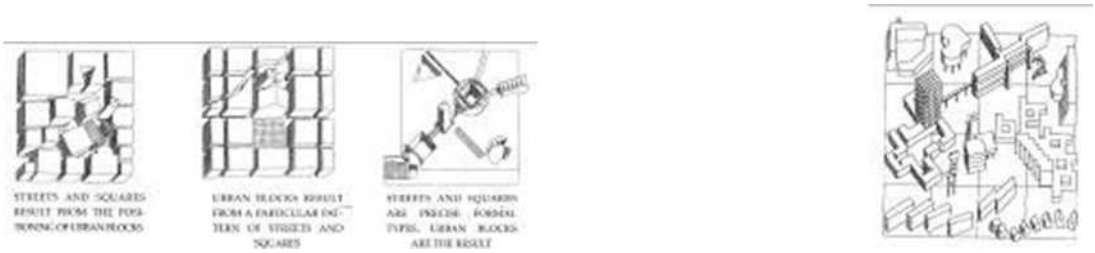


Figure 2. Diagrams juxtaposing three traditional urban core types with spatially integrated, coherent and compact structure (left) with the campus-like Modernist approach to urban form comprising spatial disintegration, incoherence and disorder (right). Source Krier, 1998.

2.3 Causes of the Morphological Shift: problems of planning systems and methods

Whilst the causes of this shift include life style and politics, it is also due to the normal approach in forward planning that places emphasis on the design of roads along with land use and densities (Hall, 1997, 2000, 2008; Hall and Doe 2000; Moudon, 2002) rather than on the quality and coherence of urban form. This is exacerbated where this planning approach, usually under pressure from public representatives, permits leap-frogging of certain land uses well beyond the urban edge and out of logical sequence. This land use pattern is supported by the prevalence and popularity of the car which, in turn, allows people to live, work and recreate outside urban cores to the detriment of the traditional town centre and of what is currently regarded as sustainable pedestrian use (UTF, 1999; Llewelyn-Davis, 2000, 2008; Altman, 2007). Together, this contributes to increased car traffic, car parking, road and other infrastructural development, further urban expansion, and so on in a viscous circle.

The situation in Ireland parallels that in the UK where there is also a systemic and methodological gap in planning regarding a conceptual structure and language to assist practitioners and provide guidance for coherence in the form of development (Hall and Doe, 2000). Moreover, the three-dimensional consequences of the conventional planning approach in regard to, for instance, spatial structure, sequence, building-to-plot positions and heights, are not normally considered (Hall, 2000).

2.4 Demand for outward expansion

While the argument supporting urban consolidation involving use of underdeveloped, unused and brownfield sites is strong (UTF, 1999; Llewelyn-Davis, 2000, 2008; Altman, 2007), it is not always easy to provide for contemporary needs and expectations within or even immediately adjacent to existing cores. Such needs and expectations include: popular demand for private (domestic) open space, easy vehicular access and truck maneouverability, frontage to vehicular traffic that usually

includes visual exposure of extensive areas of car parking, diverse shopping and leisure tastes for maximum choice and convenience, along with easy vehicular access and car parking.

However, suburban areas that satisfy these contemporary demands neither extend the traditional urban form from the core nor present a satisfactory alternative. So, the question that remains is how planning can ensure the creation of high quality environments in respect of urban form and what approach could be adopted in order to achieve this? We are in need of a different way of thinking that leads to a methodology for incorporation into the planning system.

2.5 The potential of urban morphology

Given that form has a much greater resistance to change than land use, it warrants at least the same if not greater attention (McGlynn and Samuels, 2000; Evans, 2005; Hall, 2008). Land use, for example, is mute regarding urban fabric, concerning physical mass and space, and thus cannot contribute to the forming of space by buildings or to achieving legibility and permeability (Kropf, 1993, 1996). Evans (2005) is emphatic about the need for a methodological shift away from the pragmatist consideration of land use, roads and capacities as primary bases for planning urban expansion to a form-based approach. He bemoans the fact that the UK has produced numerous tools over recent decades to assist planning in terms of structures, organisations, process and thought, comprising, for example, development frameworks, cross-disciplinary design statements and codes, but without effective improvement in the quality of urban form. Referring to certain inadequacies in the public system and damage done to the built environment due to limited thinking in planning and urban design, Kropf is likewise unequivocal: “urban morphology is essential for urbanism and urban design” (2005: 17).

Numerous studies of suburban residential types (Moudon, 1992, 1998; Hall and Doe, 2000; EDAW and Baxter 2003, 2005, cited in Hall 2008; Whitehand, 2005; Larkham, 2005) and/or inner urban fringe belts (Whitehand and Morton 2003; Whitehand, 2005) have demonstrated that morphological tools help bridge the gap between urban planning and actual implementation. Some more comprehensive form-based studies and/or planning guides have emerged, for example, in France (Samuels, 1993 and 1999; Kropf, 1993 and 1998), England (Dacorum Borough Council, 1995; Stratford-on-Avon, 2001) and Portugal (Oliveira, 2006).

Rather than deny the popularity and perpetuity into the foreseeable future of suburban development, the study on which this paper is based accepted urban expansion as a fact as well as its attendant car usage as a significant component in urban living and also accepted the consequential importance of roads and associated infrastructure as major components of urban shape and form. The study posited that an approach to planning which is not just informed, but is led, by a concern for form would make a significant improvement to the urban environment. Accordingly, it sought to redress the systemic gap by developing morphological tools to assist in the planning process regarding contemporary town expansion.

3. Methodology

3.1 Existing Methodological Bases

In adopting urban morphology as a discipline for analysis of the urban fabric, certain well established bases are available to provide methodological support (Kropf, 1993; 1996). In this regard, the interrelationship of different levels of the urban fabric is particularly important. This can be illustrated by the phenomenon of the building sitting within a plot, which sits within a plot series / street, which sits within a block, which sits within an urban tissue, which sits within the whole-town. This hierarchical parts-to-whole relationship of levels pertains not only to the traditional town, but can also be applied to the contemporary suburbs.

Another basis is the language for description and analysis. Each level within the urban fabric can be described in terms of such characteristics as position within the next level up as well as its own outline (ibid.). Its internal configuration, comprising the elements at the next level down, concerns the concept of arrangement (ibid.). Other characteristics might include frontage, grain and texture.

3.2 Morphological Determinants

While guidance and prescription within a planning framework necessitates standards, urban morphology is neutral and does not determine what is good or bad form, as standards cannot be derived purely from form itself (Kropf, 1993). Neither can urban morphology be simply based on user response or interaction with urban form (Hall 1997). There is a need, therefore, to look at sources beyond any notion of pure theory or a narrow understanding of urban form so as to provide supplementary models that broaden different aspects of urban form-making and, thus, complement, extend and express core approaches to urban morphology.

In researching influences on the morphological development of towns as well as relevant urban design theory, key determinants of urban form emerged. Conzen's (2004b) concept of morphogenesis provided a starting point regarding the manifold influences on the morphological pattern and growth of towns. For Irish towns these involve (Shaffrey, 1977) the era of origin in respect of, inter alia, the underlying zeitgeist, construction technologies and socio-political structures. They also include types of transportation, such as roads, canals and railways with their stations; a natural and/or designed focus; the importance of trade and, in particular, the market place that has shaped most of them (Freeman 1977). More fundamentally, however, landscape (including topography and water bodies) has usually proved a primary generator of urban form. In terms of urban growth and the ordering of areas, there is normally a logical sequential organisation extending from the rural hinterland through residential suburbs to the intensive urban core that reflects the rural-to-urban transect. At a more perceptual level regarding the legibility of urban structure, Lynch (1960) identifies five key elements that determine the image and navigability of urban settlement, namely paths, nodes, edges, landmarks and districts.

Based primarily on the above morphogenetic factors and perception of form during an examination of different towns in Ireland, four essential categories of morphological influence were identified and are outlined below. Whilst these categories comprise a means of critically understanding and determining urban form, they are not categorically autonomous but more often

combine to influence the shaping of towns. Moreover, they are not exhaustive in regard to tools for planning of urban expansion but aim to provide a basic analytical framework. These key influences are described as ‘morphological determinants’ and are:

Conceptual determinant: manifesting an intellectual ‘act’ that establishes an overall characteristic plan type or layout. The layout of urban settlement typically involves conceptualisation reflecting ideology and/or zeitgeist or world-view (including political, sociological and commercial) as well as construction systems and technology limitations concerning, say, maximum spans that determine plot widths and series (Bacon, 1967; Norberg-Schulz, 1983; Jellicoe and Jellicoe, 2000; Moughtin, 2005). Both the intellectual and the systematic combine to determine the physiognomic identity in plan and section which, in turn, contribute to the distinction and uniqueness of character in each town.

Physical determinant: referring to those contextual factors, both natural and anthropogenic, that can fundamentally influence the form of a town. They include (a) topography (McHarg, 1971; Norberg-Schulz, 1983; Moughtin, 2005) and water bodies and (b) the infrastructure of transportation. These two fundamental influences are recognised by Conzen (2004c) as ‘extraneous influences on townscape’ as well as by Barton et al. (2003) in their ‘twin track’ approach to the structuring of urban expansion, where they prioritise the public transport hierarchy which shapes the concentration of public activities and the greenspace / waterspace system which enables an efficacious urban ecology. Thus, topography and hydrology (eg. floodplains) as well as roads, canals and railways which themselves are often determined by natural features, can have a fundamental influence on urban form.

Organisational determinant: concerning the sequential organisation of urban tissues that involve graded densities (Barton et al., 2003; Conzen, 2009) and uses reflected in urban tissue outline, plot series, plots and buildings and, thus, determining texture (size, complexity and density of blocks and plot series) and grain (size, pattern and direction regarding position and outline of blocks and routes). This organisation draws from the traditional western settlement and has gained considerable acceptance over the past decade as the rural-to-urban transect, developed by Duany Plater-Zyberk (Bohl and Plater-Zyberk, 2006) and codified in the SmartCode (ibid., Plater-Zyberk, 2006 (www.placepakers.com) cited in Hall, 2006). The transect model provides an alternative to planning that is driven primarily by land use and infrastructure. Rather, it helps to describe, distinguish and structure urban, suburban and rural areas across a typological continuum of six zones with gradual slackening of space outwards into the surrounding countryside. It is a useful reference, finding reflection in most Irish towns to some degree, though towns and town parts that do not conform are quite common.

Structural determinant: involving the conceptualisation of urban form as perceptually read or ‘imaged’, structuring it for the purpose of understanding spatial organisation, distinguishing parts and navigating through. The likelihood of being able to form a cognitive map as well as read and remember urban form is to a considerable extent a function of the physical objects of which it is comprised and their relationship combining to project a clearly legible image. Such imageability of urban form, according to Kevin Lynch (1960), is based on five elements, namely, paths, edges, districts, nodes and landmarks. These elements, the identification of which by Lynch was based on

the psychology of cognitive perception, together provide a basis for the analysis and improvement of the urban fabric regarding the structure while also functioning as a critical set of morphological qualifiers.

3.3 The Morphological determinants applied as working tools to maps

The study research method involved the use of Ordnance Survey maps of the eight towns with figure-ground studies (Rowe and Koetter, 1978; Thomas, 2000). These were examined at a whole-town level and included enlargement of parts for more detailed analysis.

The attempt to test the potential of a form-led approach involved an analytical desk study comparing maps of each case study starting with what was taken as the 'original' town (1900-1960) with the contemporary form. A series of maps was produced that reflected the key issues pertaining to each of the four determinants and involving critical examination, again, using these determinants. Whilst aspects of urban form in respect of these tools overlap and interrelate, each one provides a particular understanding of the morphological process and required its own graphic representation. The following outlines the method employed:

The conceptual determinant was applied initially as a desk study using figure-ground maps and including a brief description of the Case Studies as well as a justification for selection. It then considered to what degree the original urban form of layout or characteristic structure of the town, described in terms of a conceptual approach, is reflected in its suburbs. The physical determinant likewise involved figure-ground maps to highlight how the original towns and their suburbs were formed by, and have responded to, topography and the infrastructure of transportation. Topography, for instance, can be expected to be more important in hilly areas but also rivers and contiguous marshland can prove dominant and key influences in the forming of a town. Regarding the organisational determinants, analysis sought to establish whether suburban growth adhered to the sequential rigour of the rural-to-urban transect. This was carried out as urban tissue studies that included the relative disposition of residential and pavilion-type development in respect of continuity of type. This part of the study also involved a homing in to establish building densities (mostly residential). For analysis of the structural determinant, Kevin Lynch's five elements of paths, edges, districts, nodes and landmarks were deployed in respect of the articulation and distinction of urban elements. Using enlarged maps, there was a particular focus on the path / route element due to the importance of road-centred perception of urban form.

The maps, thus, were a basis for application of the determinants as analytical filters underpinned by urban morphology theory in order to critically understand the morphogenesis of these towns and especially their suburbs, including identification of weaknesses and strengths. The analysis involved an exploration of possibilities for improvement of suburban form and also the identification of urban fabric with morphological coherence. This, in turn, provided the basis to verify the relevance and usefulness of the 'tool-kit' of morphological determinants and to produce a set of recommendations to achieve a high standard of planning for future urban expansion.

3.4 Selection of Case Study Towns

Eight Irish towns were selected as a pretext for research into key urban morphological issues pertaining to urban expansion in Ireland and were subjected to rigorous analysis based on a comparison between traditional and contemporary town form. This selection was intended to achieve a reasonable degree of representativeness of geographic location, variation in size and of morphogenetics regarding the determinants of form. The eight case study towns, analysed individually, are listed alphabetically, as follows: Ballinasloe, Carrick-on-shannon, Clonmel, Donegal, Loughrea, Mitchelstown, Mullingar and Westport (Figure 3).

The first of these towns is presented in this paper as an example of the application of the tool kit of determinants in a full systematic investigation. Salient aspects of the town of Clonmel are then used to elaborate on the method and positive examples are identified that offer solutions and models for improved suburbs in respect of urban form-based planning.



Figure 3. Map identifying the location of the eight case study towns in Ireland (Note: Ballinasloe and Clonmel have been selected for this paper).

4. Sample Case Study Analysis – Ballinasloe

4.1 Introduction

This town is located in the midlands on a boggy flat, interacting with the convoluted meandering of the River Suck (Figure 4 and 5). It is connected by the N6 to the cities of Galway (west) and Dublin (east). A relief road draws the commercial core towards the southeast. This town has been selected because it combines a midland location, bi-nuclearity, flat terrain, river / floodplain, marshlands, axial linearity extending into the landscape in a somewhat radial layout, formality and a relief road that attempts to create new urban frontage.

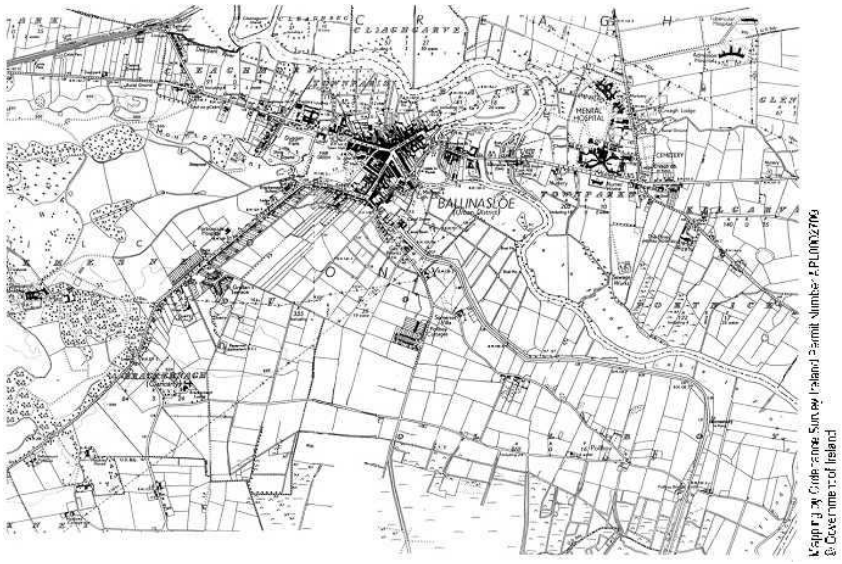


Figure 4. Ballinasloe – original Ordnance Survey map. 1,000 m

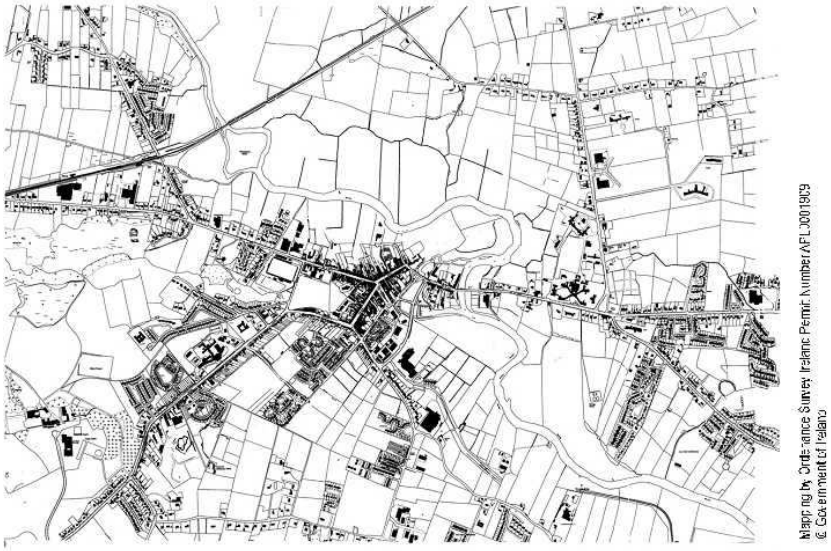


Figure 5. Ballinasloe – contemporary Ordnance Survey map. 1,000 m

4.2 Conceptual determinant

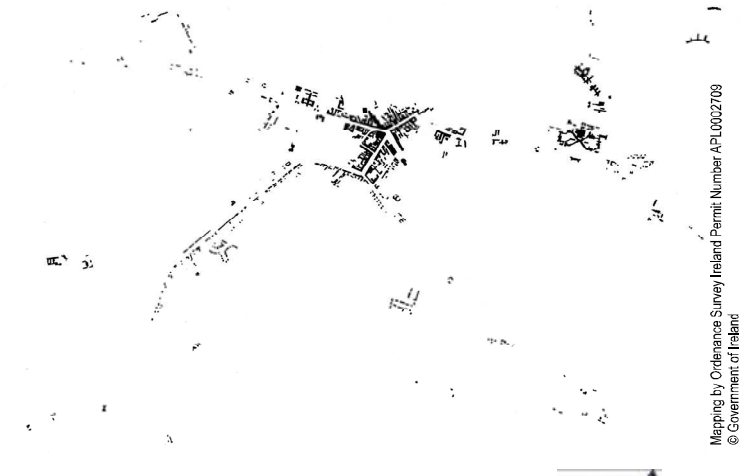


Figure 6. Ballinasloe – original figure-ground study.



Figure 7. Ballinasloe – contemporary figure-ground study.

Adhering to higher ground, the streets and roads of the original town extend as radial spokes from the linear urban hub. This characteristic layout is expressed in rigorous Georgian formality, with axes and symmetry involving the use of buildings for punctuation and vista termination (Figure 6 and 7). At a crossroads to the east on the N6 just over a kilometer from the primary core, a tiny secondary nucleus has been initiated around a church. The latter terminates the axial entry road and helps to establish a gateway. The original Georgian streets in the core consist of traditional finely textured plot series while the original suburbs, typically comprising residential units, institutions (mostly medical) or churches, have clung to and been strung out along the radial roads. Many of these buildings have by and large been positioned to affirm the axial and regular character of the town and to establish punctuation or ‘phrasing’ by mini-nodes along the routes.

The hybrid figure-ground study of the contemporary town with the core omitted confirms the continuation of the linear form into the suburbs, though without the strength of formality of the original due mainly to a failure to adhere closely to the rigors of the radial plan (Figure 8). Small pockets of residential development add depth to tissues but generally do not extend or affirm the original character. An attempt is made at reflecting the rectilinear geometry of the core in a housing estate immediately adjacent to the southwest of the main street, as will be examined in more detail below. No attempt is made elsewhere, however, to incorporate the formality of the characteristic layout type regarding, say, plot series or building position / frontage in either residential development or pavilion buildings. However, a new hotel along with other relatively large pavilion buildings flanking the relief road, initiating a relatively coarse grained plot series, combine to create a new edge to the town, albeit relatively weak and ambivalent in form.



Figure 8. Ballinasloe – contemporary hybrid figure-ground study. 1,000 m

4.3 Physical determinant



Figure 9. Ballinasloe – original physical determinants of form.



Figure10. Ballinasloe – contemporary physical determinant of form.

In terms of morphogenesis, a significant determinant of growth was the avoidance of broad marshy margins and flood plains (Figure 9). The axial and radial roads are juxtaposed to the fluidity of the serpentine river. They also stretch outwards to interact both morphologically and perceptually with the landscape, whether river, parkland or farmland. The braiding of the river contiguous to the urban core has provided islands facilitating bridges. The remains of a turreted bawn (fortified enclosure) immediately to the east of the core and river mark an earlier controlling gateway. While roads are integral to the form, neither the canal running parallel to the River Suck southeastwards nor the railway and station located to the northwest have proved important morphological influences due mostly to their relative distance and detachment from the town.

Recent urban growth has continued to avoid the river and its marshy floodplains (Figure 10). One island, however, has been developed as a tissue with a continuous plot series. The town relief road has engendered an extension of the core southeastwards, involving residential and commercial

pavilion development. Residential development at the eastern gateway extends as a narrow tissue southwards towards the river, no doubt determined in configuration more by land availability than any form-led vision.

4.4 Organisational determinant

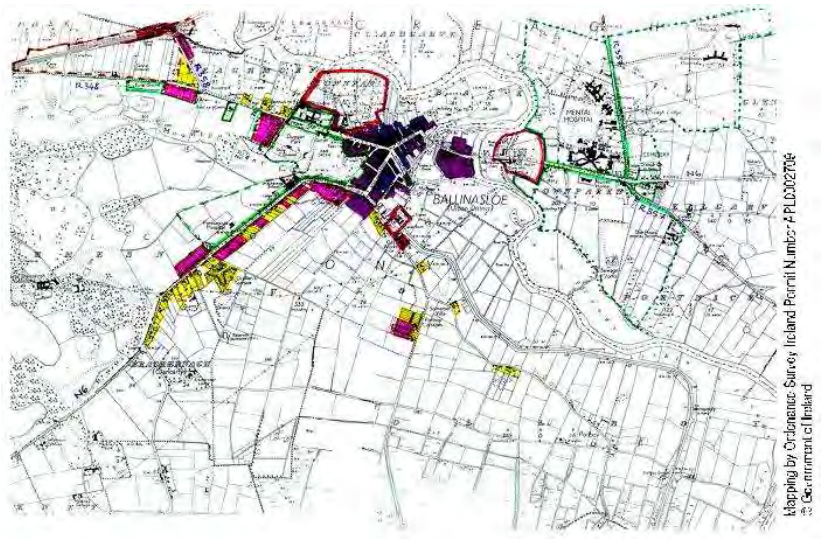


Figure 11. Ballinasloe – original disposition of core urban tissues. 1,000 m

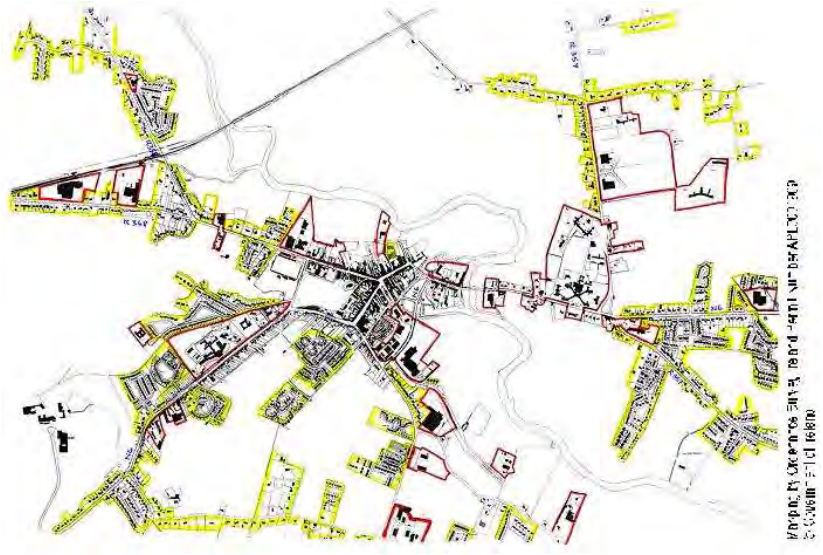


Figure 12. Ballinasloe – contemporary disposition of suburban residential and pavilion tissues. 1,000 m

The morphological frame of the original town comprised the primary and secondary commercial areas that gave way to an institutional fringe belt and industrial areas with residential use interspersed to the west, a mixture of fringe belts and residential groups to the southwest and a broad

institutional fringe belt and industrial areas to the north (Figure 11). While more or less sequential, suburban residential development has continued to cling to the radial roads.

Contemporary suburbs continue their advance along the axial routes (N6, R348) but with residential development beginning to extend along roads that are adjacent to the N6 axis as well as northwards (R357, R358) and southwards away from these axes, resulting in deeper tissues (Figure 12). However, contrary to the rural-to transect, linearity prevails overall. Non-residential pavilion development, likewise, does not fit within the kind of structure advocated by the transect model, failing to manifest any sequential morphological order regarding position in the urban fabric or relationship to the residential context. Examination in greater detail of suburban tissues, however, indicates some textural graduation of building type and plot density to the southwest along the N6 and immediately adjacent to the southwestern end of the main street (Figure 13). Yet, residential development along the R348 to the west, comprising single rows and estates of the single house type with only the occasional group of semi-detached houses, doggedly remain undifferentiated in terms of transect sequence.

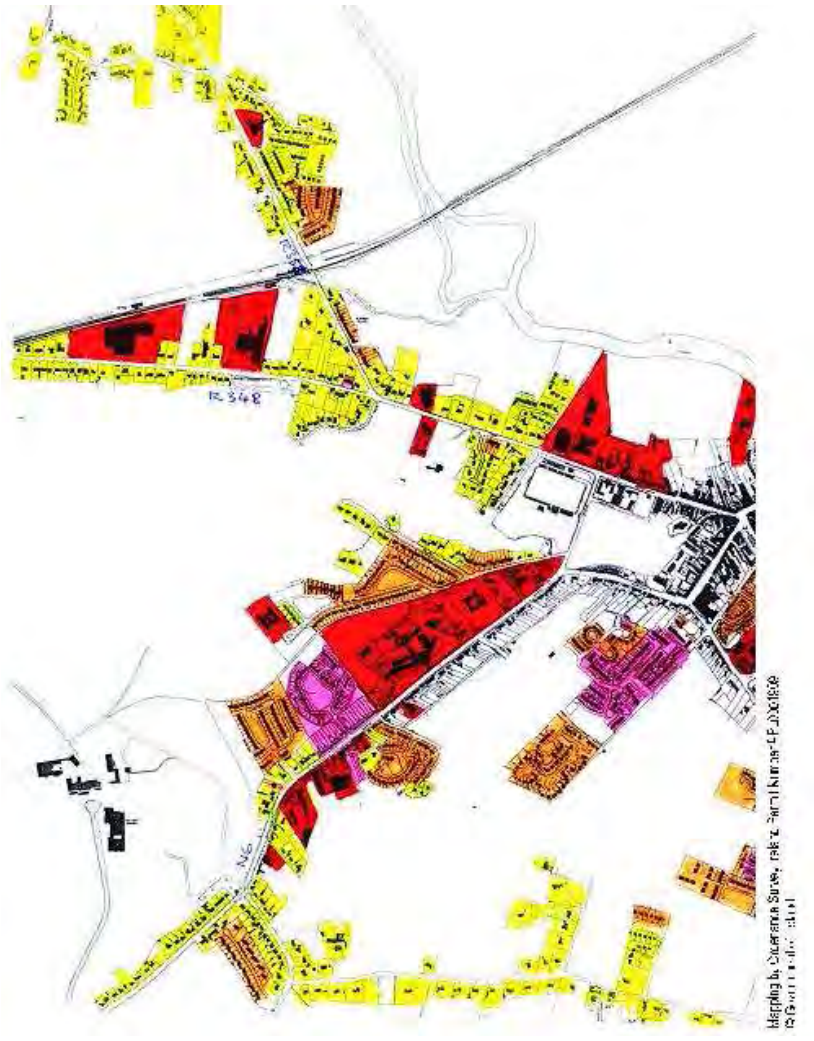


Figure 13. Ballinasloe – contemporary west side suburban tissue study. 500 m

4.5 Structural Determinant

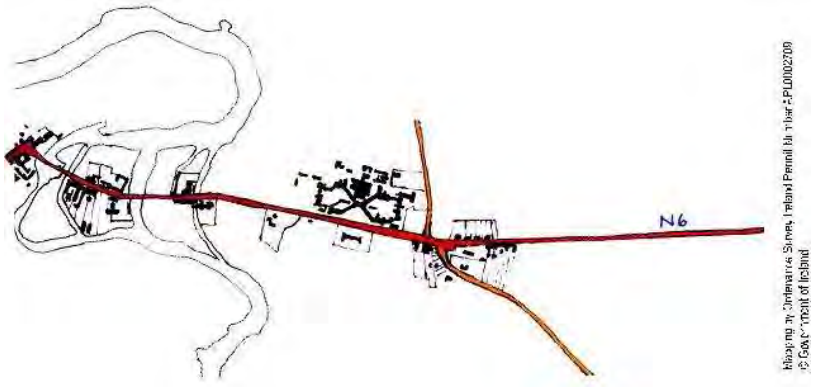


Figure 14. Ballinasloe – original road-centred form study. 500 m



Figure 15. Ballinasloe – contemporary road-centred form study. 500 m

A comparative route-based morphological examination of the original eastern stretch of the N6 and the R357 reveals a simple cluster of institutions and residences around the eastern gateway that is balanced in respect of building position, extent and relative position (Figure 14) as compared with the more recent non-sequential and spreading suburban development pattern further east (Figure 15). The sustained linearity, mostly single-plot deep, may be due to the lack of available land for development and marshy terrain along by the river. This stretch of the N6 comprises different plot series of loosely spaced institutions and houses west of the gateway but a more tightly textured and regular system to the east. There is little or no reflection, however, of the regularity of the original characteristic conceptual layout regarding texture, grain or block configuration in this contemporary

residential tissues. Neither does the contemporary expansion achieve the same sense of procession or edge definition as exists from the past.

Three locations that include examples of successful form-led structure are discussed below (see Figure 16 for key map).



Figure 16. Ballinasloe - key for example of urban structure.

A: Axial Layout and Edge: comprising the residential development immediately to the southwest of the main street that, as already noted, makes an attempt at establishing an axial layout which partially reflects the rigours of the Georgian core (Figure 17). However, without the boldness of gesture, terseness and formality of the core, this attempt is weak. Moreover, it lacks the kind of direct engagement with the urban whole that binds the original character through extended axes and a similarity of old and new physical form. Notwithstanding, the northeast-southwest access route from the estate towards the core establishes a subtle axial link with the landmark spire of a church within the core area to the northeast, at least as perceived on the ground. Further to the southeast on the town by-pass road, a hotel provides a landmark and also, together with pavilion buildings on the opposite side of the road, a new edge to the town, though this is weakly defined.



Figure 17. Ballinasloe - contemporary axial layout and edge.  400 m

B: Urban Threshold: where the river and bridge in combination with the castle wall, Georgian house (north) and opposite store house (south), establish a threshold immediately adjacent to the town core that provides a punctuating node and, combined with the river, a potential district boundary (Figure 18). Here is an example of good urban structure achieved informally but simply through the relative

disposition and size of elements as well as ‘paired opposites’ or physically corresponding buildings and plots on opposite sides of the N6.

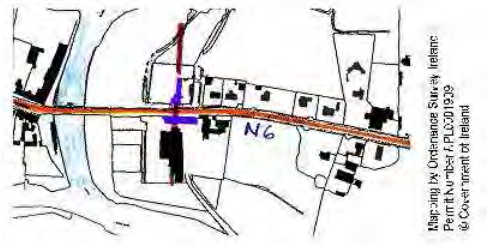


Figure 18. Ballinasloe – contemporary urban threshold. 400 m

C: Gateway and Procession: demonstrating powerfully the effect of formal paired opposites comprising a Mental Hospital on the northern side and Nurses Home to the south) of the N6, so establishing a subtle node due to building size and position on the respective plots (Figure 19). Further to the east, the church at the crossroads provides a landmark that affirms the gateway previously mentioned. This location combines with the Urban Threshold above to create a sequence of nodes that punctuate the axial route leading to / from the town and provide a diverse and eventful route.

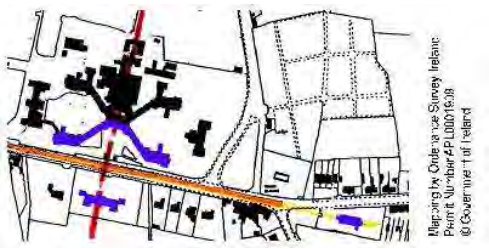


Figure 19. Ballinasloe – contemporary gateway and processional route.

400 m

5. Comparative analysis of Clonmel

Having presented the systematic analysis of the first case study town, the discussion now focuses on Clonmel supplemented by occasional comparison with Balllinasloe.

Clonmel comprises, linearity, informality and an infrastructure complex combining a railway and the national N24 by-pass as a fringe or transportation band as well as the Comeragh Mountains on the banks of the River Suir immediately to the south. These to two latter formidable landscape features have had a significant influence on the town’s morphological development, engendering a strong east-west bias in layout as well as an overt clinging of the original core to the riverside with a resulting growth pattern that extends primarily northwards.

In regard to the conceptual determinant, the physical conditions of river and mountain range have also engendered a simple directional grid structure comprising axial east-west and countering north-south streets that crank gradually to the northwest (Figure 20). The river and mountains combination not only provide a barrier and datum, but also as an urban edge and view termination of the north-south street axes. Thus, whilst being natural rather than anthropogenic (and thus pertaining

the physical determinant), these features have contributed to the physical and spatial structure of the urban fabric in a much more powerful way than does the river in Balinasloe.

Specifically concerning the physical determinant, landscape as a part of the urban fabric has also been incorporated at a tissue level where to the southeast open ground with relatively limited development and a park extend between the river and the original main eastern access road (Figure 21). Morphologically this is significant because it: reinforces the link with the river and mountains; creates a thematically suburban context that is space-dominant; and provides the possibility of establishing a dualistic entry to the town comprising a relatively extensive area of open space to the south juxtaposed with and complemented by suburban residential development to the north. Whether as a result of deliberation or chance, this is an example of a reasonably integrated urban tissue with an identifiable morphological character.

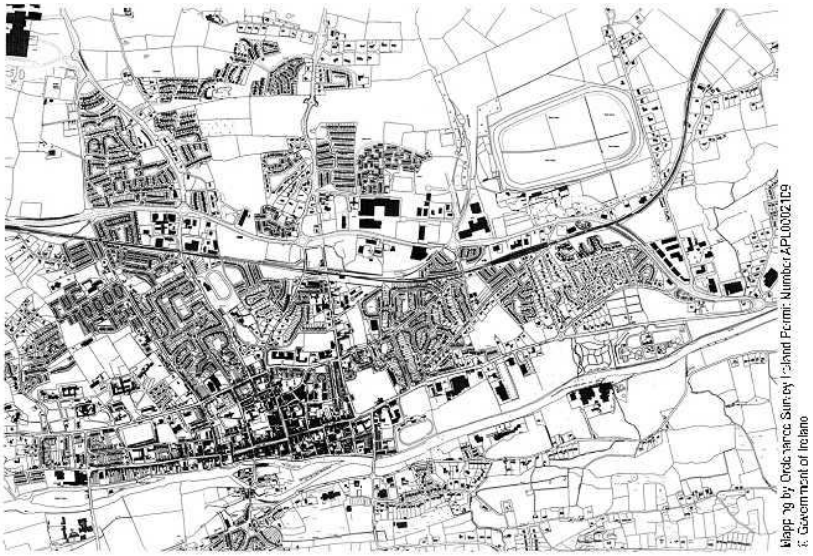


Figure 20. Clonmel – contemporary Ordnance Survey map. 1,000 m



Figure 21. Clonmel – contemporary physical determinants of form. 1,000 m

While the physical determinant is strong and positive in regard to landscape, it is also strong but flawed regarding infrastructure. Perhaps one of the greatest failings of the contemporary suburbs in Clonmel concerns the combined east-west railway and road forming the transportation band. Looking back in time and to the eastern end of the town, the rural-to-urban transect sequence proceeded consistently along the original primary route from core to countryside (Figure 22), proving more coherent than that to the east of Ballinasloe. But this original road linking the urban core directly to the hinterland east and west has been replaced as a primary route by the meandering N24 by-pass (Figure 23). Whilst in the language of Conzen (2004d) this band functions as an arterial ribbon creating a plan-seam or a fixation line, it makes little positive contribution to the form of the town and its suburbs at the level of (a) the whole-town, (b) the immediate context or (c) the arrangement of its component parts as an urban tissue. This belt fails morphologically in respect of concept layout and organisation.

As a major component at a whole-town level, the positioning of the transportation band seems arbitrary rather than knowingly contributing to the creation of a suburban morphological structure. This band could, for instance, have formed an edge to the town or, with continued expansion, at least district demarcation separating land use and/or density. Moreover, such demarcation could have been articulated by typomorphological distinction between the northern and southern sides that, in turn, might have reflected various land uses that were articulated and expressed by a differentiation of texture and grain. Whatever the potential of the road, the railway would have provided an opportunity for the incorporation of a green corridor within the urban fabric that could, in turn, have become a morphological ‘break’ or separating fringe between land uses.

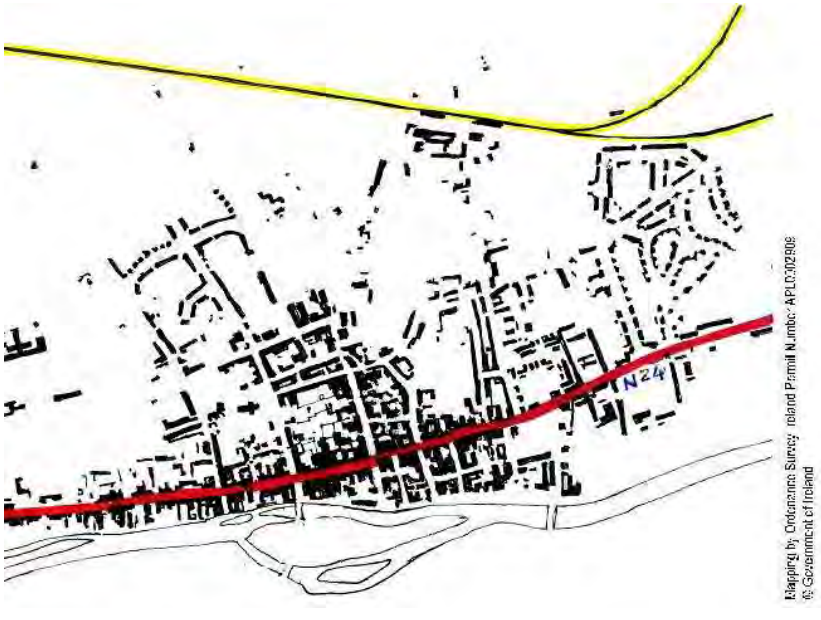


Figure 22. Clonmel – original road-centred form.

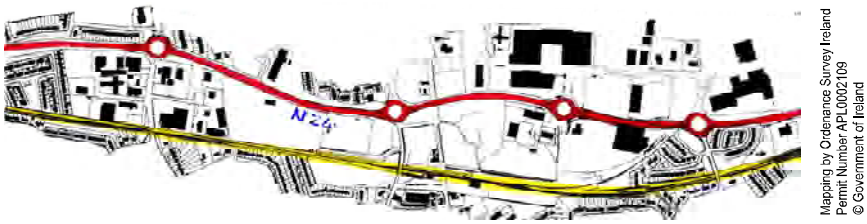


Figure 23. Clonmel – contemporary road-centred form.

Weakness is also evident in the relationship of the transportation band to its immediate context. The response to adjacent estates on the northern side of the N24, for instance, is poorly conceived, simplistic and superficial, as is epitomised by token 'skims' of tree planting that likely are attempts at screening buildings and softening the roadside. Lost, therefore, is the potential for a morphologically more complex and rich response to the road that could have involved a mix of buildings and landscaping, including a thoughtful consideration of block size and position, frontage (eg. varied setbacks), plot series (strongly defined frontage), landscape (boulevard / parkland) and building type (articulation and rhythm). Similarly, the abutting of the rear of terraced housing against the railway, whilst orderly, would prove unsightly from the tracks and also makes no functional sense given problems of noise.

Within itself, the urban landscape lying between the railway and road is occupied by a disparate mix of pavilion-type industrial buildings, housing estates and open space. This band as a morphological entity or linear tissue might have comprised, for instance, one or a combination of the following: a generous green corridor / landscape fringe; a mixture of alternating open space and morphotopes; or an urban fabric with a distinctive character of land use specific parks, such as commercial / business or leisure.

In terms of the organisational determinant, as with Ballinasloe (and, indeed, all of the other case study towns), there is little morphological clarity regarding a sequential and graduated ordering of the suburbs in Clonmel. Its contemporary suburbs comprise extensive areas of residential development that are distinct in texture and grain from those comprising pavilions (used for, say, employment or education) but without any apparent morphological order, cohesion or logical categorisation. More positively, at the tissue level, the grain structure of some of the residential areas immediately to the northwest of the core and south of the transportation fringe belt reflects the grid concept of the core (Figure 24).

In general, therefore, this is an example of a missed opportunity to respond to the pressures of urban expansion with coherent urban form. It fails to create a hierarchically stratified suburban structure and distinctive and unique character in respect of the whole-town. Whilst in Ballinasloe this problem is manifest in the radial form, here it comprises a more or less spreading patchwork of pavilion and residential development and is particularly critical given the scale of impact.



Figure 24. Clonmel - contemporary suburban residential and pavilion tissue study.





Figure 25. Clonmel - key for examples of urban structure.

Regarding the structural determinant, there are positive examples of urban form both along the N24 and elsewhere around the town. Four locations have been selected for more detailed analysis and comment (Figure 25), three of which being located along the N24.



Figure 26. Clonmel – contemporary gateway node. 400 m

A: Western Gateway Node: This is a node complex at the most westerly roundabout on the N24, comprising a housing estate and commercial pavilion building to the south and a hotel and retail warehouse to the north (Figure 26). The hotel establishes a landmark at this important junction, so strengthening the sense of route/path as well as of an entry point as a gateway tissue. The legibility of this entity, however, is critically weakened by the absence of road frontage due to setback distance as well as the poor definition in plot and building layout, especially on the southern side. Edge and frontage are, however, somewhat more clearly established on the opposite side of the road by the retail warehousing at the eastern end.

However, a different kind of problem is found here involving the legibility and differentiation of front and rear, where the service area backs onto the road while the front entrance on the opposite side faces into the courtyard. Although this 'back-side frontage' problem is partially mitigated through architectural gesture on the northern side of the road, it more critically and fundamentally should to be resolved in respect of such morphological factors as site layout, position arrangement and frontage. Whilst this example is comparable to the Urban Threshold example in Ballinasloe comprising a castle and mill as well as to the Gateway and Procession, it is in respect of these factors that this situation in Clonmel proves particularly weak.

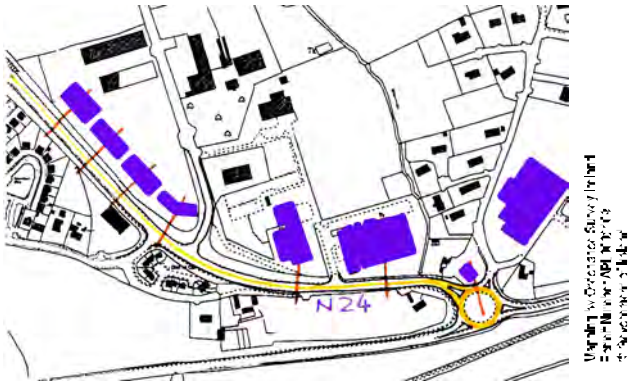


Figure 27. Clonmel – contemporary urban structure study of route edge.

400 m

B: Route Edge: This has been selected as it comprises a series of pavilion-type employment buildings on the northeastern side of the N24 as well as a roundabout to the east (Figure 27). Unlike the weak urban edge seen in the Axial layout and Edge of Ballinasloe, here the pavilions establish a clear plot series and strong edge due to the continuity, repetition and position of physical mass and to frontage, so helping to define the route/path. Nevertheless, an opportunity for stronger articulation of the edge and establishing a processional sequence is lost due to poor definition of plot series and road-line on the opposite side provided by the rear of housing and a single house. Further to the east along the N24, a roundabout with a service station and industrial pavilions prove weak as a gateway in respect of edge, definition of the urban fabric, and distinction of place.

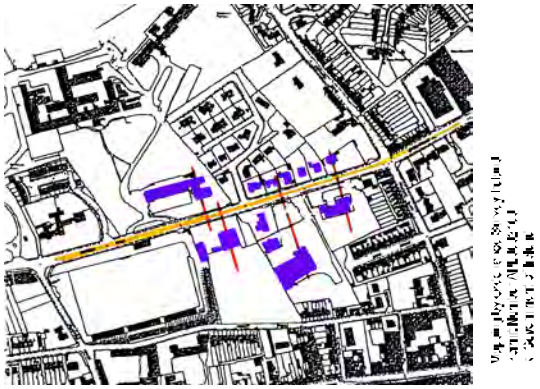


Figure 28. Clonmel – contemporary urban structure study fringe route.



C: Western Fringe Route: located on the original main road to the west of the urban core, it includes public, retail and commercial use on the southern side and public institutional along with residential use on the northern side (Figure 28). At the level of tissue, it, thus, comprises a route/path-based complex of suburban character, the fabric of which being articulated and varied. At the street and plot / building levels in the morphological hierarchy, two plot series are identifiable on the northern side of the road, each establishing a particular texture and including a clearly formed recessed building-line of houses with front gardens to the east and a series of relatively large institutional pavilion buildings set in parkland to the west. On the southern side of the road, a coarser texture is created by relatively loosely but more or less regularly spaced plot series. The edge condition is determined by recessed frontages accommodating surface car parking and recessed pavilions comprising a public library, a supermarket and commercial offices.

Yet, because of their relative proximity to one another (position), rhythm (plot series) and similarity in size (building outline) as well as relative proximity to the road (street line / frontage), they combine in providing a sufficiently coherent plot series to maintain a sense of route/path. This is further strengthened by the forming of paired opposite pavilions on either side of the road to the west, similar to those at the Gateway and Procession on the N6 east of Ballinasloe core, and paired opposite complementary building / plot types, such as residential morphotopes and pavilions to the east.



Figure 29. Clonmel – contemporary morphotope + node. 400

D: Nodal morphotope: comprising pavilion-type commercial development located on the transportation belt between the N24 and the railway (Figure 29). The layout is grid-like with a grain formed by a block size that approximates that typical of the urban core and which, similar to the residential development of the Axial layout and Edge immediately to the southwest of the core in Ballinasloe, could, in principle, affirm the conceptual basis of the traditional core by replication. However, there is no legible relationship to the original town and neither is there any alternative physiognomic identity within the tissue or provided in response to the adjacent roundabout. With its coarse grained arrangement, this morphotope could, alternatively, have initiated the development of a unique character along the transportation belt and, thus, have contributed morphologically at the whole-town level.

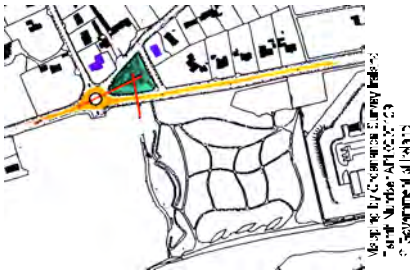


Figure 30. Clonmel – contemporary green node. 400 m

E: Green node: establishing a triangular green space located on the original main entrance road approximately mid-way between the town centre and the roundabout entrance to the east off the N24 (Figure 30). It forms a mini-node that divides the road and provides punctuation of the route. As a pocket of open space, it affirms the role of landscape in the suburban fabric. The incorporation of this feature is significant as a common character type in Ireland and it might poetically be regarded as a symbol or, at least, a distillation of the idea of the garden-suburb on the fringe of Irish towns.

6 Discussion and Recommendations

The study confirmed the morphological incoherence of the contemporary suburbs of Irish towns. As the problem is systemic, remedial action could comprise an urban planning and design framework that includes policies and objectives as well as means and methods. Maitland (1984) posits that any

urban design theory setting out a framework must provide two things to be effective, namely, it must define the elements to be employed and it must provide the rules for their association. The discipline of urban morphology provides the basis for defining both the elements that are the focus of form-led planning and the necessary tools / language. Based on the results of the case study analysis but with due caution in avoiding over-simplification (Conzen, 2009), the following conclusions could be loosely regarded as, if not 'rules' then, at least guiding recommendations.

6.1 Morphological incoherence of suburbia – room for improvement

The research has demonstrated that, while the traditional cores establish a unique characteristic identity for each town, their suburbs might easily be interchanged – typically they neither reinforce original character and form nor create an alternative that is equally distinctive yet complementary. This incoherence of suburban form results from life style and politics but also from a planning system that prioritises land use, infrastructure and capacity and also that permit leapfrogging of development out of logical sequence. Based upon examples found and presented above of coherence of form at the level of the urban tissue, plot series and plot, the benefits of morphological deliberation are obvious as compared with incoherence otherwise. It is reasonable to conclude from this that a form-led approach underpinned by urban morphology as a discipline and language provides a fundamental basis for improved urban fabric at different levels, achieving greater legibility, articulation, coherence and meaning than that which prevails in contemporary Irish suburbs and it is also clear that this provides a basis for developing physiognomic identity or distinction of character between towns. Moreover, existing traditional types need not curtail innovation or alternatives - whilst being authentically of our own age, contemporary planning can adapt or, at least, learn from successful morphological models of bygone eras.

6.2 Morphological determinants as tools: room to extend

The application of urban morphology for planning is facilitated by a conceptual framework that becomes a categorical basis for description and analysis and also for structuring policy, strategies, objectives and vision making. The four morphological determinants, developed from different existing sources of understanding morphogenesis and of morphological order, proved effective at all levels of urban form from the whole-town though tissues, plot series / street, plots and buildings..

The conceptual layout, concerns primarily the whole-town and urban tissue levels. Alternative layouts within a given town are valid, especially considering how different are the functions of the suburbs from those that influenced the original cores. Ultimately good urban form in this regard will be a question of integrity of layout and clarity of concept.

Regarding the physical determinant, transportation corridors should be planned as linear tissues in respect of their context as a whole morphological entity. The potential for form-based response varies from one type of transport route to the next, whether roads, canals or railways. Natural elements should also be positively incorporated into the urban fabric, including rivers, floodplains, lakes, the sea and topographic features. They should be considered for their role in articulating and complementing the original conceptual layout or to prompt an alternative landscape-based morphological response. Floodplains, for instance, have a particular potential in this regard

and should, thus, be preserved from development. The traditional institutional fringe should also be preserved as an integral part of form-led urban landscape ecology as well as for cultural scenic and recreational reasons.

The rural-to-urban transect is a useful starting point for organising urban form in terms of the sequential spatial planning of land use (mixed or single use), intensity of use and densities. It is, however, a tool and not a solution and should not be applied absolutely, but rather should make provision for significant variations and differences, which are, after all, the basis of distinctive character. Moreover, routes as linear elements require a particular morphological approach that does not necessarily comply with the rigours of the transect model at the whole-town level.

The structuring of urban form so as to achieve legibility can pertain to the different level of the urban fabric. The five elements of Lynch provide the basis for rendering urban form more coherent by being structured in a manner that is legible and memorable. The study focused on lower levels by attaching particular importance to the sequential structuring of the urban fabric along routes as the latter provide key locations for perceiving and comprehending urban form and also because roads and streets, as previously established, play a critical morphological role in structuring and sustaining urban form. It might be noted here that the four morphological determinants could be joined by a fifth comprising an urban character or the identity and distinctiveness of urban areas. This has been explored by the author, involving the role of townscape (the three-dimensional reading of the urban fabric from the ground) and urban character as distinct from reliance upon the plan or urban tissue as the main generator of a form-led approach (McCormack 2010b).

6.3 Urban Morphology regarding Planning Policies and Systems

Although government policy and urban design theory will continue to encourage urban core consolidation, suburban expansion will also likely continue into the foreseeable future. Thus, the push in government policy common across Europe for higher residential densities, especially in town centres, may prove at odds with manifest and expressed public preference. National policy needs to embrace urban expansion and reflect the concerns of planning based on sound principles of urban morphology. There is an urgent need for a broader understanding of the diverse nature and complexity of urban form as well as for a longer-term perspective on successful urban growth.

Because urban morphology provides a language for a systematic and integrated way of understanding urban form and urban growth, it can be used as a discipline that underpins the spatial planning process. It, thus, warrants being adopted by Local Authorities and incorporated into the planning system. This proposed paradigm shift needs to be reflected in: (a) policies and guidelines involving the systematic constitution of urban form and, in particular, (b) the processes of planning urban areas, especially regarding expansion. For the implementation of this, planning policy and urban tissue-based forward planning that is typomorphological can provide a starting point for an integrative approach that interrelates the various levels of resolution of the urban fabric and also provide a basis for planning control. Where planning control needs to lean towards conservation, urban tissues can refer to local examples in order to prescribe indicatively solutions that contribute to the building up of local character. However, this basis must not be abused as a default by the planning system and so become a stranglehold on innovation.

There is, therefore, an urgent need for the education of both technical staff and political members of local authorities regarding the tremendous advantages of a form-led approach over current practice. Moreover, national guidelines as well as seminars for planning and design professionals focused on urban morphology would highlight its relevance and assist in its implementation. Included in such guidelines and education would be the concept and application of typomorphology; the significance of a hierarchical structuring of the urban fabric that accepts a loser less complex interpretation of form for suburbia than that for the traditional core; the inclusion of both plan-based and perception-based methods; exemplar solution of such specific conditions affecting urban form as front-back / public-private relationships, roundabouts, gateway nodes and the positioning of service stations and other building types of public use within the urban fabric. In essence, for a given planning jurisdiction, the outcome of using this approach should be an urban planning and design framework that establishes form-led guidelines. This framework would need to balance and reconcile different influences on urban form and on urbanism generally.

7 Summary and Final Conclusion

In summary, this study identified and discussed problems with urban expansion in Irish towns and also developed a case for the potential of urban morphology providing the underpinning discipline for a form-led basis for urban planning. This discipline is applied analytically through the filters of four morphological determinants, each of which playing a key role in influencing urban form in one or more ways. Methodologically, the study successfully uses these four determinants as a descriptive language, tool kit, discipline and guide, so extending urban morphology theory for the achievement of improved planning in respect of coherence, legibility, articulation and hierarchy in the urban fabric. The determinants have the potential to become a morphological framework for the creation of form-led vision regarding the planning of urban expansion.

”Urban morphology is not a formalistic diversion. It is the root of urbanism ....” (Kropf 2005: 18)

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Bringing urban form and urban metabolism into planning - the SUME project

Paulo Pinho, Vítor Oliveira, Sara Santos, Magda Barbosa

CITTA – Research Centre for Territory, Transports and Environment

Faculty of Engineering, University of Oporto

pcpinho@fe.up.pt, vitorm@fe.up.pt, scruz@fe.up.pt, magdab@fe.up.pt

The functioning of current urban systems involves high levels of resource consumption and a huge number of flows. The fundamental concern of this paper is to understand how future urban systems can be designed to be consistently less damaging to the environment. Therefore, its main contribution for the sustainability debate is the design of a methodology for evaluating the urban development process from a metabolic perspective. After a brief introduction to the field of evaluation, the state-of-the-art on urban planning, urban form, impact assessment, environmental accounting, and urban metabolism, in an attempt to identify theories, concepts, and particularly methods and techniques, that can contribute to the purpose of the article. Based on this literature review – which highlights three particular methods – a set of principles for a metabolic evaluation of the processes of transformation of city-regions is outlined. The Metabolic Impact Analysis is proposed and characterized, its main influences are identified, and the procedure of evaluation is described in considerable detail.

Keywords: evaluation methodology, urban metabolism, impact assessment, urban planning, urban form, urban development

1 Introduction

The concept of urban metabolism helps to understand and analyze the way how societies use energy, materials, water, food, and land, for maintaining and reproducing themselves. Urban systems are a specific form of organizing societies, namely a concentration of economic, reproductive and distributive functions in certain locations, while using and exchanging resources from much larger areas, especially in a global economy context. The way cities and urban areas are being built is greatly influencing the quantities and qualities of resources being used in maintaining urban life. The quantities and the qualities of this exchange with the environmental system are increasingly damaging.

This paper is part of a 3-year European research project, the 'Sustainable Urban Metabolism for Europe' (SUME), funded by the Seventh Framework Programme, involving ten partners from nine countries and two continents. The main goal of the project is to understand how future urban systems can be designed in a way which is consistently less damaging to the environment than the current status. For a detailed description of SUME see Schremmer et al (2010). This article focuses on a particular stage of the SUME project, the design of a methodology for evaluating the urban development process from a metabolic perspective, the MIA.

The first section of the paper, after this brief introduction, presents the fundaments of evaluation activity, focusing then on five fields of knowledge – urban planning, urban form, impact assessment, environmental accounting and energy, and urban metabolism. The review is oriented to the identification and characterization of evaluation methods and techniques for planning practice that relate urban form and urban development with urban metabolism – focusing on the consumption of energy, water, materials and land. Based on the literature review, and particularly on three specific methods – threshold analysis, land suitability analysis, and environmental impact assessment – a set

of principles framing the design of the methodology is defined – it should evaluate the urban development process (from a metabolic perspective), focus on plans and projects as fundamental drivers of the urban development process, assess the city wide metabolic impact of the proposals included in plans and projects, have an evaluation rationale provided by the territory, be better suited to short-term (ex-ante or ex-post) analysis although it may address different temporal scales, and deal with the environment in an integrated way. We then move to a characterization of MIA against the background of the Environmental Impact Assessment (EIA). In addition we describe its main components, and structure the evaluation procedure in six main stages. Finally, we present our main conclusions on the design of the methodology and reflect on our future research particularly on the application of MIA in a set of European cities in order to validate it in different geographical and planning contexts.

2 Evaluation

Evaluation is not something new, it has always been an intrinsic part of decision making. Whenever a reasoning actor undertakes a particular course of action, some consideration and assessment of the possible consequences, however intuitive it may be, is an inevitable preliminary to the commitment (Alexander, 2006).

In the absence of a general and consensual vision on the evolution of evaluation theory, many authors converge on the acknowledgment of a shift from a positivist paradigm to a constructivist paradigm. Some describe this evolution in four evaluation generations (Guba and Lincoln 1989; Khakee 1998, 2003). According to Guba and Lincoln (1989) the first generation of evaluation exercises was intended to measure individual attributes, the second generation was geared towards the description of programmes and objectives, the third was dominated by judgments on the contextual values of the object, and the fourth was centred around the negotiation of claims, concerns and issues presented by the different stakeholders. Nevertheless evaluation theory and evaluation practice seem to be two different realities.

Evaluation and each activity under assessment – planning, education, health… - interact and are in constant change. In addition, one of the main challenges of evaluation lies in the lack of a single approach, valid for every situation (Rossi et al, 1999). Accordingly, the evaluator should structure his methodology depending on the specific nature of the situation, and should not follow, in a rigid way, a number of standardized procedures.

In general, the evaluation process comprises three different stages: ex-ante evaluation, taking place in the beginning of the process and promoting the comparison of possible alternatives; on-going evaluation occurring during implementation and enabling shifts in the process according to its conclusions; and finally, ex-post evaluation, taking place in the end of the implementation process and focusing on the results and impacts. Different stages in the process are stressed according to the different activity under assessment.

Another important issue, not consensual in literature, is the role of the evaluator. Undoubtedly, there are advantages, but also disadvantages, in the integration of the evaluator in the team whose work is being assessed. The main advantages of an internal evaluation are fourfold: a greater knowledge on the specific institutional context, a greater probability of adopting the final

recommendations, a reduced possibility to look at the assessment exercise as a threat to the institution, and eventually, a reduced use of financial resources. The major disadvantage is the tendency to avoid negative conclusions and to accept the conventional line of thought. The main advantages of an external evaluation may be a greater objectivity in the evaluation, and the facility of external hiring during short periods of time. The most important disadvantages of an external evaluation mirror the main advantages of an internal exercise. Two different possibilities should also be considered, a mixed evaluation, and an internal assessment prepared by an evaluator independent from the planning team.

The design of an evaluation methodology involves three main definitions, the questions, the criteria, and the indicators. The questions, developed by the evaluator, the decision-maker and the main stakeholders, should identify the issues the evaluation will investigate and should be stated in terms such that they can be answered in a useful way involving methods available to the evaluator.

Each of these questions should correspond to, and be synthesized in an evaluation criteria. The assessment of each criterion should involve the use of indicators, from traditional ones – economic, social, and environmental – to integrated approaches.

Finally, the presentation of evaluation results and their use by decisions makers are two crucial stages of the evaluation process. First, it is necessary that the main stakeholders be able to understand the evaluation results. Accordingly, the presentation mechanisms must find the balance between communication and technical knowledge. Second, it should be possible to find the actual utility of evaluation results to the activity under assessment. In fact, the evaluation exercise must establish the terms and the required mechanisms by which a successful utilization may be judged.

3 Literature review

3.1 Urban planning and urban development

3.1.1. Ex-ante evaluation in planning

Planning evaluation has been an established field of research for a considerable number of years. Its development has been closely associated with changes in planning theory and practice as well as in policy analysis and programme evaluation. Planning evaluation most obviously refers to the making of normative judgments about the success of the intervention outcomes of planning or assessing the success of the process of planning (Khakee et al, 2008).

Comprehensive reviews of these methods can be found, for instance, in Lichfield et al (1975), Lichfield (1996), McAllister (1982), and Talen (1996). Drawing on Table 1, taken from Lichfield (1996), the next paragraphs present the most important methods for the ex-ante evaluation of planning. Due to its importance for the development of MIA methodology, land suitability analysis will also be presented. Impact assessment will be analysed in a different sub-section.

Cost-Benefit Analysis (CBA) was initially conceived to evaluate American federal projects on water resources, and the UK investments in transports. Later this methodology was extended to the appraisal of several kinds of public actions and projects. It is probably the evaluation method most widely used. The technique, although complex, uses one main criterion the willingness-to-pay, and follows a simple principle – the association of a monetary value to each identified effect of a project or

action. In order to determine if the benefits, or the desired effects of a project, are larger than the costs, or the undesired effects, a number of monetary classifications are summed up in a grand index.

The Planning Balance Sheet Analysis (PBSA) was presented by Lichfield in the 1950s and, soon after, applied by this author in a number of plans in Britain (Lichfield, 1956). It is an adaptation of CBA to urban and regional planning, sharing the basic theory and techniques of the former. PBSA goes beyond CBA in two aspects at least: it integrates non quantifiable impacts, introducing symbols in the appraisal tables alongside with monetary impacts; and it records detailed information on costs and benefits distinguishing how the different social groups and stakeholders will be affected by the proposed plan under analysis. More recently, Lichfield (1996) presented the Community Impact Evaluation (CIE) – a natural departure from PBSA, with similar foundations on the CBA and on impact assessment.

Hill presented the Goals-Achievement Matrix (GAM) in his PhD thesis in 1966, as an attempt to eliminate the weaknesses of existing evaluation methods, particularly the CBA and the PBSA (see Hill, 1968 for a synthesis). This method has been used in the evaluation of urban plans in Great Britain. The main characteristics of GAM are the organization of effects according to the goals and to the different parties involved, and the incorporation of non-monetary effects in the grand index. The main stages of this method are: the definition of goals and objectives in operational terms to enable the measurement of their achievement; the attribution of value weights to the goals, reflecting their importance; the identification of goals achievement to different groups; the sum of achievement levels in a grand index; the adjustment of this index, considering equity issues.

Multi-criteria Analysis (MA) emerged in the 1960s in France. The *Electre-techniques* or *Concordance-techniques* soon became dominant among the new evaluation methodologies. In general, MA methods adopt the form of a matrix with at least two dimensions, one expressing the different project alternatives, and the other, the objectives and the evaluation criteria. The relative importance of the different criteria is reflected by an appropriate set of priorities or weights. As Lichfield's method is inseparable from CBA also contemporary MA is strongly related to GAM. For more information on these methods see Voogd (1983) and Nijkamp et al (1990).

Threshold Analysis (TA) was proposed by Malisz in Poland, in 1963, and further developed namely by Kozlowski – who introduced the method in the UK in 1965 – and Hughes (see for example Koslowski and Hughes, 1972; Malisz, 1963). It was generated by the need to develop effective cooperation between physical planners and economists, to help the dialogue between different planning levels, and to refine the (long-term) planning process. It is based on the assumption that cities encounter limitations to their development, due to topography, land uses and technology of infrastructure. These limitations, called development thresholds – which should be identified and measured by the proposed method – are irremediable and can be overcame but only at additional costs, or threshold costs. The major contribution of TA lies in four main issues, enabling: an improved planning methodology, a measure of efficiency, a basis for improved interdisciplinary cooperation, and improved links with decision-making. As Kozlowski and Hughes (1972) stated, it remains a strong need to balance TA processes and results with other complementary studies covering together the comprehensive spectrum of the planning process.

McHarg's method of land suitability analysis is synthesized in the book *Design with nature* (McHarg, 1969). Framed by an environmental philosophy, where man and nature should not be viewed as separate, the method provides an expert judgment based on the scientific knowledge of natural environment. The application of the method is expressed by a map overlay. The ratings on each part of the territory under analysis are expressed in the form of shades of gray: the darker the shade, the less suitable the territory for the proposed land-use. A map of each land characteristic is prepared on clear plastic overlays, using the color shadings to indicate the variations in the characteristic throughout the study area. In the original applications of the method, the plastic sheets were placed one over the other and viewed with the assistance of a back-lighted map table. The composite picture that emerged was a pattern of light and dark shades indicating the estimated aggregate suitability of each land parcel in the study area for the particular land use. The optical process of adding shades was then expressed by a mathematical equation (McAllister, 1982).

3.1.2. Ex-post evaluation in planning

Planning evaluation methods focused on plan implementation and on the planning process are framed by the debate between conformance and performance. Conformance-based evaluation means judging the success of failure in planning efforts by one or both standards. One is the degree to which outcomes on the ground fit the plan or conform to planning prescriptions; the other is whether a plan or policy implementation instruments in fact promote the espoused planning objectives (Alexander, 2009). After the development of some fundamental research works in the end of the 1970s (Alterman and Hill, 1978; Calkins, 1979) and in the second half of the 1990s (Baer, 1997; Talen, 1996b, 1997), a number of interesting studies on this topic have been produced throughout the last decade, mainly in the United States – see Table 2.

Performance-based evaluation follows from defining a plan or policy as a decision framework. Its performance is an expression of its usefulness and effectiveness in filling this role: whether and how the subject plan or policy was consulted for subsequent decisions and was followed in implementing plans, programmes and projects (Alexander, 2009). Based on the work of Fudge and Barrett (1981), who have highlighted the differences between a performance and a conformance view, the Dutch school of planning evaluation has been developing a continuous research on performance.

In some few cases, studies on plan implementation explored the potentialities of an integrated use of both approaches (Alexander and Faludi, 1989; Oliveira and Pinho, 2009) and their simultaneous application for comparative purposes (Altes, 2006; Berke et al, 2006).

3.2 Urban form and urban development

Studies on urban form and urban development can be roughly divided accordingly to the level of analysis, at macro level (European or National) or at micro level (municipal or local). Although this paper makes some references to the former, it is mainly focused on the latter.

Research studies on urban development, urban form, and land use at a macro scale have been mainly promoted by the European Commission. CORINE (Coordination of Information on the

Environment) complied and organized information on the state of the environment, including the land cover structure, in the Member States. MOLAND (Monitoring Land Use / Cover Dynamics) provided a spatial planning tool for assessing, monitoring and modelling the development of urban and regional environments. GEOLAND (Integrated GMES Project on Land Cover and Vegetation) provided a framework to develop and demonstrate a range of reliable, affordable and cost efficient European geo-information services. The URBAN AUDIT provided European urban statistics for 258 cities across 27 European countries. It contains almost 300 statistical indicators presenting information on demography, society, economy, environment, transport, information society and leisure. The DOBRIS ASSESSMENT covered the state of the environment in almost all of Europe's nearly 50 States, aiming at describing and explaining the changes and effects in the environment, and to provide a comprehensive picture of the state of Europe's environment.

During the last decades a number of studies and approaches on urban form at a lower scale have been developed. Comprehensive literature reviews or papers focusing on different approaches are rare (see for example Kropf, 2009; Osmond, 2010; Pinho and Oliveira, 2009). The next paragraphs briefly describe some leading approaches on the study of urban form: the Conzenian school, the Muratorian school, the normative approach, the space syntax, isovist analysis, cellular automata, agent-based modelling, shape grammars, and finally, fractal analysis.

The Conzenian school (Conzen, 1960; Larkham, 2006; Whitehand, 2007) has been mainly developed by the Urban Morphology Research Group / UMRG in the University of Birmingham after the seminal work of Conzen. This school approaches the urban form and structure for descriptive purposes, with the aim of developing a theory of city building. The focus is on how cities are built and why. It purposes a tripartite division of townscape in town plan (site, streets, plots and block plans of buildings), building fabric (three-dimensional form), and land use. The historical development is analysed according to concepts such as morphological period, fringe belt, morphological region, burgage cycle and morphological frame.

The Muratorian School (Muratori, 1959; Cannigia, 1963; Cataldi, 2009) approaches the urban form for prescriptive purposes, with the aim of developing a theory of city design resting on historical city-building traditions. The focus is on how cities should be built. As in the previous school this approach develops around a number of concepts such as type, fabric, organism, operative history, to name just a few.

The so-called Normative approach (Alexander, 1965; Alexander et al, 1977; Cullen, 1961; Krier, 1975; Lynch, 1960, 1981) is based on the analysis of successful case studies, and on the consequent selection of the principles that had contributed to that accomplishment. This approach aims at finding a practical connection between analysis and design. It is supported by a normative discourse, pointing out the definition of urban policies, conceptual solutions and evaluation tools.

Space syntax (Hillier, 1996; Hillier and Hanson, 1984) is based on a theory of space as an aspect of social life. It focuses on space, providing a representation of spatial relationships, expressed by a number of syntactic measures aiming at the establishment of a pattern language oriented approach. It holds a number of key concepts namely spatial configuration, axial map and axial line. Methods such as axial analysis and segment analysis, or software applications (Depthmap, Confeego, Segmen, to name a few) have been used by a growing international community.

Besides space syntax some quantitative approaches have emerged in the last decades (for a synthesis see Batty, 2005). Isovist Analysis (Benedikt, 1979) involves measuring the geometric properties of the isovist field associated with particular environmental configurations. Cellular automata represent physical systems as cells within a grid, subject to transition rules which specify the cell's behaviour based on input from neighbouring cells. Agent Based Models / ABM, developed from artificial intelligence research, removed the need for reliance on cell-based rules. As autonomous, goal-directed software entities, agents carry out their pre-programmed instructions without further interference from the programmer (see for example Wu and Silva, 2010). Shape grammars (Stiny, 1980) constitute sets of rules for performing recursive operations - rotation, translation, combination, replacement - on an initial 2D or 3D shape, to obtain a set of alternative forms. Finally, Fractal Analysis (Mandelbrot, 1977; Batty and Longley, 1994) focus, obviously, on fractals, i.e. on a particular type of shape, with an irregular but self-similar form – the irregularities are repeated across many scales.

3.3 Impact assessment

Impact assessment can be generally understood as the process of identifying and evaluating the future effects or consequences of a current or proposed action. As such, it refers to an evaluation that precedes and supports the decision-making process of a new development (ex-ante evaluation – see section 2).

The concept of impact involves the comparison between the situation without the action/project and the situation with the action/project. Both cases should engage the characterization of the future evolution of the environment starting from the present state-of-art. The focus of analysis should be on those changes significantly affecting the environment. This means there must be some criteria to determine the impact significance (Canter & Canty, 1993), referring to, for example: the lack of conformity with pertinent laws or regulations, the characteristics of the location (protected areas, for example), the possibility of mitigation, the public concerns with impact risks and the existence of cumulative impacts or other related effects that can affect the prevision.

The term impact assessment is usually associated with the Environmental Impact Assessment (EIA) process, first proposed by the National Environmental Policy Act in 1969. Since then, the EIA process spread worldwide and has been introduced as a legal procedure in different countries. The methodology is sufficiently well-know and needs no further explanations (for more, see Canter, 1996; Glasson, et al., 1994; Jay et al., 2007). Other methodologies emerged, in the last decades, comprising other dimensions of the analysis, but preserving the main principles of the general framework. More specifically, we will refer the Social Impact Assessment, the Strategic Environmental Assessment, the Sustainability Appraisal and the Sustainability Assessment.

Despite being an evaluation methodology, EIA is usually recognized as the process of evaluating the likely impacts arising from a proposed project or development significantly affecting the environment. It is a process that has spread worldwide, with some differences in each context, but generally following the same general sequential procedure. This procedure ensures that the environmental effects of a development are identified and assessed before decision is taken assuring that the public takes part in the process.

The need for better understanding the social impacts in the EIA process of projects and policies, led a group of social experts to establish the International Committee on Guidelines Principles for Social Impact Assessment (ICGPSIA), with the purpose of defining a set of guidelines and principles that should assist the authorities and stakeholders involved in the EIA process. The main purpose of a SIA methodology is to assess the impacts on society of certain projects and planned interventions (Vanclay, 2006). The focus of SIA is the evaluation of intended and unintended social consequences of planned interventions and any social change processes invoked by those interventions (Vanclay, 2003). Nowadays, most socio-economic concerns are already incorporated in other current formal planning and approval processes in several countries, in order to categorize and assess how major developments may affect populations, groups, and settlements. However, in most of the cases, it is part of, or in addition to, an EIA, and plays a minor role in combining environmental and social components within an EIA study. The SIA methodology follows a sequential framework, similar to the one of the EIA (for more, see ICGPSIA, 1994).

The main purpose of a Strategic Environmental Assessment (SEA) is to guarantee that the environmental effects of policies, programmes and plans are identified and assessed in the preparation phase, before they are adopted. The SEA differentiates from EIA basically on the nature of the object of analysis – SEA provides a whole strategic approach, in contrast with EIA that focuses on the project level. In the case of the SEA, the spatial macro scale of analysis (global, national and regional) and the longer time scale (at long and medium term) contribute to a less rigorous assessment, and to a more distant and vague perception of the impacts. However, the strategic nature of the assessment allows an easier consideration of sustainability issues. As Sheperd & Ortolano (1996) refer, the SEA has emerged in response to the urge need of integrating urban sustainability in EIA and comprehensive planning. Policies, programmes and plans can be evaluated according to environmental objectives and targets, and sustainability strategies can be part of this integrated framework. The anticipation of impacts at an earlier stage also endures for a better consideration of cumulative effects. The SEA allows for a more proactive approach towards sustainable development in opposition to the EIA that is usually associated to the reactive approach at a project level.

Sustainability Assessment (SA) is a relatively recent concept that has been evolving due to the recognition of its importance as an evaluation tool to achieve sustainability. The term, however, is too generic, including a broad range of approaches (Pope *et al*., 2004), emerging originally from EIA and SEA, and the recognition that those environmental processes should incorporate sustainability-based criteria. In the sustainability assessment, the focus shifts from minimizing damage (i.e., reducing the negative) to maximizing long term gains and opportunities for multiple parties. Although the EU argues that one of the SEA Directive aims is to achieve sustainable development, it would not be appropriate to say that the goals of a sustainability assessment are similar to those of the SEA or even EIA.

Some methodologies associated to sustainability assessment have recently emerged. One example is the process of sustainability appraisal that exists in some countries, such as the UK, in which social, economic and environmental considerations are integrated into plan revisions. Besides the term sustainability appraisal, other terms have appeared in the literature being also examples of

either an EIA-driven integrated assessment or objectives-led SEA approaches, as referred by Pope, *et al*. (2004). That is the case of integrated assessment appraisal (discussed by Eggenberger & Partidário, 2000), or integrated impact assessment (Sheate *et al*., 2003) or even sustainability assessment (Lee, 2002, in Pope, *et al*., 2004).

The EIA-driven integrated assessment and the objectives-led SEA approaches represent, according to Pope, *et al*. (2004), the two possible approaches to sustainability assessment. The first is defined as being reactive because usually is the response to a proposal already conceived. The scope of analysis is not only limited to environmental impacts, but also to the social and economic dimension, embracing the three pillars of the sustainability concept. The final target is to minimize the adverse effects, maximizing the beneficial impacts. The objectives-led integrated assessment envisages the integration of environmental, social and economic objectives. The difference between the two, is that the first ensures that impacts of the proposal are acceptable in comparison to the baseline conditions, and the second assesses to what extent the objectives that will be implemented can contribute to the sustainability principles.

3.4 Environmental accounting and energy related methods

In this section two groups of methods will be presented. A first group, designated by Environmental Accounting Methods (EAMs), gathers methodologies that analyze the stocks and flows of materials: Material Flows Analysis (MFA), Life Cycle Analysis (LCA), Material impact per unit of service (MIPS), Ecological Footprints (EF) and Sustainable Process Index (SPI). The second group relates to the analysis of energy in the urban system and considers the Emergy and the Exergy Evaluations.

In general, these methodologies are based on the input-output theory in economics, transferred as an analogy to the environmental impact analysis. The environmental resources are the inputs, and the purpose of the analysis is to maximize the output, when minimizing the environmental resources, in order to promote economic development with less environmental damages. Thus, as referred by Wang & Xu (2009) the environmental performance represents the environmental cost incurred by the economic development of modern societies, and the urban metabolism is surely a useful method to better estimate that environmental performance.

Material Flow Analysis (MFA) is a method from industrial ecology, that systematically assesses the flows and stocks of materials within a given system defined in space and time. The method evolved from earlier concepts of material and energy balancing, from the work of Ayres in 1978. The first studies on the national level were presented at the beginning of the 1990s for Austria, by Steurer, and Japan, by the Environment Agency of Japan (Hinterberger, *et al*., 2003). In literature, MFA is usually divided in three types of methodologies according to the object of analysis: i) the material flow accounting, when it is applied at a national or regional scale, focusing on the exchanges between economy and natural environment; ii) the corporate material flow analysis, or industrial supply chain, when it is applied to a company, studying the processes of production in order to obtain the most efficient processes regarding energy and materials; and finally, iii) the life cycle of a product or life cycle assessment, when it is applied to a product.

There are two possible approaches to the material flow accounting depending on the different levels of economic activity (Blanc, *et al*., 2009). At the macro level, the Economy-wide MFAs are

presented at national and regional level. The material inputs that are considered are domestic extraction and imported materials. At the meso level, the Input-Output Tables (PIOTs) are the most comprehensive type of accounts. They include the material flows between production branches and the flows from production to domestic final demand.

MFA uses an Input-Output methodology applied to physical stocks and flows of economic systems. It consists of an accounting system that balances the inputs (such as extractions and imports) and outputs (such as consumptions, exports and wastes). It can be a supportive tool for decision-making in resource management, waste management and environmental management. The main limitations relate to the difficulties inherent to obtaining all the necessary data and to the need of conciliating methodologies applied in the different case studies in order to make them comparable.

As referred to before, Life Cycle Assessment follows a similar rationale as the one of MFA at the product level. The life cycle can be understood as the consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal (ISO, 2006). In the LCA, the aim is to determine and account for the effects – environmental and social damages that a product can provoke – and to select the least burdensome one. However, it should be noted that LCA accounts for the technology used in delivering the products and services, but does not evaluate the global impact associated to the production process and the economic choice for using it.

The Material Input Per Unit of Service (MIPS) is not as detailed as the LCA and can be considered mainly a screening method. The MIPS is a concept that was originally developed by Friedrich Schmidt-Bleek in Germany in the 1990s. The concept can be used to measure the eco-efficiency of a product or service and can be applied either to a single product or to more complex systems. The method calculates the materials required to produce a product or service. The rationale behind the MIPS concept follows the material flows analysis giving a good indication of the environmental risks and impacts of the human activities, including for example the emissions and wastes that originate pollution (Osmond, 2008).

The term Ecological Footprint (EF) first appeared in 1992, and was introduced by William Rees (Wackernagel & Rees, 1995). The concept is based on the assumption that anything that consumes resources/materials or energy needs a certain amount of land, water and other natural resources. The total footprint of a certain population's activities is quantified in terms of global hectares. It compares actual throughput of renewable resources relative to what is annually renewed. The methodology consists of a simple but detailed procedure. The EF assembles data from different sources: built-up land, consumption of crops, pasture, forestry and energy to derive land area equivalents (Blanc, *et al*., 2009). It has been recognized that the EF is a useful and suggestive indicator to communicate to policy makers and to a wider public (Blanc, *et al*., 2009), and this is one of the reasons for its widespread application at national, regional or local level. It is also a valuable tool for comparison among different regions or countries.

The Sustainable Process Index (SPI) was introduced in 1996 by Krotschek and Narodoslawsky, and defines a similar method to the ecological footprint, focusing on the production of certain goods and services. The index reflects the area of land required to provide raw materials, energy, plant and equipment and waste disposal relating to the production process that is then

divided by the area per inhabitant for the region associated to the production process (Osmond, 2008). Despite its more specific focus, with more rigorous sustainability valuation, the SPI is still subject to criticisms as the environmental impacts must be evaluated through a single index, and there is no room for maneuver in comparison to other cases with more accuracy.

Finally, there are two relevant energy related methods: Emergy and Exergy evaluations. Emergy was first proposed by Odum, in the 1980s, as a method for integrating the accountability for the quality of matter, energy and information within systems (Siche, *et al*., 2009). Emergy, spelled with an “m”, measures both the work of nature and that of humans in generating products and services (Odum, 1996). The concept takes into consideration every contribution from nature and human economy in order to know the relative importance of each resource. Emergy therefore accounts for quality differences among distinct forms of energy and allows for the inclusion of information and monetary flows to those of energy and materials (Meillaud et al., 2005).

Exergy is a measure of the maximum amount of work which can theoretically be obtained by bringing a resource (energy or material) into equilibrium with its surroundings through a reversible process (Brunner & Rechberger, 2004). It is the fraction of complementary energy corresponding to entropy, i.e. the energy that keeps the capacity to be transformed into work. The Second Law of Thermodynamics requires that on irreversible transformations the exergy always decreases - an increase of entropy corresponds to degradation of energy through its dissipation as heat; this is inevitably a decrease of exergy. Recently, some studies have been published on the relation between exergy and environment. Reduction of environmental impact, increasing efficiencies of resources utilization, sustainable energy use, land use and urban planning are best addressed by using an exergy evaluation method.

3.5 The Urban Metabolism

The concept of urban metabolism was introduced by Abel Wolman in 1965 to determine the urban metabolism of a typical American city. This concept compares a city to a living organism, in order to better understand the functioning of urban areas. The analysis comprises the quantification of the flows of energy, water, materials and wastes into and out of an urban region. Following Wolman’s work, other metabolism studies have been conducted to cities worldwide. These studies, from industrial ecology and urban ecology, make evident the importance of particular aspects (such as urban form, material supplies, infrastructures networks supplies, or groundwater withdrawals) in the calculation of the overall urban metabolism.

Recently, the interest for urban metabolism has increased due to the recognition that the model can provide a more comprehensive understanding of the sustainability of a city. First, because the model gives a holistic and integrated viewpoint of an urban region. Second, because it is able to examine aspects of urban relationships among infrastructures and inhabitants, beyond the strictly functional analysis of urban systems. By comprising the analysis of all activities in an integrated and cyclical approach, urban metabolism can offer a way of measuring urban sustainability within the ecosystems capacity to support it. Additionally, there is a need to view the urban system as a whole if the aim is to understand and solve complex urban problems.

A definition of urban metabolism is given by Kennedy, *et al*. (2007) as 'the total sum of the technical and socioeconomic processes that occur in cities, resulting in growth, production of energy, and elimination of waste'. Thus, the economy is basically interconnected with the surrounding environment through the material and energy flows. The impact on the environment, or the size of the metabolic throughput, can be then estimated by the amount of materials that society appropriate from the environment and return back to it in other forms (EC, 2001).

One of the main difficulties associated with the urban metabolism model relates to obtaining the adequate data for the total amounts of stocks and flows. It is not easy to assemble all types of materials produced or consumed in an urban area, or even the amount of energy flows, for example. Throughout the last decades, different studies have been trying to develop new ways of integrating the maximum of data as possible, although most of them have only developed a partial analysis of the urban areas. It is evident from the literature, that urban metabolism usually considers five different flows or cycles of the environment: water, materials, soil, nutrients and energy (Kennedy, *et al.*, 2007).

4 The Metabolic Impact Analysis

4.1 Introduction to MIA

This section presents the general features of a novel methodology, the Metabolic Impact Analysis (MIA). This methodology provides an operational instrument to assess the overall impact of a particular development proposal on the existing urban metabolism performance of a given city, metropolis or city region.

MIA attempts to address a common problem found in many cities throughout Europe and elsewhere. Often times, a particular development project or urban project seen in isolation, i.e. detached from the geographical context in which it will be located, may well look quite attractive and able to secure, in principle, a sustainable performance from an energy, water, materials and land, point of view. However, when plugged into the existing and receiving urban fabric, the final overall results may well fall short of the most reasonable and substantiated expectations and instead of improving the overall urban metabolism performance of the city it may well end up contributing to worsen that same performance. The other way around may also be true. A given development proposal may not be, in isolation, that interesting from an urban metabolism perspective and yet, in the right location, it could provide a positive contribution to the overall metabolic performance of a particular city.

4.2. Main influences of MIA

The following are the main sources of inspiration that assisted the general conceptualisation of MIA. To start with, MIA draws on EIA methodologies. Both are geared towards tackling new proposals and both attempt to provide an operational tool for analysis and assessment. However, while in EIA the environment is seen as a sum of different and to some extent isolated components, from air, water and solid wastes, to noise and vibration, landscape quality or socio-economic factors, MIA provides an embracing and holistic perspective based on the urban metabolism concept (see Table 3). In fact,

it has some resemblances to the Sustainability Appraisal approach referred to before in which the sustainability concept offers the glue to integrate the different analysis topics.

MIA has also been influenced by the somehow démodé Threshold Analysis of the Polish planning researcher Malisz, back in the 1960s. The idea of selecting directions for expansion areas, in a particular city, in accordance to cost minimizing solutions as far as the existing provision of infrastructures and public equipments are concerned has some obvious similarities to MIA. MIA is able to explore the installed urban metabolism capacities and natural capital across the complex puzzle of urban fabrics that constitute the contemporary city.

MIA has also been influenced by Ian McHarg's Design with Nature (1969) in respect to the systematic use of layers of environmental information and to the application of the environmental sensitivity concept. Contrary to the mainstream application of the urban metabolism concept that simply ignores the spatial dimension of development processes and of the sustainability concept, MIA explores this spatial dimension and attempts to take the best use of GIS techniques. See Table 4 for a synthesis of these influences.

In addition, the urban metabolism and the environmental accounting methods made evident some relevant and useful aspects for the conception of MIA. The first refers to the importance of defining the system boundaries. All these methods follow the same common rationale of what can be called a *black box*, and the accountability of the inputs and outputs of a certain system. The second aspect refers to the difficulties in obtaining data/information, and recognizing that available data is usually presented in annual terms, but not always for the adequate scale of analysis, matching the system boundary. Finally, the environment is modelled according to a system and/or sub-systems. The components of the environment are understood in an integrated and holistic way within those sub-systems. An urban metabolism perspective of analysis will allow, in this way, for a more integrated analysis of the impacts of a proposed intervention within the systems boundaries, in contrast to the impact assessment methodologies.

4.3. Fundamental principles of MIA

The following are MIA's general purposes. First, it evaluates the urban development process, from a metabolic perspective. The urban metabolism concept was initially developed for large territorial units – countries, regions, metropolis and large cities. At city level, the application of urban metabolic models tends to embrace the whole city territory as a black box. MIA uses this same concept, however, it is geared not only to the assessment of overall city development scenarios but also, and more importantly, towards the assessment of urban transformations within the city.

Second, MIA focuses on plans and projects as fundamental drivers of the urban development process. The evolution of our cities and metropolis is shaped by numerous and successive public and private investment decisions - these decisions are framed by the local planning system in operation. Land use plans, urban development projects and, also, urban policy documents are the main objects of analysis of MIA.

Third, the methodology assesses the city wide metabolic impact of the proposals included in plans and projects. The likely changes in the overall metabolic performance of a city derived from the

implementation of urban plans and projects constitute the main output and, indeed, the main contribution of MIA.

Fourth, MIA explores the spatial dimension of alternative development processes, by focusing on particular plans and projects with specific and, sometimes, alternative locations within cities. MIA attempts to explore the hidden territorial dimension of the urban metabolism concept. Needless to say that, this territorial dimension is essential for planning purposes.

Fifth, it may address different temporal scales but is better suited to short-term assessments. MIA can be applied to long and medium term assessments. However, due to the complexity and to the ever-changing relationships between urban metabolism variables, the application of MIA to short-term (ex-ante or ex-post) analysis will surely provide far more accurate results. Similarly to Input-Output techniques, MIA is tailored to either explore the near future or assess the recent past. In fact, MIA relies on existing urban metabolism models that are continuously changing reflecting the rapid transformations in the working of our cities and metropolis.

Sixth, it deals with the environment in an integrated way. Through the systematic analysis of the changes in, and interactions between, stocks and flows of energy, water, materials, and land, the rationale behind the urban metabolism concept offers the necessary tools to understand and integrate the complex web of interdependencies between the natural and the built environments.

4.4 MIA evaluation process

The application of MIA in a given city requires the previous availability of an overall urban metabolic model, sufficiently updated to provide an accurate picture of the most important metabolic processes, covering the energy, water, material and land matrices. A comprehensive GIS database including land use, natural and built environment, as well as transport variables is also needed.

The evaluation process associated to MIA comprises six main stages as follows. The first stage corresponds to the definition of the study area, scoping and the intervention area. Within the larger city or metropolis – the study area for which a metabolic model is previously available – a confined intervention area has to be defined to initiate the MIA application. Generally speaking, the intervention area is defined according to the nature of the evaluation object, i.e. the planning proposal, the urban plan or the urban project one intends to analyze, as well as the scope of the analysis in terms of energy, water, materials and land . The intervention area has not a single and precise definition, it has a “variable” geometry according to the metabolic dimension under analysis. For instance, the energy dimension of the metabolic impact analysis may well require a different boundary from the water dimension, the land dimension or the materials dimension. That is why a simple scoping exercise is necessary at this stage.

According to the scale and nature of the planning proposal under analysis, the intervention area can comprise (Table 5), in principle, three layers of urban form: Large Urban Configuration, Urban Diversity Pattern (comprising the whole city and the distribution of functions), and Urban Building Stock. In any case, the intervention area should correspond to the smallest area able to analyze the direct interactions of the planning proposal with the rest of the city. On the contrary, the study area is the area of the city that supports the application of the general (and previously available) urban metabolic model. If the proposal encompasses alternative locations the

corresponding intervention areas have to come on board. This option will enhance all the exercise, in particular the final stages of the assessment process.

The second stage of the evaluation process involves the metabolic characterization of the study area. A baseline characterization of the study area, from a metabolic point of view, is needed. This characterization shall take advantage of the city's urban metabolism model to describe the main city inputs, throughputs and outputs, in terms of flows and stocks of energy, water, materials and land. Let's call it submodel 2. The metabolic role and performance of the city can be explored and diagnosed. The main metabolic issues affecting the city (the study area) shall become explicit.

The third stage corresponds to the metabolic characterization of the planning proposal. The planning proposal – the object of analysis – shall also be characterized from a metabolic perspective and on the basis of the intervention area previously defined. A description of the likely inputs, throughputs and outputs associated to the planning proposal, in terms of flows and stocks of energy, water, materials and land have to be estimated (submodel 3). This description should be able to match, at least in part, the main metabolic issues revealed by the city (study area) characterization (Stage 2).

The fourth stage involves the identification and characterization of the metabolic impacts. In order to identify and characterize the metabolic impacts of the planning proposal under analysis, the two sub models developed in stages 2, study area, and 3, planning proposal (intervention area) have to come together, plugging in the proposal to the larger territory of the city on which it will be located. This exercise is expected to reveal the overall forecasted inputs, throughputs and outputs associated to the implementation of the object, not just on the intervention area but also, and most importantly, on the entire urban metabolism of the city or metropolitan area (the study area). It will highlight the net potential contribution of the plan (or project), in other words, the added value of the proposal to the global urban metabolic performance of the city.

The fifth stage is the evaluation of the proposal and alternative scenarios. The net metabolic impact of the proposal and/or alternatives, positive or negative, have now to be considered in a wider perspective of the general dynamics and transformation goals previously set for the city. This stage will address issues related to public and institutional participation, overall understanding of urban development processes, interplay between development actors, to name just a few.

Finally, the sixth stage of the evaluation procedure corresponds to potentiating the metabolic efficiency**.** MIA was designed not just to support decision making (Stage 5) but also to provide a sound basis for the improvement of development proposals, as far as their metabolic performance is concerned. In this respect the final results of the application of MIA are bound to illustrate ways to improve the intrinsic quality of the proposals as well as the way they fit and adjust to the urban context they are supposed to address. In other words, these final results are likely to incorporate a number of recommendations to change and/or adapt the development proposals, plans or urban projects to the particular circumstances of the city or metropolitan area, in order to improve the metabolic performance of both the proposal and the city at large.

5 Conclusions and further research

This paper has two main goals: a selection and a brief presentation of the most important evaluation methodologies from an environmental planning and an urban metabolism point of view; and the development of an innovative methodology based on the urban metabolism concept and designed to assess specific planning proposals.

Under the first objective, a set of approaches and methodologies were grouped under five main fields: planning, urban form, impact assessment, environmental accounting and energy related methods, and urban metabolism. Malisz's threshold analysis, McHarg's land suitability analysis, and the environmental impact assessment were highlighted as the main influences of MIA.Under the second objective, the MIA was presented and justified, considering the links with other evaluation methodologies, the possible field of application, and the main methodological steps.

Our further research will involve a practical application of MIA taking the city of Oporto as a truly testbed for this methodology. As a result, the present format of MIA is likely to suffer some adjustments and improvements provided by the insights and lessons learned from a real first application. Subsequently, three other applications of MIA will be carried out in 2010 to the cities of Vienna, Stockholm and Newcastle-upon-Tyne.

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On the discovery of urban typologies

Jorge Gil, Nuno Montenegro, José Beirão, José Duarte

Faculty of Architecture

TU Delft / TU Lisbon, j.a.lopesgil@tudelft.nl

Phone number: 00 31 152783885

When pursuing a more sustainable and integrative urban development, the first stage of the urban design process should consist of a pre-design phase where the context of the site is analysed both qualitatively and quantitatively. This information provides a base line for the contextualisation of the urban programme, of the design solutions and of the evaluation benchmarks proposed for the site. Our research project aims to develop an urban design system using an urban ontology that can be applied to the formulation, generation and evaluation of urban plans. The purpose of this urban design system is: (1) formulation - to read data from the site context on a GIS platform and then generate adequate program descriptions, given the contextual conditions; (2) generation - to generate alternative design solutions that match the program, and (3) evaluation - to evaluate evolving design solutions against the program to obtain satisfactory results. In this paper we present a methodology for data mining an urban Geographic Information System (GIS) data set, consisting of three main phases: representation, analysis and description. The process reveals a series of block and street typologies that highlight the different character of two neighbourhoods. This methodology is demanding in the preparation phase and requires a high level of GIS and statistics expertise in the analysis phase. However, it successfully addresses the complex multi-scale and multi-level nature of cities in a systematic way, providing a tool for systematic profiling of neighbourhoods, which is site and problem specific.

Keywords: Sustainable urban development; GIS; data mining; urban typologies; neighbourhood profiling

1 Introduction

When pursuing a more sustainable and integrative urban development, the first stage of the urban design process should consist of a pre-design phase (Montenegro and Duarte, 2008) where the context of the site is analysed both qualitatively and quantitatively. This information provides a base-line for the contextualisation of the urban programme and of the design solutions proposed for the site. The definition and description of urban patterns appears to be a useful way to translate the urban design requirements into a format adequate for flexible, and parametric rule-based design processes.

We have recently seen statistical classification techniques applied to building typology (Reffat, 2008) and urban block form (Laskari, 2007) where archetypes are identified. Can similar techniques provide an efficient method for the classification and description of urban typologies from the base-line information gathered in the pre-design phase?

In this paper we present a methodology for data mining a Geographic Information System (GIS) data set of two neighbourhoods in the city of Lisbon, Portugal, in order to identify urban typologies of blocks and streets.

Firstly, we review previous work on urban analysis and urban patterns and introduce the concept of data mining as a tool for multivariate emergent classification that can be applied to architecture and planning. The objective is to develop and test a data mining methodology for urban environment data sets to extract site specific typologies and archetypes based on a variety of attributes from different disciplines of urban morphological studies to obtain a more integrated perspective.

We then present the overall stages of the methodology, describe the operations and the outcomes of each stage, and at the end present the results obtained from the case study. We conclude with an appraisal of the process, highlighting its strengths, shortcomings and future work.

2 Spatial Assessment of Neighbourhoods

The urban space is perceived, apprehended, and seized by humans. Lynch (1960) wrote that users understood their surroundings in consistent and predictable ways by forming mental maps. The classic method of site analysis, deeply embedded in Lynch's principles, is elaborated through a collection of visual annotations. Nevertheless such a process reveals a variety of flaws, due to cognitive and cultural constraints of the observer. In an attempt to overcome such limitations in the planning process, it is necessary to implement a collection of quantitative analysis and assessment tools aiming to assist the planner.

With the introduction of the concept of pattern languages, Alexander, Ishikawa and Silverstein (1977) offer 'patterns' as a tool for the systematic description of urban entities. In a catalogue aiming to achieve a certain ideal of urbanity, it is an explicit attempt to address the multi-scale, multifaceted and relational complexity of urban environments. The urban design community hasn't adopted this catalogue because the design codes seem outdated and suited only to a very specific geographic and socio-cultural context. The concept of pattern as a best practice tool has nevertheless flourished in other fields, like computer science. We consider that this concept can still be useful in the urban development process if we find efficient ways to update the available patterns to be problem and context specific.

An important step in this approach comes from Rapoport (1990) through Environment and Behaviour Studies (EBS). He suggests that grain, texture and complexity are qualities of the environment that can be derived or read from data and quantities. His work introduces the systematic analysis of the environment, looking at the object and the context around the object, taking data from the past (historical data) and from the present, to construct concepts, models and theories. The derived precedents or archetypes must not be applied directly in a historicist fashion, but serve as patterns and process.

2.1 Description and classification of urban typologies

There are several studies that advance into the detailed analysis of urban environments, offering different methods to describe and classify urban entities to obtain urban typologies.

Urhahn and Bobic (1994) identifies principles of good city life and catalogues urban neighbourhoods through a quantitative and qualitative description. He covers several scales, from city to district, block and building and uses different classifications themes for description, including form, density, land use, and mobility infrastructure. The final presentation is textual for complex dimensions such as context and accessibility, quantitative for the built form, and highly visual, displaying the various attributes of each area in a disaggregate format. Interestingly it formally ignores the street as classification entity, although it receives a brief mention in some descriptions.

Streets receive full attention from Stephen Marshall (2004) underlining the importance of urban layout and configuration for urban quality. He criticises the misuse of typologies to mime appearance

and structure of urban neighbourhoods missing the essence of streets in the process. Furthermore he exposes the limitations of classification and catalogues as they offer a univariate interpretation on a theme, resulting in a fragmented vision of the phenomenon. Marshall uses quantitative attributes relating to configuration, composition, complexity, and constitution of streets, combined in triangular multivariate charts, to define street typologies.

A similar multivariate approach is taken by Berghauser Pont & Haupt (2004) in relation to neighbourhoods and urban blocks, around the theme of development density using a set of four built up area indices. A novel aspect is that they create an interactive on-line tool so that users can systematically compare existing or planned neighbourhoods against the ones on their catalogue for a characterisation through precedent (http://www.permeta.nl/spacemate/index2.html: April 2010).

Marshall and Berghauser Pont & Haupt have to restrict their themes to three or four variables in order to achieve a way of visualising and defining their typologies. But the sustainable urban development process has a degree of complexity that requires the consideration of many morphological, socio-economic, environmental and cultural attributes.

2.2 Data mining

The data mining process is characterized by a recursive withdrawal procedure enthused by a statistical platform towards data emergence, and is commonly used to perform three alternative tasks (Fayyad, 1996):

1) Classification - arranging the data into predefined groups,

2) Clustering - where the groups are not predefined and the algorithm tries to group similar items together,

3) Regression - to find a function that models the data with the least error.

Technically data mining is the process of finding data correlations or data patterns amongst dozens of fields in large relational databases. In this paper we perform data mining using a clustering technique.

The relevance of these techniques to the planning process is that they allow users to analyse the environment from different angles simultaneously, categorise it, and summarise the relationships identified. Data mining seems to facilitate the discovery of data patterns that would be difficult to reveal in a complex urban space, today controlled by a bursting environment of economic and social phenomena.

Some examples of the use of data mining in architecture research can be found for buildings, defining archetypal office building layouts (Hannah, 2007) and Arabic house typologies (Reffat, 2008), and for urban block morphology, in terms of shape and density (Laskari, 2007). These examples demonstrate that using methods of semi-automatic classification according to multiple variables reveals typologies in a systematic way and may be used to better understand typologies of the urban space and the relationships amongst their variables.

3 Research objectives

The “City Induction” research project aims to develop an urban design tool using an urban ontology that can be applied to the formulation, generation and evaluation of urban plans. The purpose of this urban design tool is:

1) formulation - to read data from the site context on a Geographic Information System (GIS) platform and then generate adequate program descriptions, given the contextual conditions;

2) generation - to generate alternative design solutions that match the program;

3) evaluation - to evaluate evolving design solutions against the program to obtain satisfactory results.

Within this framework, this paper’s aim is to develop and test a context analysis methodology for urban environment GIS data sets through the application of data mining techniques to two levels of the urban ontology, streets and blocks. We will be using the recommendations in Witten and Frank (2005) in a process of reverse engineering, where from the existing environment we extract descriptions of street and block typologies to be used as precedents in formulation and obtain sets of rule constraints that can support a parametric rule-based design process in generation.

4 Data mining methodology

The proposed methodology has three main phases, namely representation, analysis and description (1 – 3). It involves the work of all three modules of the tool, formulation, generation and evaluation, in the following tasks:

1) Representation
a. Selection of classification attributes
b. Preparation of the plans
c. Integration in the GIS, when required
2) Analysis
a. Spatial analysis of plans
b. Statistical analysis and clustering of attributes
3) Description
a. Statistical profiling of clusters
b. Semantic description of typologies
c. Extraction of design rule constraints

Next we go through the three phases as applied to our case study, describing the key steps and lessons learned.

4.1 Two Lisbon neighbourhoods

The case study consists of two adjacent, but different in character, neighbourhoods in Lisbon, Portugal (Figure 1). The first is the Expo 98 PP4, the northern most detail plan for the 1998 world exhibition site, which is a contemporary neighbourhood, planned from scratch on a brown field site and developed over the last 10 years. The adjacent Moscavide is a neighbourhood founded in 1928

and developed more slowly over the following decades suffering from densification, in particular inside the urban blocks, due to a strongly bounded geographic location without room for expansion. Can this method identify different typologies between the two sites? Are there elements in common?

5 Representation

The representation phase involves the selection of classification attributes and the preparation of the geometric data that constitutes the plan, according to the urban ontology elements, keeping their topological relations. All the information is gathered in a GIS to build an urban morphology data base.

5.1 Selection of classification attributes

"The best way to select relevant attributes is manually, based on a deep understanding of the learning problem and what the attributes actually mean." (Witten and Frank, 2005)

Since the attributes must be meaningful in relation to the sustainable urban development problem, the urban program includes an extensive list of attributes that are linked to sustainable urban form covering bioclimatic, morphological, configurational, socio-economic and cultural aspects (Higueras, 2006; Uhrahn and Bobic, 2004; Berghauser Pont and Haupt, 2004; Marshall, 2004; Hillier and Iida, 2005). To develop the methodology, from this list we select block and street attributes focusing on aspects of morphology and land use for both entities, and density for blocks and configuration for streets (Table 1). We combine a set of attributes that cover different domains of urban form research to demonstrate the potential of this method for cross-disciplinary studies.

5.2 Preparation of the plans

The proposed methodology requires the use of GIS vector features representing urban entities linked to descriptive information like number of floors, number of dwellings and land use. This is different from a conventional geometric representation used in urban design where the urban elements are not whole topological entities but are composed of lines that define shared boundaries, and their attributes are encoded in graphic formatting or layers.

In our case study we have used CAD software to create layers to reflect the urban ontology and organise levels of information that need to be captured, e.g. building type, then edited the available plans to match these criteria. The other important task was to correct and complete those plans to define polygonal objects for buildings, plots, blocks, streets and pavements that correspond to correct topological entities. The typical operation is the closing of polylines and the joining of the adjacent polygon's edges and the task can be more elaborate depending on the method for representing limits and boundaries used in the original drawings. For this manual editing purpose CAD software seems to be more flexible.

As for the streets' network it was also represented as a linear model based on road centre lines, which had to be verified for connectedness, and a space syntax model based on an axial map of the city.

Table 1. List of the selected block and street attributes

Attribute	Entity	Code	Calculation
Length	Street, Block	LEN	m
Width	Street, Block	W	m
Orientation	Street, Block	DIR	degrees
Solar Orientation	Street, Block	SOLO	N,S,E,W
Number of Buildings	Street, Block	BLDN	integer
Area	Block	TA	m2
Built-up area	Block	BA	m2
Perimeter	Block	PER	m
Proportion	Block	PROP	LEN/W
Compactness	Block	CMP	A/PER
Floor Area Ratio	Block	FAR	GFA / TA
Ground Space Index	Block	GSI	BA / TA
Layers	Block	L	GFA/BA
Open Space Ratio	Block	OSR	(TA - BA) / GFA
Private space area	Block	PRVA	m2
Public space area	Block	PUBA	m2
Pavement width	Street	PAVW	m
Pedestrian area	Street	PEDA	m2
Continuity	Street	CNT	Links
Connectivity	Street	CON	Degree
Global accessibility	Street	ACCG	Closeness
Local accessibility	Street	ACCL	Closeness
Global movement flow	Street	MOVG	Betweenness
Local movement flow	Street	MOVL	Betweenness

5.3 Integration in the GIS

When importing the geometry it is important to specify the correct coordinate system for each source so that they overlay correctly, in this case we used the Portuguese National System D73. If the coordinates in CAD don't comply with a geographic coordinate system, the plans have to be moved to a correct reference location. At this stage we have to verify the imported geometry, converting any remaining closed polylines to polygons and creating the polygonal objects with holes.

We then add columns to each entity for its descriptive information, like names, codes, land uses or number of floors. First we transfer the information contained in text layers to the relevant entities, the most important being any unique ID code that enables linking these entities to urban plan data available in other formats, like CSV or XLS.

Once we complete the preparation of the features describing the two neighbourhoods, both in terms of geometry and plan information (Figure 1), we end up with the following data layers in the GIS:

- Building: any built-up object, both public and private.
- Open space: empty space within blocks, both public and private.

- Plot: the legal boundary of a property, containing buildings and open space
- Block: group of plots and private or public open space, forming an island surrounded by the transport network.
- Pavement: the public space between the blocks and the roads.
- Road centre line: linear representation of the street network.

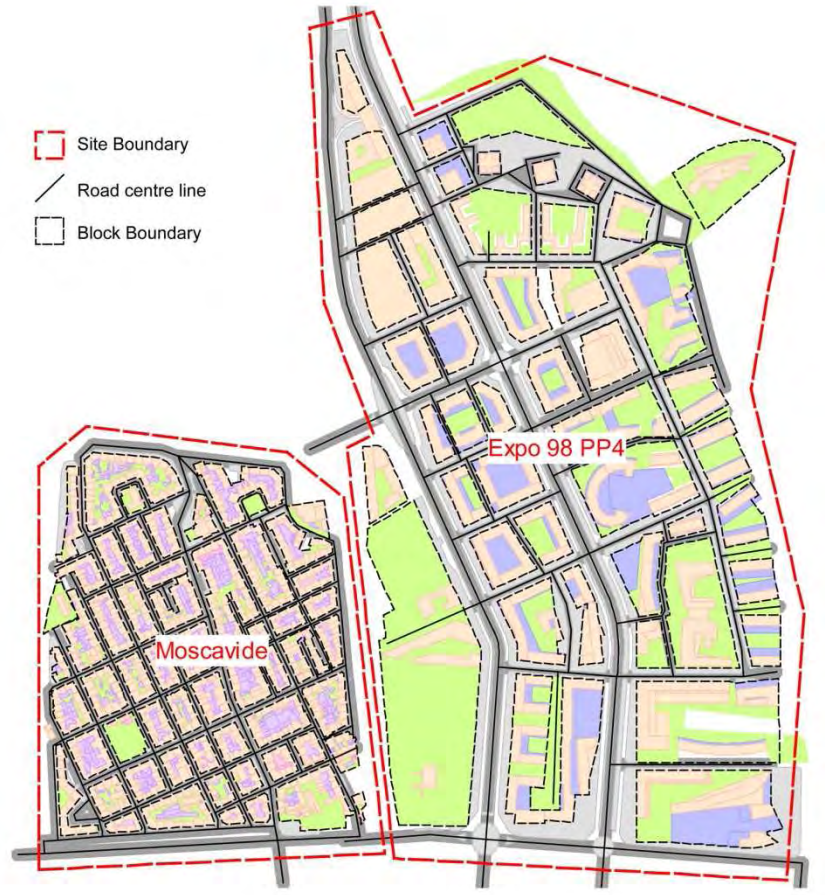


Figure 1. Plan of the case study areas in the GIS.

6 Analysis

In the analysis phase the plan is analysed spatially to extract further attributes and statistically to evaluate the importance and relation between attributes. We then perform k-means clustering on the resulting data set to identify typologies of streets and urban blocks.

This is where the statistical data mining occurs, which can be defined in the following terms:

- Concepts – Block and street.
- Instances – The collection of blocks and streets from the case study.
- Attributes – The selected meaningful properties of blocks and streets, both numeric and nominal.

6.1 Spatial analysis

A GIS is used to perform spatial analysis operations involving geometric and network calculations on the axial map, as well as simple data filtering and mathematical calculations, to obtain all the required attributes (Table 1).

Once this is completed it is important to visualise the individual attributes of blocks and streets by mapping them as it helps the verification of representation mistakes, inconsistencies in the calculations and is also a first step in becoming familiar with the data (Figure 2).

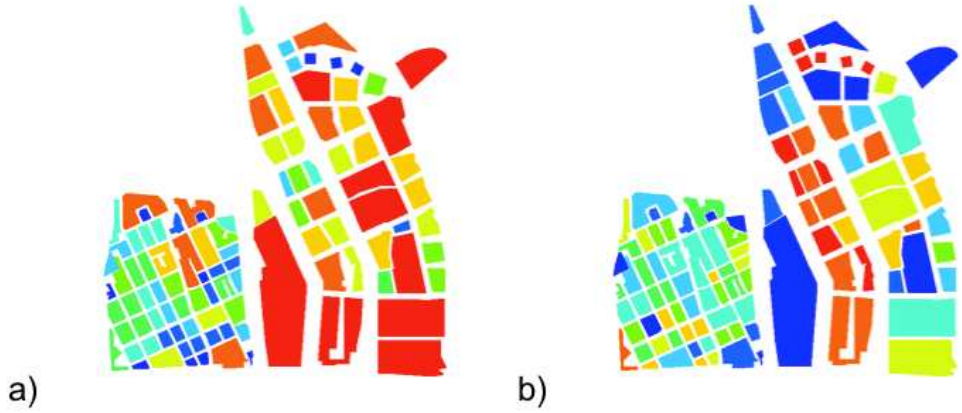


Figure 2. Maps of block area (a) and block FAR (b).

6.2 Descriptive statistics

At this stage, we explore the data through descriptive statistics, data distributions, and perform the cleaning of errors, understand outliers or missing values. Because most urban spatial attributes do not have a normal distribution, we transform those using log(x), as a normal distribution is expected in most statistical operations.

Next, performing pair-wise correlation can help identify and exclude dependent attributes, which would bias the study towards a specific theme of classification. For example, in our case study we found a strong correlation between block area and the other dimensions of length, width and perimeter, which are excluded from the classification process, but are accounted for in other ratios like proportion and compactness.

6.3 Clustering

Clustering allows the classification of numeric and nominal attributes in multi-dimensional space where there are no classes beforehand and their number (k) is not known. We apply a classic k-means clustering technique, which is suitable for a small database (in data mining terms) with many outliers, and also gives us the distance of every instance to the centroid of the cluster, which allows

us to select the k-medoid (archetype) of each cluster. Other clustering techniques can be used depending on the data set.

We produce various sized (k value) sets of clusters of block and street typologies according to the notable points in the scree plot function (Figure 3) that uses the sum of squared distances in all clusters. The optimum should be where the plot shows a kink; when it flattens more clusters provide more detail with lower information gain.

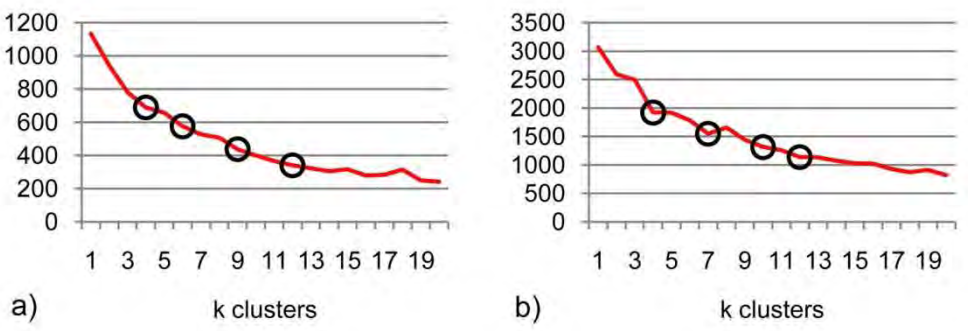


Figure 3. Scree plot of block (a) and street (b) clusters, where circled are the selected k numbers for testing.

We visualise each cluster by mapping its elements on the plan (Figure 4), to observe if there are any clear typologies or known classes being identified. We observe that some cluster sets look like transitions in the classification not giving obvious typologies, but there are points that produce clear separations of increasing detail. For blocks we identify 4, 6 and 12 clusters and for streets 4, 8, 10 and 14 as such demarcation points.



Figure 4. Mapping of (a) six block and (b) four street clusters.

7. Description

The description phase translates the results into a format that is more useful for the urban design process, which includes a semantic definition of the emergent clusters of urban typologies. In addition, the cluster attributes, e.g. length, width, number of floors or density, can serve as inputs for a parametric rule-based urban design process.

7.1 Statistical profiling of clusters

The block and street attributes, which in most cases are continuous numeric values, e.g. area or length, should be classified to facilitate the description process. Data discretisation can be achieved using:

- quantiles
- normal quantiles
- equal intervals
- natural breaks
- domain knowledge classes when these are known

Ideally there are domain knowledge standard classes, which are more useful in practice because they are meaningful beyond the data pattern, but in this case we have used quartiles. We then profile each cluster according to the share that it has of each of the attributes (Figure 5).

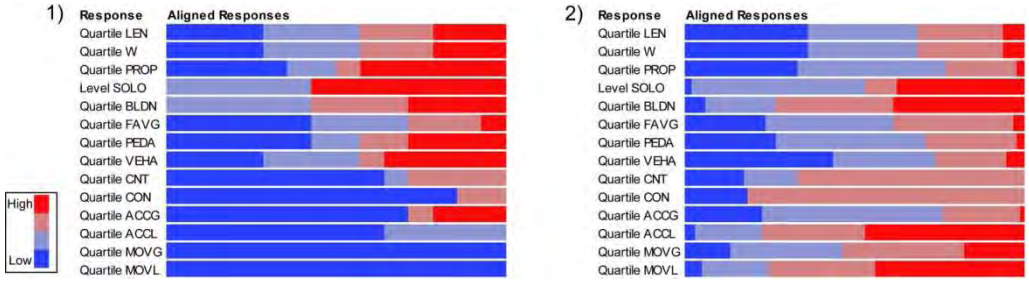


Figure 5. Sample of the categorisation charts: profile of street clusters 1 and 2.

7.2 Semantic description of typologies

For the semantic description of the clusters we focus only on the attributes that have dominant and unique characteristics, in order to highlight the specificities of each typology instead of the generalities common to both neighbourhoods. Dominant characteristics have a share of a class above 70% within that attribute, e.g. 94% of blocks in cluster 3 have an area of public space classified as very low. Unique characteristics have a share of a class 50% above or below the average of that class in other clusters, e.g. cluster two has 6% of blocks with the lowest open space ratio, which is 50% below the average of all other clusters. We present a succinct description of the six block and four street cluster sets (Table 2), together with a sample of the “archetype” block and street entities (Figure 6).

Table 2. Sample of block and street typology descriptions

Cluster	Description
Block 1	Closed block, medium density with private courtyard only
Block 2	High density, compactness and pressure on open space
Block 3	Low density with private open space
Block 4	Open block of medium density with privileged public space
Block 5	Open public space with no built area
Block 6	Large, low density block with equipment and associated public space
Street 1	Very low or no continuity and movement flow
Street 2	High connectivity and continuity streets
Street 3	Low continuity streets
Street 4	Long streets with wide pavements and high average of tall buildings

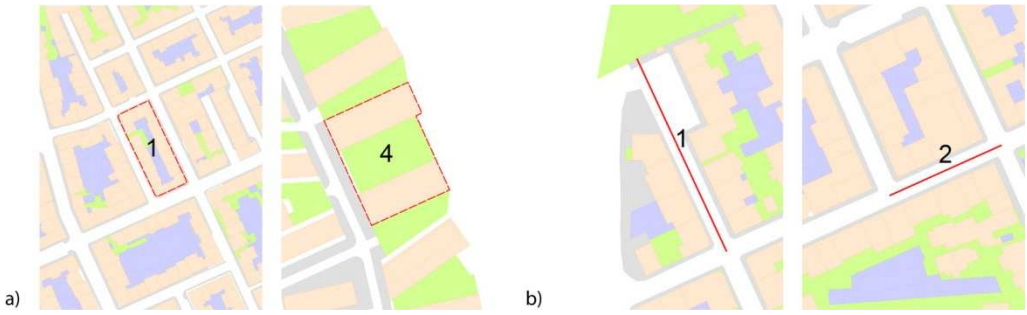


Figure 6. Sample of block (a) and street (b) typology archetypes for the clusters in Table 2.

7.3 Design rule constraints

Another output of this process is a table with the quantitative description of each cluster, in terms of minimum, maximum, average and standard deviation values of every attribute used, which can provide useful input to parametric rule-based design.

8 Results

The results of applying the data mining methodology to the case study are encouraging. By statistically correlating the instances in the clusters to their pre-defined neighbourhood, Expo 98 or Moscavide, we observe the degree to which the clusters are characteristic to a neighbourhood. We find that some clusters clearly correspond to one of the areas, eventually with few outliers indicating the odd instances of that area (Table 3). The overall R2 between clusters and neighbourhoods is 0.67 for the block clusters and 0.58 for the street clusters, where a value of 1 would correspond to complete identity between the two variables.

The clusters with an even share of instances from both areas, e.g. “Block 3” and “Street 3”, tend to get subdivided when the number of clusters is increased demonstrated by an R2 of 0.8 between four and six block clusters, and 0.87 between four and ten street clusters (Table 3).

Table 3. The percent share of instances from the two neighbourhoods in each cluster

Cluster	Size	Expo 98	Moscavide
Block 1	45	0.00	100.00
Block 2	16	93.75	6.25
Block 3	17	52.94	47.06
Block 4	22	90.91	9.09
Block 5	2	50.00	50.00
Block 6	2	100.00	0.00
Street 1	14	28.57	71.43
Street 2	96	3.13	96.88
Street 3	44	63.64	36.36
Street 4	66	95.45	4.55

Visual inspection of the cluster instances on the plan (Figure 3) confirms the consistency of the statistics and demonstrates the extent of typological overlap between areas. Some blocks in Moscavide are more recent and correspond to the typologies found in the Expo 98 site, and some street typologies, such as the dead end, are universal and can be found on both areas. Only further clustering of those groups would eventually identify types of dead end unique to one area or the other.

9 Discussion

The emergent classification helped us to identify a series of block and street typologies at various levels of detail that at expert inspection correspond to known typologies and highlight the different character of the two neighbourhoods. In doing so, this clearly moves away from the one-dimensional classification on a theme criticised by Marshall (2004) and picks out instances that are typical according to different themes, an essential aspect of a less fragmented vision of complex urban environments.

9.1 Methodological issues

However, this context analysis methodology can be demanding in the preparation phase if an adequate GIS database is not available and requires a high level of GIS and statistics expertise in the analysis phase.

Usually there aren't GIS vector data sets available for urban areas with the architectural level of detail required for urban morphology studies, which go down to the building scale, although these are becoming more common with the introduction of GIS in local authorities, the upgrade of national data bases, as is the case with the UK Ordnance Survey's "MasterMap" data set, or the increasing availability of public domain GIS data, for example OpenStreetmap (http://www.openstreetmap.org/: Accessed April 2010). For the required level of detail one often has to resort to CAD drawings and to extra survey or plan information in text format to complement it.

There are many operations needed to convert a CAD drawing into a GIS urban topology for analysis, partly due to inconsistencies in the original plan representation, including defining the entities' geometry clearly and grouping each type in separate layers. Even the definition of the

entities' topology in certain urban areas, such as the unclear boundary between street, public space and private space can be problematic

Furthermore, there needs to be clear agreement on the attributes' selection and how they should be calculated, otherwise one risks ending with typologies that are of little use for urban regulations or design operations. For a complete appraisal of this matter we would need a more complete data set with attributes for other types of indicators relating to socio-economic conditions, in particular land use, population size and type.

Still this methodology offers insights into the complex nature of urban environments that could not be obtained manually, by identifying multivariate typologies within large numbers of instances. Also, by using systematic statistical operations the process can be consistently applied to different sites by different people, avoiding much of the subjective nature of urban environment profiling.

9.2 Further work

With such a methodology we offer a process of producing a context sensitive sample of typologies, which can be used as precedents for an urban design program. Furthermore, when integrated in a parametric rule-based urban design system, it provides useful quantitative rule constraints that direct the system towards solutions that fit to the context or to an urban program of sustainable development. Both of these scenarios need to be formally tested by using these outcomes in a formulation and generation process.

Two other topics deserve consideration. In this example we assume that all attributes are of equal importance, but maybe using domain knowledge one could assign weights to the attributes to better address a specific problem. The danger is to bias the clustering results towards some misconception, reducing the emergent quality of the process.

On the other hand, by not filtering attributes for the site or for the specific problem, we would obtain more universal results and could consider building a catalogue of precedents. But would it be actually useful for design practice? Many criticisms exist of standard catalogues and design codes. Ultimately, by following this data mining process, we are acknowledging that urban interventions deal with complexity and are problem and site specific.

Finally, further work using a similar approach involving more detailed information on other aspects of the public space and their relation with the blocks, for instance, issues of ground floor transparency, land use and permeability may me able to give a deeper insight towards the understanding of urban typologies and neighbourhoods, and inform the development of new urban patterns.

10 Conclusion

In this paper we presented a data mining methodology that applied to urban environment data sets is capable of identifying typologies from the site context during the pre-design phase and is useful in defining values for parametric rule-based design. In doing so it addresses the complex multi-scale and multi-level nature of urban environments binding qualitative and quantitative requirements.

While descriptive statistics facilitate the general description of a neighbourhood as a whole, according to socio-economic, morphologic and network layout information, using data mining

techniques it becomes possible to classify the elements of those neighbourhoods according to multiple qualitative and quantitative attributes simultaneously. This provides a more detailed profiling of the character of a neighbourhood, which facilitates the understanding of the site context or of a plan's design rules and constraints.

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The spatial network of the study area and its surroundings was taken from the "axial map" of the Lisbon region with permission from its author, João Pinelo, University College London (UCL).

The following academic software was used in the described methodology: Confeego 2.0 from Space Syntax Limited and UCL Depthmap 8.15 by Alasdair Turner, UCL.

Urban Centralities. Places of liveability

Francisco Serdoura, Helena Almeida

CIAUD – Centro de Investigação em Arquitectura, Urbanismo e Design

Faculdade de Arquitectura, Universidade Técnica de Lisboa, fs@fa.utl.pt; almhelena@gmail.com

Phone/fax numbers: 00 351 21 361 58 28 - 00 351 21 362 51 38

The evolution of Lisbon's urban structure has been associated with both morphological and functional factors. In fact, as the public life changes, so does the use of public space, as well as its urban functions. On the other hand, the city structure has been directly related to its urban fabric over the last 50 years, which sought to expand into areas with greater accessibility. Consequently, the areas near the centre gradually lost importance and visibility, which led to their spatial and functional segregation, and to a further deterioration of the socio-economic fabric. The human flows generate a complex web of public space appropriation. The assessment of the human activity helped to construct the centrality model for the city of Lisbon. This paper aims at contributing to a better understanding of Lisbon's functional structure evolution. The purpose of this study is the deepening of the knowledge about city planning as a process of dynamic growth, which is supported by land use management. The current study concluded that there are new centralities emerging in Lisbon, where land use dynamics lead to preferential locations for central urban functions. Therefore, land uses and syntactic properties of urban space proved to be essential to find the possible location for public spaces with intense human activity.

Keywords: centrality; functional centre; urban dynamics; spatial analysis; Lisbon.

1 Introduction

Centrality is no longer understood as a geographically localized and static area. It is identified with a spatial-functional process, an urban reality of constant change. It can be at any level of the urban structure and may also change, as people change the way they use public space or transform urban morphology (Hillier, 1999). These changes are a reaction to the regular transformations of the whole urban network (in what concerns central spaces and the whole network).

The current knowledge of urban evolution processes indicates that the correlation between syntactic properties and its land uses and activities are the engine of centrality (Serdoura, 2006).

The aim of the current paper is to deepen the understanding of urban planning as an evolutional process, through the study of the urban dynamics evolution of Lisbon's integrated centre.

To proceed with the syntactic analysis of Lisbon's urban grid, we applied a methodology based on the 'Space Syntax' of Hillier and Hanson (1984) work 'The Social Logic of Space', which consists on studying the correlations of natural movement patterns in the urban grid. This methodology used integration (rn) as the main measure of centrality, which represents the depth level of an axial line in relation to the whole system. The spatial system can be the whole urban grid or just a limited number of axial lines within radius 3 (r3). The r3 integration is also used and it's called "local integration". The resulting values are as higher as the analyzed axial line is more accessible (Serdoura, 2006). Other measures were also used, as the axial lines length (measurement of the largest possible axis which crosses a public space) (Jiang and Claramunt, 2002; Desyllas, 2000) and connectivity (expresses the connections intensity of an axial line in relation to the adjacent lines), which were used to find and compare the permeability of the urban network and the functional centre of the city of Lisbon during the analyzed period of 1950-2001.

2 The Evolution of Functional Dynamics in Lisbon

During the second half of the twentieth century, the process of urban planning was influenced almost exclusively by the topographic elements of the territory, which led to an expansion of the city to greater accessibility areas. This premise, associated to the lack of urban regeneration processes in areas with less accessibility, led to the promotion of spatial and land use segregation of former central areas. During this period, there were also major changes in social and economic fabric of Lisbon, increasing since the decade of 1970.

In 1932, Government promoted a whole range of works such as roads, ports, railways, airports and hydraulic works, resulting from the current urban policies. During this period of time, urban policies promoted both by the central and local authorities were the creation of basic infrastructure for urban development (Serdoura, 2008).

The Master Plan for the City of Lisbon (Plano Director da Cidade de Lisboa - PDCL) was the first city planning instrument, having been introduced in 1948 by Gröer. Its main tool for intervention was the 'zoning', which organized the city by land use. The eastern area was specialized in the industry, as well as other peripheral areas of the city, which were related to the port activity and the railways. For the downtown, an area of specialization of services and administration was proposed, and, in the remaining areas of the city, housing was prevalent, especially in Avenidas Novas district (Silva, 1994). This planning instrument was reviewed in 1958, although maintaining the same strategy, only indicating reductions on some proposed green areas (Brito and Camarinhas, 2007).

The master plan of 1967 (Plano Director de Urbanização de Lisboa – PDUL) regulated the expansion of the city for the next 20 years, particularly regarding the road network, distribution of employment and housing. It defined as prior orientations: (a) the creation of a North-South distributor axis from the airport to the projected bridge; (b) extension of Avenida da Liberdade, which was, at the time, the main expansion axis to North, in order to develop an offices and services area, additionally to the downtown, and create a new centrality; (c) propose densities homogeny, in opposition to Gröer's proposal; (d) division of the city into several independent territory order units (Serdoura, 2006). Figure 1 presents the major land uses distribution for this plan. There was a concern on focusing central activities (offices and services) in the downtown, Avenida da Liberdade and Avenida Fontes Pereira de Melo, beyond some other clusters which were dispersed through the city and in the continuation of the pre-existent central areas. Industry was located mainly at the riverfront, between Santa Apolónia and Olivais.

In 1977, a revision of PDUL was approved. The major problem of this plan was social housing and location of industry. The permanence of the large industrial area and social housing near the urban centre was not adequate to reality anymore. This plan was reminded by its ineffectiveness, since it did not contemplate the socio-economic changes that were happening, proposing an inappropriate strategy in relation to the effective powers of the municipal administration (CML), overtaken by the private agents' dynamics. In fact, the 1980 decade was the time for large construction developments, without concerning the strategic growth of the city, which resulted from the privates pressing allied to the incapacity of the authorities to manage the territory without damaging socio-economic dynamics (Serdoura, 2006).

During the period 1981-2001, Lisbon presented a trend of losing population to other municipalities in the metropolitan area (Salgueiro, 2003). This was partially due to a lack of appropriate housing policies and to a degradation of residential conditions in central areas, associated with real-estate speculation, which was encouraged by the expansion policies for the city (Serdoura, 2006).



Figure 1. Master Plan of Lisbon (PDUL), 1966**.** Source: CML, 1967.

Moreover, the attractiveness of Lisbon as a place for jobs was also weakened, mostly since the 1980's. The industry had almost disappeared and the growing demand of the tertiary sector for the new office parks in neighbouring municipalities (Serdoura, 2006) accentuated the crisis of socio-economic structures and affected the whole Lisbon's metropolitan area (AML).

During this decade, the modernization of the city was synonym of outlining new expansion areas and land uses specialization in the centre, as it was understood as a natural process of evolution of the "traditional town" (Pereira, 1986). Additionally, public space was a result of charges on real estate by the municipality. Therefore, most of the time public space design would not go beyond that imposed role (Krier, 1977).

The problems resulting from the lack of adequate housing policies and municipal planning, which gave space to real-estate speculation, were felt in the end of the decade of 1980. A discussion about renovating municipal strategies of planning and development for Lisbon was launched, and resulted in the elaboration of the Strategic Plan for Lisbon (PEL). This study oriented the further elaboration of several municipal plans, as Lisbon's Master Plan (PDM) of 1994 (see Figure 2).

For the PDM of 1994, it was given priority to the establishment of occupation, use and transformation rules of the municipal territory, by the implementation of urban concepts which were considered in the scope of the Strategic Plan of Lisbon (PEL).

The planning methodology of 'zoning' was not exclusively related to land use anymore, but with a development strategy, which could combine uses and strategic goals to achieve in each area (for instance, "areas for urban restructuring", "areas for special purposes" "areas for research and technology", "historical areas", "consolidated areas").

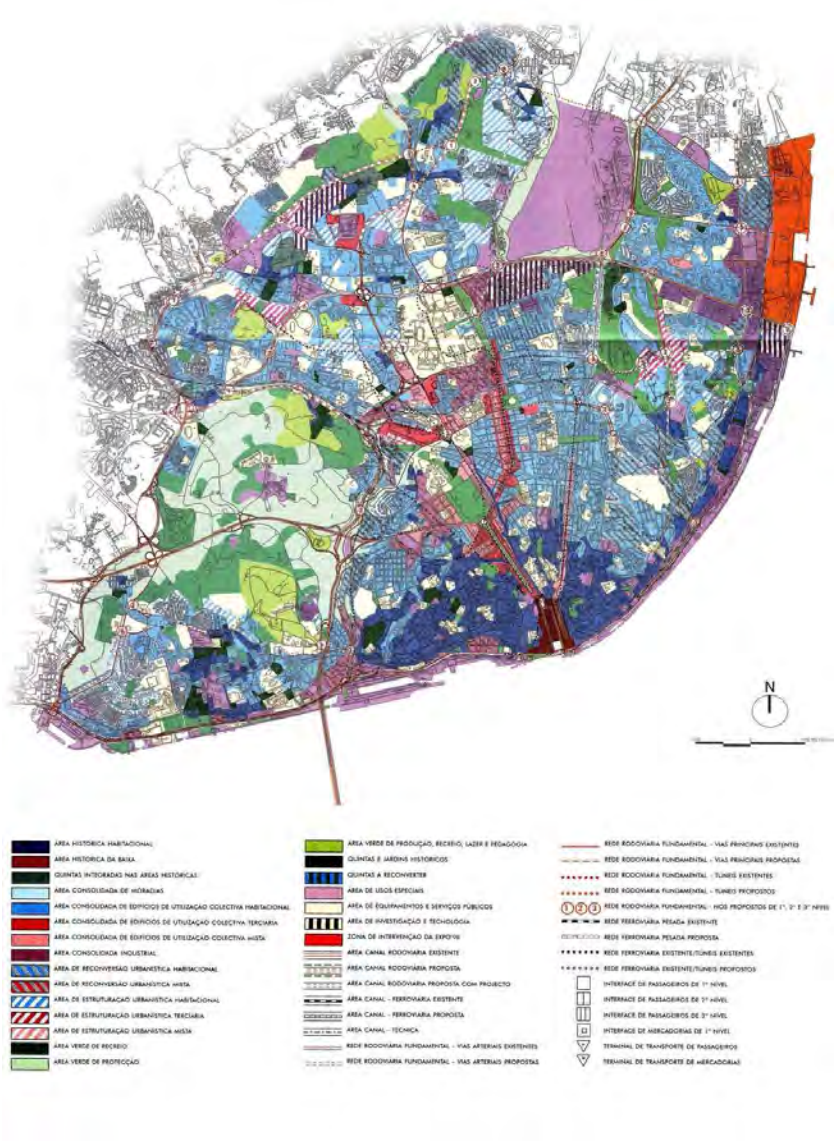


Figure 2. Master Plan of Lisbon (PDM), 1994**.** Source: CML/DPE, 1994.

Generally, offices and services were mainly proposed for central areas as the downtown and Avenidas Novas district. The concentration of commercial uses (office and retail) foreseen in the PDM seems to contribute to justify the dimension of the central area of the town core, the Avenidas Novas. However, this land use was also reinforced in less centralized areas, such as Chelas area

(SE of town), Olivais (NE of town), in the area of intervention of Expo'98 (E of town), in Aterro da Boavista (S of town) and in Alcântara industrial area (SW of town); as well as in different spots throughout the northern periphery of the city.

The industrial use was even more restricted to near the EXPO'98 intervention area. This land use almost disappeared since then, and the only examples left are the port area and some other areas of Lisbon, like Marvila, where industrial uses disappeared but there were no restructuration of the urban fabric, which led these areas to a gradual degradation process. On the other side, the privileged accessibilities between the geographical centre – Avenidas Novas – and the new urban expansion of the city – Expo'98 – contributed to the emergence of a new centrality there.

3 Morphological Dynamics of Lisbon

To complete the study on the evolution of Lisbon, it is necessary to combine the functional dynamics, which were already discussed and justified through the evolution of municipal planning process, with the morphological dynamics.

Generally, urban centres are related to their attractiveness for the location of economic activities. Their configuration is the result of the competitiveness between them for the best location in the urban grid. Hillier, *et al*. (1993) states that one of the primary properties of the urban grid is to be the main generator of movement patterns.

The methodological framework of this study will be the description of spatial variables (syntactic) of integration and the analysis of their correlation with the functional variables (land uses). This analysis will be developed through the space syntax process. This methodology was developed by Hillier and Hanson (1984) and consists on the correlation of natural movement patterns in the urban grid. Space Syntax is useful for the understanding of the formal logic of the urban fabric, in what concerns its evolution and the emergence of centralities and living open spaces where the main urban activities take place.

The main variable to be used for spatial analysis will be integration, which represents the depth level of an axial line in relation to the whole axial lines system, which can be all the urban grid or just a limited number of axial lines within any radius (for example, radius 3 (r3)). The r3 integration is called "local integration". The resulting values are as higher as the analyzed axial line is more accessible. The centrality effect was analyzed through the study of the evolution of integration (rn) values, which transmits the accessibility level of specific space in relation to the whole spatial system (Hillier and Hanson, 1984).

To complement the already described evolution of functional dynamics, the research will now focus on the analysis of Lisbon's axial maps of integration in different periods of the twentieth century, in order to compare the gradual functional and the morphological changes.

Figure 3 represents Lisbon's axial map of integration (rn), which emphasizes the importance of the concentric structure of the urban grid, implemented by Ressano Garcia, and reflects the planning strategy developed by PDCL (1948). The most accessible axes to the centre are N-S oriented and, secondarily, W-E oriented. The centralization of specialized shops, administration, offices and services in the downtown and the increment of housing in Avenidas Novas district are visible,

corresponding to the red areas in the axial map, which are the most integrated (accessible) lines of the grid.

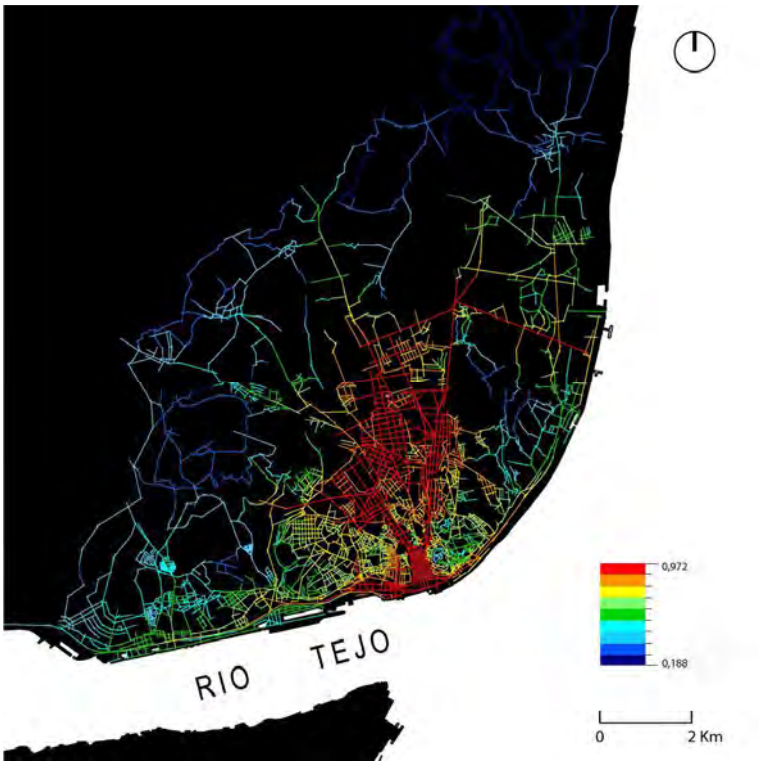


Figure 3. Integration (rn) axial map of Lisbon in 1950**.** Source: Serdoura, 2006.

Through the overlap of the axial map integration (rn) (see Figure 3) with the topography of the city of Lisbon (see Figure 4), it is possible to confirm that the spaces with greater accessibility and which form the integrated centre (axial lines represented with colours from yellow to red) are located in flatter areas of the municipal territory, especially in its central plateau (Avenidas Novas district).

The analysis of Lisbon's axial map of local integration (r3) (see Figure 5), which represents the most important axial lines at a local level (viewed from those who are inside the urban grid - residents), shows a different understanding of the hierarchical relations inside the central areas which were all homogeneous in the previous map (see Figure 3). This axial map is helpful to find sub-centres inside the whole network.

The areas that stand out for their local integration (r3) (see Figure 5) are the downtown district (1), Avenidas Novas district (2) and Avenida Almirante Reis and its surroundings (3). However, other sub-centres emerge from this map, mainly at west, as Campo de Ourique (4), Santos (5), Belém (6) and Restelo (7).

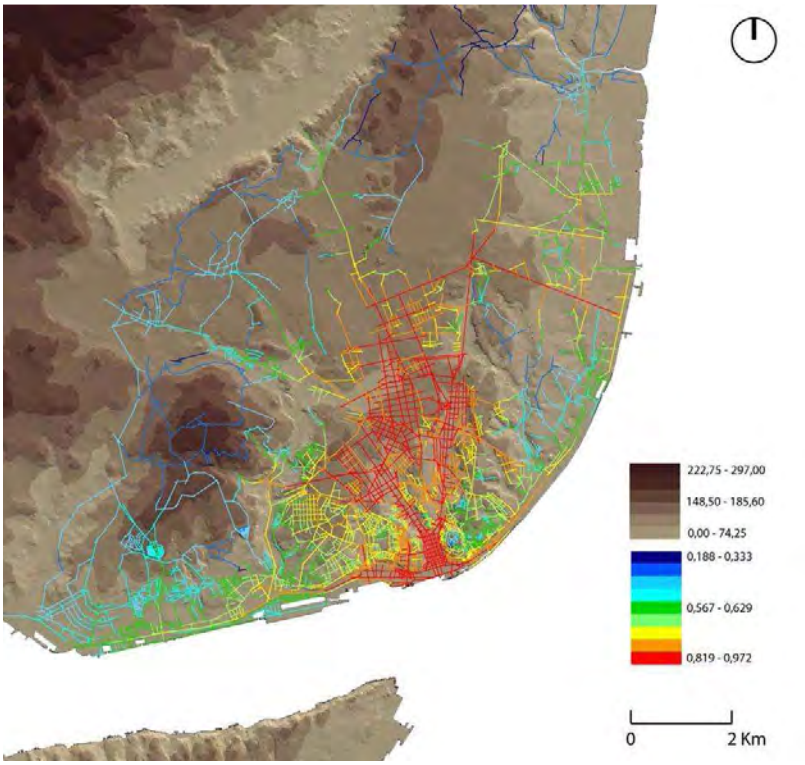


Figure 4. Overlap of the integration (rn) axial map of Lisbon in 1950 with Lisbon's topography.

The analysis of the correlation between local (r3) and total (rn) integration reflects the accessibility cohesion between the local and global levels of the spatial system of Lisbon. Regarding the high dimension of the urban structure, it is a satisfactory value (r=0,5894), which means that near 35% of the local integration (r3) values can be directly related by total integration (rn). In fact, it is the highest analyzed level, as for the further decades (1970, 1990 and 2000) the results are gradually lower. This phenomenon can be explained by two factors: (a) the increasing dimension and complexity of the spatial system; (b) the lack of adequate planning policies through the analyzed decades.

It is possible to recognize the configuration of the integrated centre, observing the most integrated lines of this decade. It is a multi-nuclear centre, formed by three clusters, articulated by structural axes: Downtown (1), Avenidas Novas (2) and Avenida Almirante Reis (3). Each cluster is complex, forming an urban sub-system within Lisbon's grid. At the eastern periphery, the areas where industry was proposed were linked to the centre by a single central axis, intersecting the Northern part of Avenidas Novas near the airport (8) (see Figure 5).

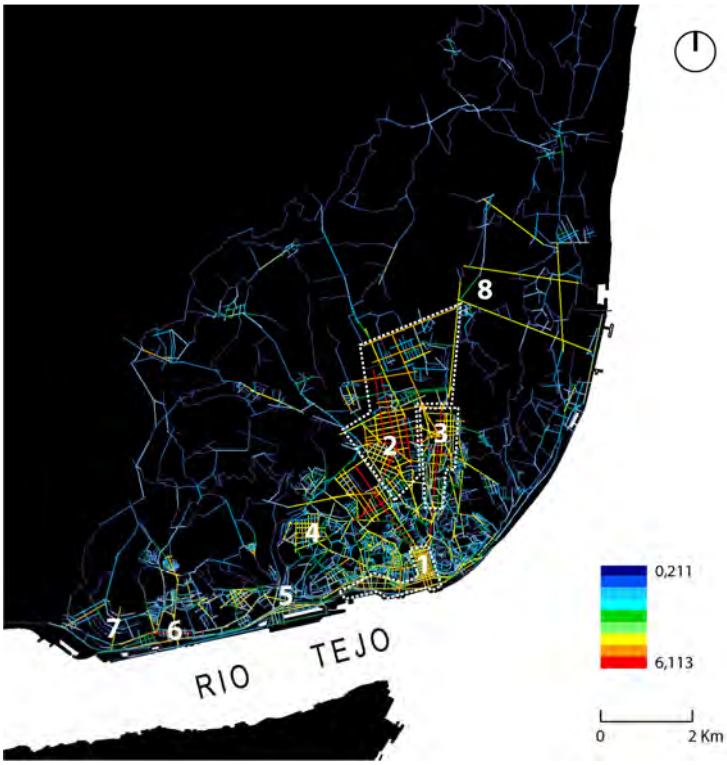


Figure 5. Integration (r3) axial map of Lisbon in 1950.

In what concerns the centre, the first cluster (see Figure 6), downtown, or 'Baixa', is formed by a regular and cardinal oriented grid, which expands to west, in a linear way. Baixa was, at the time, the centre of shops, administration, offices and services, being the central and denser grid the main prestige area, and the linear expansion to west the centre of popular shops and services, mainly related to the port activity (Serdoura, 2006).



Figure 6. Integration (r3) axial map of 'Baixa' in 1950.

The second cluster, Avenidas Novas district (see Figure 7), is characterized by its radial structure, which develops through an articulated network of orthogonal grids. It is also composed by

two different areas. The first one is the nineteenth century plan of Ressano Garcia (1). In 1950, this area was a high standard residential area and PDCL intended to reinforce its importance, proposing to expand the location for central functions to this area. The other part of this cluster, at east, is mainly a lower standard residential area (2), and articulates with the other cluster of Avenida Almirante Reis.

The third cluster is structured by the Avenida Almirante Reis, which is one of the main entrances of Lisbon, being historically related to popular shops and services.

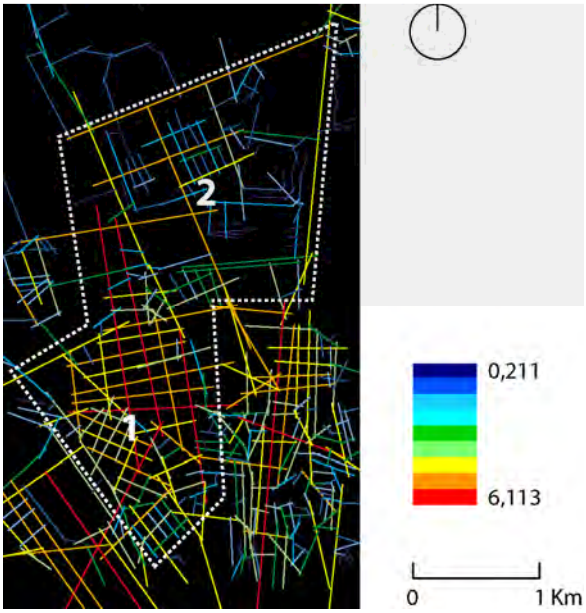


Figure 7. Integration (r3) axial map of Avenidas Novas in 1950.

Lisbon in 1970 was a reflection of the policies of PDUL (see Figure 1), proposing an expansion of central functions to the North of 'Baixa' and a creation of several sub-clusters in the periphery, namely Benfica, Lumiar and Chelas. At this time, 'Baixa' is still the centre of the main services, administrative functions, offices and shops. However, it is noticeable a loss of importance mainly in the western linear extension of Baixa, which lost accessibility in comparison to other areas and with it, some central functions. In fact, there is clearly an intention to expand the centre to more accessible areas like the gradually more important and dense Avenidas Novas district.

The axial map (see Figure 8) confirms that the functional centre of Lisbon met the concerns of mobility and accessibility, which would start to compromise the capacity of 'Baixa' to follow the new premises of centrality (Serdoura, 2006). The increase in density of Avenidas Novas gave the area a sense of more unity than in 1950. There were also important social housing developments at the eastern part of the city, reflecting the mentality of distinguishing residential areas by social class. This peripheral part of the city was increasing in centrality, along with the northern part of Lisbon, in direction to the neighbouring urban areas of Odivelas, Sacavém and Loures, which were outside the municipality although growing in population.

The overlap of total integration (rn) with topography (see Figure 9) reinforces the understanding of accessibility at the time and illustrates the concerns of this decade with the expansion of the city to flatter areas with more potential to develop a better transport and road system. The gradual densification of the centre was also due to the topographical conditions, allied to the traditional model fabric (grid). The area of the central plateau includes Avenidas Novas district, the airport, and a gradually more central area where a circular road was being built to improve accessibility to peripheral areas, allowing the further development of secondary centres.

The local integration (r3) axial map (see Figure 10) reveals a greater functional division of the centre. The axis that goes from Avenida da Liberdade to Avenida da República (1) marks the privileged location for special uses and services. The axis of Avenida Almirante Reis, Avenida Guerra Junqueiro and Avenida de Roma (2) is more specialized in the location of small offices and local commerce. Within this axis there were even more distinctions, like Avenida de Roma, which was associated to sophisticated shops, restaurants and cultural facilities, in opposition to Avenida Almirante Reis, where the main economic activity was the gross commerce (Serdoura, 2006).

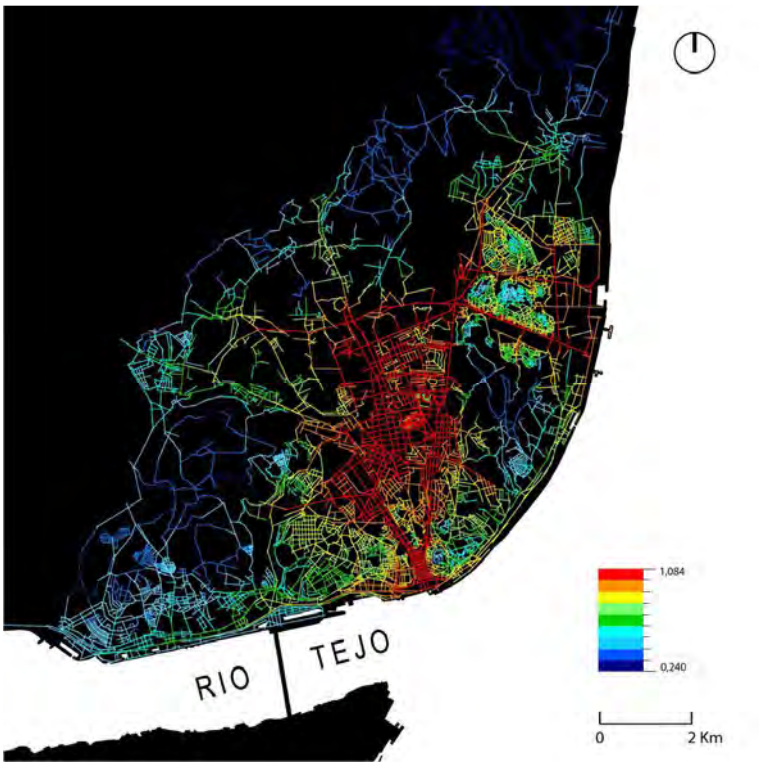


Figure 8. Integration (rn) axial map of Lisbon in 1970. Source: Serdoura, 2006.

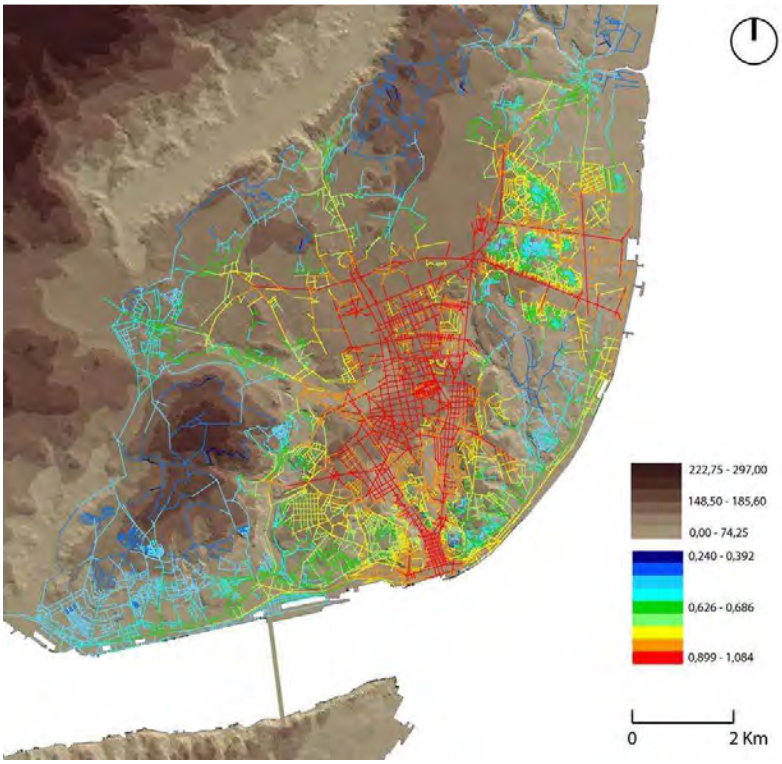


Figure 9. Overlap of the integration (rn) axial map of Lisbon in 1970 with Lisbon's topography.

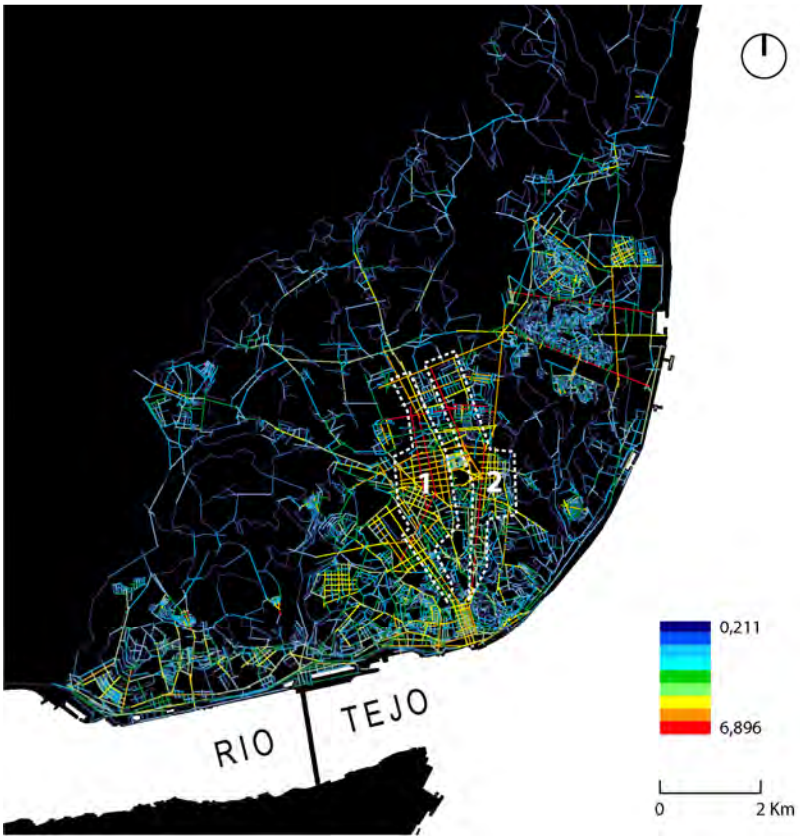


Figure 10. Integration (r3) axial map of Lisbon in 1970.

The total integration (rn) axial map of Lisbon in 1990 (see Figure 11) confirms the lack of planning strategies and the emergence of real-estate speculation, by a strong increase in density since 1970 (see Figure 8), mainly in peripheral areas. The configuration of the centre didn't change significantly since the last period, in spite of a network dimension growth of 30%. This densification of the urban grid didn't contribute to increase the integration of segregated areas, as these developments were mainly resulting from private operations, without any concerns with territorial cohesion.

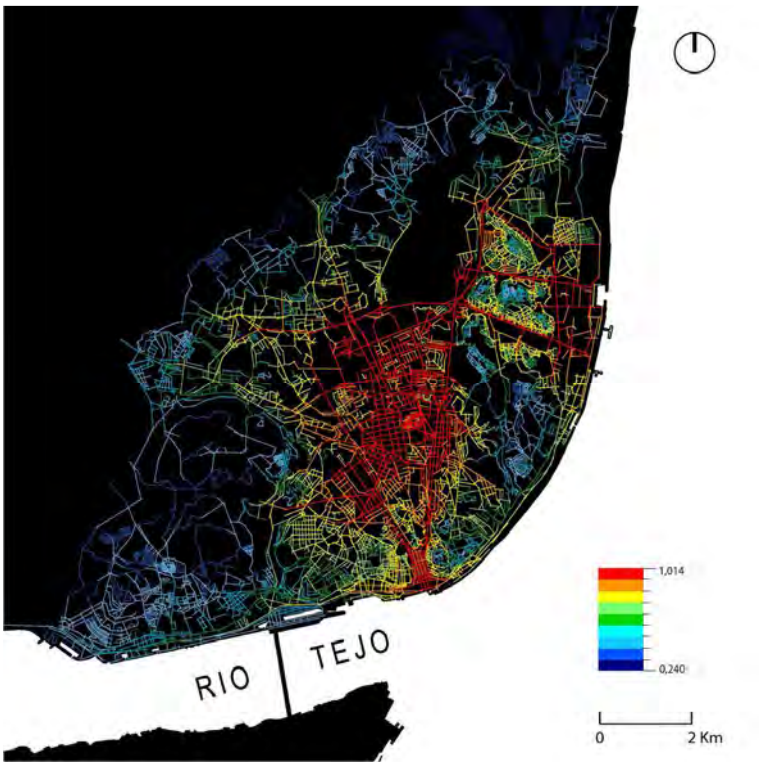


Figure 11. Integration (rn) axial map of Lisbon in 1990. Source: Serdoura, 2006.

The loss of population and lack of appropriate housing policies contributed to desertification and to the transformation of houses into offices and services in Avenidas Novas, and to deteriorate the situation in 'Baixa'. Suddenly, the centre became desert of residents, while peripheral areas were filled by social housing estates, mainly to the east. Consequently, there was an abrupt loss in public space and architecture quality, which contributed more to deepen Lisbon socio-economic problems. During this period, the majority of the developments were located in the central plateau and inside empty areas of the urban network at east (see Figure 12).

The local integration (r3) axial map of Lisbon in 1990 (see Figure 13) reveals that there was an evolution on the dispersion of local centralities (see some of these areas marked with dashed circles, in Figure 13), apart from the larger central area, Avenidas Novas. The resulting values of the correlation between total Integration (rn) and local Integration (r3) of 1990 reflects the lack of planning strategies and the emergence of real-estate speculation by a sudden decrease on the global value

(r=0,3391). In fact, the 1970 correlation presented much higher values (r=0,4542), in spite of the already complexity of the network.

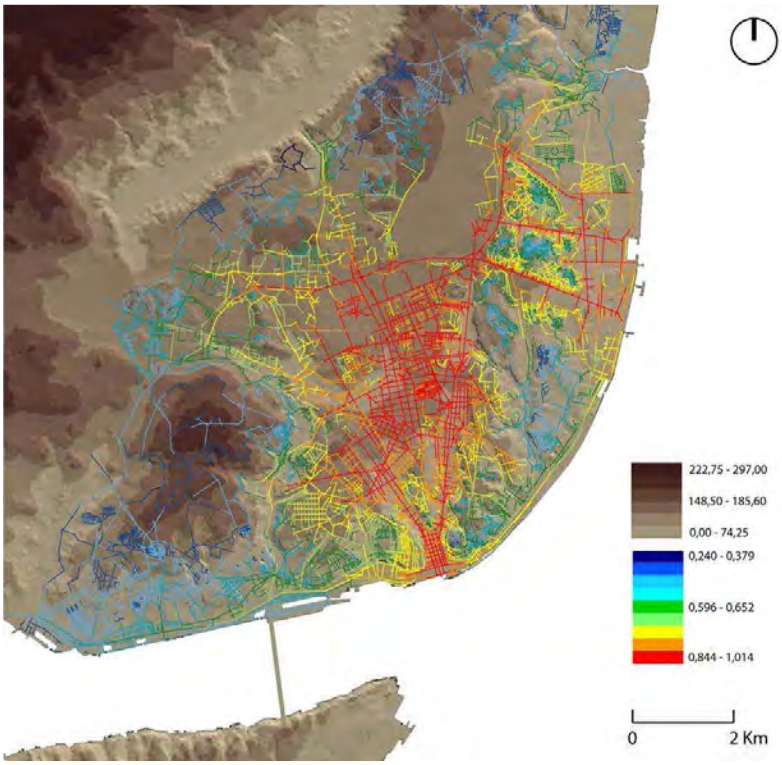


Figure 12. Overlap of the integration (rn) axial map of Lisbon in 1990 with Lisbon's topography.

The most integrated (rn) spaces in the 1990 network were Avenida Marechal Gomes da Costa (3) and Avenida Almirante Reis (2) (see figure 13). The space which presented the best correlation value was Avenida de Berlim (4). It was also noticeable an increase on the local integration (r3) of Baixa and Chiado (1), which had been losing its centrality during the last decades. The fire that happened in Chiado (1985) and its subsequent reconstruction may have been the cause for this increment. However, this intervention wasn't enough to invert the tendency of losing population and the consequent buildings degradation.

After the approval of Lisbon's PDM in 1994, which resulted from the development of the strategic plan for Lisbon (PEL) and, for the first time, combined land uses with strategic approaches to the territory, it was noticed an improvement on the global accessibility of the network for the first time in many years (see Figure 14). The planning strategy of PDM (1994) aimed at improving local centres where there was already some potential (as the marked areas in Figure 13, especially at north and east from the functional centre) and to improve accessibility to the new expansion, EXPO'98 intervention area. The reinforcement of local centralities also led to a density increase in peripheral areas, in opposition to the western area, which kept its lower accessibility. The overlap of total integration values (rn) with topography reveals that the expansion areas maintained the same logic of earlier decades, developing mainly in the north and east, with particular attention to the former industrial area, now transformed into a new centrality – Parque das Nações.

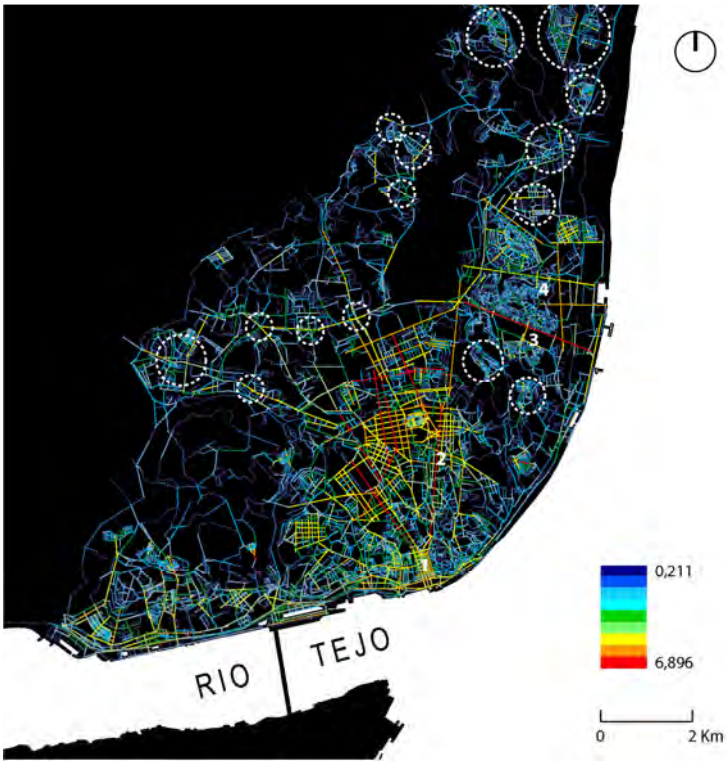


Figure 13. Local Integration (r3) axial map of Lisbon in 1990 and location of several centralities.

The requalification of EXPO'98 area, which was an already obsolete industrial area inside the urban fabric of Lisbon, gave a new dynamism to the centre, extending to a peripheral area, instead of keeping its expansion north oriented and to interior areas. This area was distinguished by its urban coherence and strong connection to the centre, namely Avenidas Novas district.

Beyond the expansion to the eastern part of Lisbon, during the period 1990-2001, the configuration of the centre hadn't grown significantly. On the other hand, some areas even decreased in centrality, as Avenida Almirante Reis and Baixa, which means that their importance was fading with time, giving place to others.

The local integration (r3) axial map of Lisbon in 2001 (see Figure 16) confirms the evolution of local centralities since the 1990's (see Figure 13). The concentration of higher levels of local integration (r3) at the eastern part of Lisbon as well as the clear hierarchy of public spaces may have been some of the factors which contributed to a greater stability of the urban fabric since then. Also, the implementation of some public space requalification projects reinforced the liveability of some peripheral areas and urban quality parameters, improving their local importance.

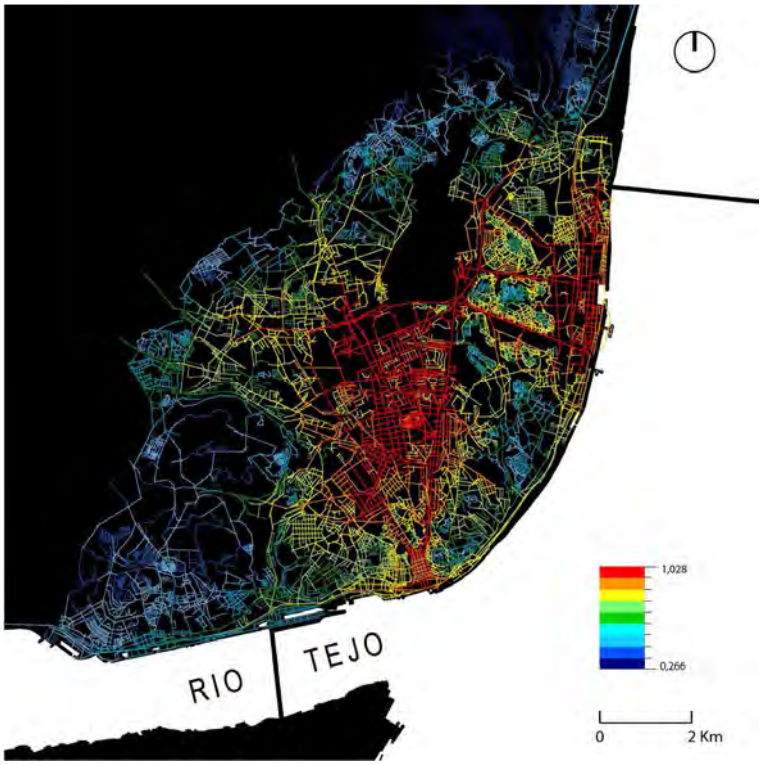


Figure 14. Integration (rn) axial map of Lisbon in 2001. Source: Serdoura, 2006.

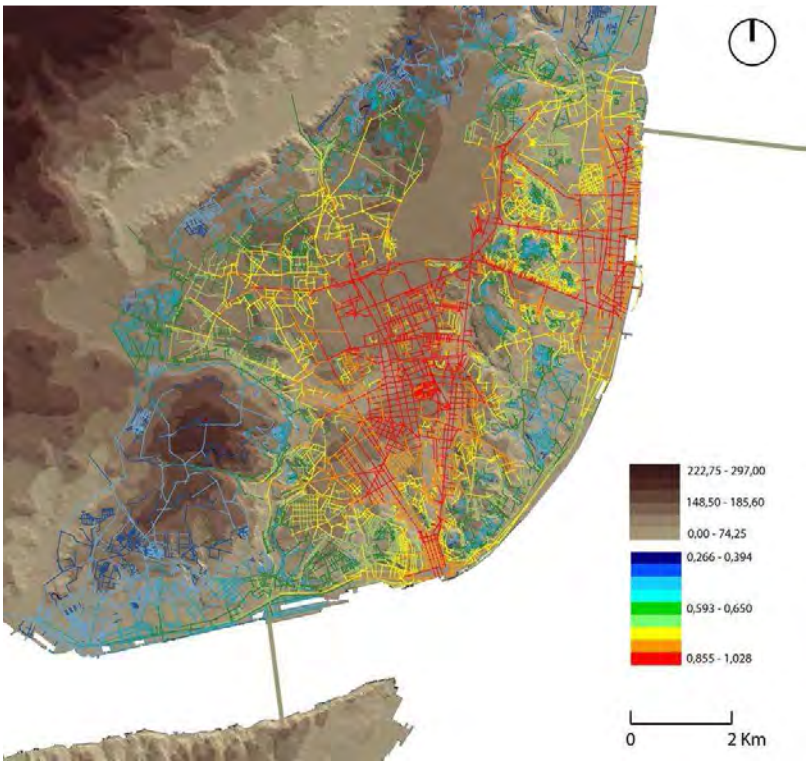


Figure 15. Overlap of the integration (rn) axial map of Lisbon in 2001 with Lisbon's topography.

Nevertheless, the centrality effect of Avenidas Novas, 'Baixa' and Avenida Almirante Reis is still higher and confirms the emergence of a new local and global central area: former EXPO'98 intervention area, which is now called 'Parque das Nações'. In fact, the 2001 highest total (rn) and local integration (r3) correlation value is referred to Alameda dos Oceanos, the main street of Parque das Nações (1). Other strong correlation axes are Avenida Marechal Gomes da Costa (2), Avenida Almirante Reis (3) and Avenida de Berlim (4). These values confirm that there are several central axes which outline a spreading network from the geographical and functional centre of Baixa / Avenidas Novas.

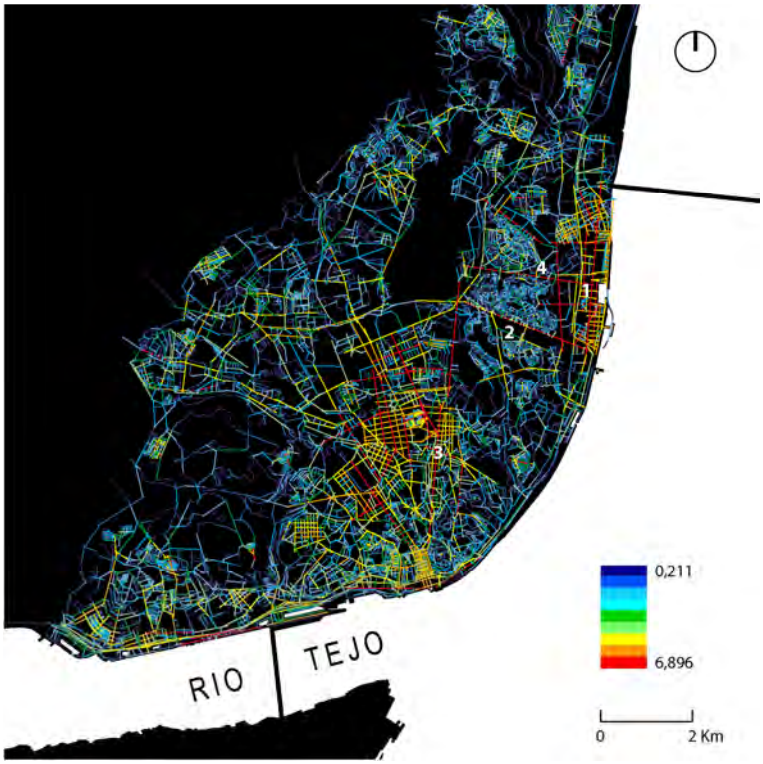


Figure 16. Integration (r3) axial map of Lisbon in 2001.

During the second half of the twentieth century, the city of Lisbon has almost tripled the number of its axial lines, increasing significantly in complexity, although most time with a lack of planning strategies. This led to a gradual decrease on the intelligibility (correlation between total (rn) and local integration) of its network. The greatest leap on the intelligibility values was during the period between 1970 and 1990, which was characterized by the emergence of real-estate speculation and inadequate housing policies. However, the period of more growth of Lisbon was from 1950 to 1970 (there was an increase of 88% of lines in its spatial system), which confirms that growth was not directly related to the loss of intelligibility of the system, but a combination of growth and inadequate planning policies.

Also during the period of 1950-1970, it was noticed an increase in the permeability (correlation between axial lines length and connectivity values) of the functional centre, in spite its increase of 88% in dimension, as well as in complexity and in density. In opposition, during the period of 1970-

1990, the permeability values of the integrated centre decreased, and only recovered in 2001, when planning concerns emerged for the municipality development.

In what concerns the average integration values, there was a decrease from 1950 (53,61) to 2001 (46,68). The same phenomenon happened to the functional centre axial system, which means that the planning practices during this period did not focused neither on urban design, territorial cohesion nor on social and economical development. In 2001, the spatial system of Lisbon is the result of these planning practices, which can be described as a fragmented and dispersed urban fabric, defined by several weak connections between the smaller grids to the whole network (Dalton, 2001).

With the expansion of the whole urban network, Lisbon's functional centre has also expanded, and revealed its own vitality, which most of the time was superior to the dynamism of the whole network.

However, Baixa's deep decrease of centrality may be related to a gradually lower accessibility of the network, apart from socio-economic aspects. However, other morphological and functional factors like its high density, good permeability level and concentration of several important economic and administrative activities confirm its *status* of being part of the functional centre. In fact, Baixa is the area of the centre with the best permeability level (correlation between axial lines length and connectivity), which reflects its potential to shelter urban life and dynamism.

It is also noticeable that the relative importance of the centre has been decreasing with time. In fact, in 1950 it represented 19,64% of Lisbon's total number of axial lines and in 2001 it was only 18,82%. Avenidas Novas is the largest central district, representing 64% of the functional centre. The eastern part of the centre represented near 1/3 of the functional centre. Nevertheless, the lower permeability of Avenidas Novas in relation to Baixa and its mainly residential nature made it only a secondary central area, in spite of its potential importance increase. In fact, during this period, Avenidas Novas has been gradually more attractive to central activities, as offices, banks, administrative offices and some specialized commerce.

4 Conclusions

The syntactic analysis of an urban network helps deepen the understanding of spatial organization, which is the key both to the form of the city and how the use of the urban environment. In fact, urban uses are related to the form of the city through two functional factors: "how we as individuals find the city intelligible, and how we move around it" (Hillier, 1996: 152).

In Lisbon, the recent evolution of planning processes has proved to have a clear relation to the evolution of land uses distribution. During the second half of the twentieth century, territory order was almost exclusively related to accessibility and topography. Simultaneously, the lack of requalification of less accessible areas contributed to deepen their segregation level, accenting socio-economic problems.

The current knowledge recognizes the importance of morphological concerns along with land use concerns for territorial cohesion and a sustainable evolution in time. This change in the mentalities happened in the late 1980's and it was already visible in the integration axial maps of 1990, in spite of being more recognizable in 2001. The improvement of 2001 values resulted from the

emergence of adequate planning strategies like the requalification of public space in peripheral areas and a more equitable distribution of civic and social facilities through the whole Lisbon network.

The decade of 1990 was the turning point of planning policies, when territorial cohesion appears as a strategic concern, including its environmental, economic, morphologic and social components. This mentality led to a more successful approach to municipal planning, which was soon reflected in the urban fabric.

Portuguese settlements are commonly located in high places, which may generate some mobility and accessibility problems with their expansions. In fact, the expansion of Lisbon's centre reflected the need of growing to flatter areas of the city, where it was easier to meet the modern requirements for central areas. The inability of responding to these requirements soon compromised the historical centre, which had been shrinking to a more symbolic role. On the other hand, the western area of Lisbon remained segregated, in part due to topographical characteristics, which justify the existence of an urban park (Monsanto) on a higher area of the city. This interruption of the spatial network, allied to the difficult connections to the centre from the riverside, also due to topography, seem to prove that there are direct relations between accessibility, land uses and physical characteristics.

In spite of the topographic and morphologic characteristics of Avenidas Novas urban fabric, the period between 1970 and 1990 didn't contribute to its affirmation as the main central area, in part because of the lack of planning policies and the real estate speculation.

The last ten years were important for the evolution of the centre to a more peripheral area - Parque das Nações. This area contributed to give a new dynamic to the whole centre and to integrate the eastern area of the city.

The study of the integrated centre of Lisbon identified the existence of a central core which developed through the traditional model of the grid, and whose morphological consistency was determinant in urban planning through the whole analyzed period of time. Lisbon's evolution was most of the time due to the continuous densification of these traditional morphological patterns, which did not affect the accessibility and permeability of the centre, in spite of creating land use imbalances.

From the study of the functional and planning evolution of Lisbon, it is possible to conclude that the policies carried during the analyzed period were responsible for the urban problems that defined its urban fabric. Functional and morphological concerns must be connected, in a sustainable strategy of development for the territory, including all of its components, namely physical, environmental, social, economic and morphological.

The spatial analysis of Lisbon evolution used syntactic measures as integration (rn), r3, axial lines length and connectivity, in order to better understand the relations between land uses distribution and morphological factors and their role in the planning process. In fact, land uses and syntactic properties of the urban space seem to prove essential to know the potential of central areas for the location of certain activities in terms of accessibility and mobility. Through this method, it is possible to study the spatial dynamics of an area where land uses are preferably located in a specific area over another.

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Alternative (bioclimatic) urban design for compact urban fabrics

João Granadeiro, Fernando Brandão Alves

CITTA - Research Centre for Territory, Transports and Environment

Faculty of Engineering, University of Porto, granadeirocortesao@gmail.com, alves@fe.up.pt

Phone numbers: 00 351 225081461, 00 351 225081463

Considering the predominant pedestrian-focused contemporary urban renewal programs and the urban heat island effects in summer, the improvement of outdoor (thermal) comfort is crucial to ensure that public spaces are positively used. Incorporating bioclimatic urban design principles into common urban design practice is undoubtedly relevant for re-shaping public spaces into more comfortable units of urban life. Bearing it in mind, this article argues that the application of bioclimatic principles, alongside all other public spaces qualities, into urban design projects can contribute to the creation of a different nature of public spaces – spaces that could function as alternative areas for citizens needs. Focusing on compact urban fabrics, the correlation between facing materials and vegetation is highlighted as these are the (bioclimatic) physical parameters influencing a space's microclimatic performance considered as the most potentially workable in compact urban fabrics. A square in Porto, Portugal, is referred in order to illustrate the extent to which such relationship can affect thermal comfort and use. Which alternative urban typologies can we think of for compact urban fabrics when considering the intersection of bioclimatic and common urban design? This paper concludes about the advantages of creating such alternative spaces, bearing in mind the referred combined qualities, in the context of urban renewal programs.

Keywords: bioclimatic urban design, urban renewal, thermal comfort, urban typologies

1 background issue

Cities are presently faced to many environmental problems with important impacts on human health, urban quality of life and economic performance of the cities (2006). When considering that in Europe cities are also places where around 80% of population live (Sarvan, 2006), environmental questions are more important there than in any other place.

Additionally, the value of open space and urban renewal within compact urban centres has been increasingly recognised, encompassing the "(…) rehabilitation of existing structures, redevelopment of existing buildings and sites, or simply the reuse of urban land" (1996).

Except for massive destruction caused by wars, natural disasters, etc., the urban fabric has changed slowly until the 19th and 20th centuries (Marques-Clarke, 1998). From this moment on, dramatic and fast changes took place in cities motivated by three main moments: the Industrial Revolution, which brought a deep change and reorganization of society; Modernism, that attempting to answer to the problems of overcrowding, congestion, squalor and pollution brought to cities with the Industrial Revolution, has valued fresh air, sunlight and space on a basis of functional segregation (zoning); Finally, Post-World War II with the development and growth of technology and economy, enabling a fast construction period but often creating a very poor built environment, in an attempt to reduce labour and maintenance costs.

These three moments are important to contemporary urban form and functioning. However, the Modernist functional zoning, by separating residential, commercial, cultural or industrial uses, etc., can be considered as the main responsible for two major problems posed to contemporary urban renewal: the reliance on private car for transit between areas of activity, and the separation of vehicles from pedestrians. Such dependence on private transportation, and its valorisation over

public transports and pedestrian circulation, has created in the past decades several urban environmental problems mainly related to the combustion of fossil fuels. A growing number of cars circulating in the cities' open spaces has increased emissions of air pollutants to the atmosphere. In fact, throughout the 20th century there was a permanent adaptation of cities to cars that has suppressed the traditional multifunctional character of streets and other public spaces (Menezes and Farinha, 1983). As a consequence, several social problems arose such as gentrification, abandon of central areas, lack of civility, less spontaneous surveillance and consequent feeling of insecurity, crime, etc.

Faced to these evidences, "a consensus is now being reached that in the light of its adverse consequences rising demand for car travel must be curbed (…)" and that this should base urban renewal of urban central areas (Marques-Clarke, 1998).

This is why urban renewal programs are presently mainly aimed at promoting more central pedestrian-focused public spaces, the ideal of the "compact European city" (where work, residence and recreation areas are in close proximity so that private car use can be reduced and public transports or bicycles enhanced) and the urban open spaces' 'ecological role' (e.g. reducing the emissions of greenhouse gases, calming public life rhythm, increasing green and blue areas).

However, considering climate change, it may not be effective to conceive an intended attractive pedestrian public space if people cannot bear its thermal conditions. Adaptation to climate change requires approaching the design of buildings and open spaces from a different perspective in order to ensure they provide good quality of life (2008).

Thermal comfort — as 'the absence of any sense of discomfort' — is especially important here because the degree and intensity of outdoor activities are dependent upon the "level of satisfaction or dissatisfaction under the prevailing climatic conditions" (Gaitani, Mihalakakou et al., 2007). Hereby, more (thermally) qualified public spaces need to be provided.

In this context, bioclimatic urban design, as all urban design projects concerned with minimizing the negative impact of urbanization on the environment by adapting each plan to the local unique conditions of climate and territory (Higueras, 2006), comes forward as one of the most recent keywords and urban renewal programs as the major opportunity.

Faced to climate change the urban heat island phenomenon, according to which "(…) air temperatures in densely built urban areas are higher than the temperatures of the surrounding country" (Santamouris, 2001), should not be disregarded in urban renewal programs as it has the potential to "(…) compound and accelerate temperature rises" in urban areas (Handley and Carter, 2006). This is especially important in temperate climates, where in summer this phenomenon is mainly negative. So in order to ensure successful public spaces it is urgent to put into practice straightforward urban design solutions to counter the urban heat island.

Although the heat island intensity grows rapidly after sunset, reaching a maximum 3 to 5 hours later (Oke, 1987), this article considers the daytime phenomenon as it is during the day that heat is stored to further release at night, and that people most use public spaces.

As Alcoforado (1988) suggests, in most large cities, one cannot think about one heat "island" but rather of an "archipelago", because within an urban fabric there are several warmer and cooler areas varying accordingly to land uses. The same can be said about cities from different latitudes,

where additionally geography sharpens differences between phenomena. As such, the microclimatic scale of action has to be considered. Besides determining the use and activities carried out in an urban public space (Nikolopoulou, 2004), microclimate conditions also affect thermal comfort indoors.

2 Alternative (bioclimatic) urban design for compact urban fabrics

Improving a microclimate is potentially more easily carried out in new expansion areas than in compact urban central areas. This is due to the fact that here the hard structure cannot (or can hardly) be changed (1996) as the built environment has been primarily defined (Tirone, 2007). As a consequence, changes in topography, street and building orientations, built density or other structural physical parameters are not easily expected to take place in compact urban fabrics (e.g. the demolition of an entire block to improve wind flows or solar access). It follows that in these areas one must try to obtain the greatest benefit from the existing structures (1996).

Bearing this in mind and that, on a bioclimatic perspective, urban designers can basically control urban microclimate through topography, buildings, facing materials, water elements and trees (Tojo, 2007), facing materials and vegetation are potentially the most easily and expectedly workable in compact urban fabrics. The reason for this is that they can produce results through 'lighter' interventions, when compared to the other parameters.

Thus we believe that it is possible to help improving comfort in public spaces of compact urban fabrics by intersecting a combined facing materials and vegetation program to the usual guidelines and elements of public spaces projects. Nonetheless, each case is unique so though we assign equal importance to facing materials and vegetation, each project can/should focus more or less on one or the other parameter, according to its geographic, physic, socio-cultural and functional framework.

A methodology for identifying appropriate facing materials and vegetation in public spaces, in order to assist urban designers through the bioclimatic renewal of compact urban fabrics, can thus be useful.

This methodology would introduce main bioclimatic issues and parameters about facing materials and vegetation into the common human-based urban design planning and design stages. The term 'human-based' is used in order to frame the herewith considered common urban design notion within the qualified urban design that includes the human dimensions of public spaces. On its turn, the human dimensions of public spaces refer to the rights and needs of users and deal with organizing ideas about the social value of a space (Alves, 2003). Hence, the human dimensions are paramount in urban renewal programs envisioning a tighter bond between man and cities' spaces.

Table 1 shows how this intersection could generally be shaped during the definition of the intervention program. Obviously, this would be integrated in a wider methodology that would start by a previous spatial analysis and a subsequent design stage. The table was prepared based on and adapted from Alves, F. (2003) and Brandão, Carrelo et al. (2002), in what concerns to overall human-based urban design guidelines and common urban design elements; and from several authors (indicated along the table) with respect to the bioclimatic design parameters.

Table 1. Intersection of human-based urban design guidelines and main bioclimatic urban design parameters (materials & vegetation)

<table>
<tr><th>Overall human-based urban design guidelines (Alves, 2003)</th><th>Main bioclimatic urban design parameters
about facing materials and vegetation</th></tr>
<tr><td>Human needs</td><td rowspan="11">Facing materials
• To raise the albedo of urban surfaces and increase urban vegetation (Rosenfeld, Akbari et al., 1995).
• Whenever possible, to totally or partially remove paved surfaces (Tojo, 2007).
• To use vegetation as facing material for both vertical and horizontal surfaces (Nikolopoulou, 2004).
• In compact urban areas consider the impact of sunlight in all existing directions (Tirone, 2007).
• To use water surfaces (water surfaces are seen in this research as a ‘facing material’ as they directly affect, although by different means, the performance of a horizontal surface – pavement – such as any other facing material) in combination with the ventilation strategies in order to cool down air temperatures (Nikolopoulou, 2004).
Vegetation
• To preferably provide shade of the ground by using shade trees (Yilmaz, Toy et al., 2007).
• To combine deciduous and evergreen species (Higueras, 2006).
• To carefully choose, place, and orientate the vegetal species accordingly to which site (Higueras, 2006).
• To combine trees with solid vertical, horizontal and/or sloped shading devises (Nikolopoulou, 2004).</td></tr>
<tr><td>Comfort
Microclimate; convenience devises; pathways and slopes; seating; lighting; urban furniture.</td></tr>
<tr><td>Relaxation
Ambience; relation to context; safety.</td></tr>
<tr><td>Citizens active involvement
Opportunities for festivities, children, adolescents and adults recreation, socializing.</td></tr>
<tr><td>Citizens passive involvement
Contact with nature/contemplation.</td></tr>
<tr><td>Exploration
Pathways and details.</td></tr>
<tr><td>Usage rights</td></tr>
<tr><td>Access
Physical, visual, symbolic accessibility.</td></tr>
<tr><td>Freedom to act
Multifunctional spaces; protection to more vulnerable age or disabled groups.</td></tr>
<tr><td>Fruition
Subspaces available for temporary individual or group appropriation; activity scheduling.</td></tr>
<tr><td>Transformation
Short-term and long-term transformations.</td></tr>
<tr><td colspan="2">Meaning</td></tr>
<tr><td>Legibility
Simple pedestrian network; periphery and inner distinct and permeable barriers; clear identity of each subspace.</td><td rowspan="4">Facing materials & vegetation
• To design the landscape in such ways that it can grow old gracefully, so that places become more attractive (Llewelyn-Davies, 2000).
Vegetation
• To plan planting in such ways that the height and mass of planting does not cut of the view of an activity or performance area for some space’s users (Marcus and Francis, 1998).
• If a space has to be sunken, to plant trees in it that will soon grow above sidewalk level so that their foliage will add to a pleasing street experience (Marcus and Francis, 1998).
• If a tree has to be eliminated due to its precarious health conditions, or to a spatial reconfiguration, immediately replace it by a new one (Alves, 2003).</td></tr>
<tr><td>Relevance
Cultural values and space’s characteristics; integration within the surroundings.</td></tr>
<tr><td>Individual and group connections
Possibility of individual “anchorages”; symbolic elements; subspaces for everyday activities; places for several groups meeting.</td></tr>
<tr><td>Biologic and psychological connections
Participation of children and adults in planting and maintenance; landmarks; stimulation of protection, shelter and welfare feelings.</td></tr>
<tr><td colspan="2">Management / Maintenance</td></tr>
<tr><td>Scheduling
To allow several uses; definition of use norms.</td><td>To consider the parameters proposed to the “human needs” and “usage rights” topics.</td></tr>
<tr><td>Human and technologic resources</td><td>Facing materials & vegetation</td></tr>
</table>

To supply the necessary human resources; to integrate cost-effective technology compatible with the place's characteristics and dimension.	• To design in such ways that the resources available in each place are optimized considering all the proposed uses, and to think about sustainable ways of obtaining it (Higueras, 2006).
Materials To consider durability, easy replacement, familiarity to pre-existing materials, capacity of a moderate and nearly natural maintenance.	Facing materials • Reduce to the utmost the exterior texture of the building finishing avoiding having to paint it frequently (Tirone, 2007). • To use materials easily available on site (Higueras, 2006).
Planting, irrigation and drainage Vegetation adapted to each site; irrigation uniformly distributed; slopes adapted to the natural drainage of rain and irrigation water; preservation and appropriate use of the water network and stored rainwater.	Vegetation • To promote urban biodiversity (Higueras, 2006). • To carefully assess a site's pre-existent trees and preferentially try to keep the mature ones (2001). • To use maintained prairies rather than grass (Tojo, 2007). • To accept the spontaneous vegetation (Tojo, 2007).

Most of the public activities that used to occur in cities public spaces have been presently moved to other special-purpose places, from amongst which shopping centres play the main role. Simultaneously, new forms of open space are being created such as long-distance hiking or biking trails (Marcus and Francis, 1998).

The intersection of bioclimatic parameters during common urban design practice (Table 1) could then be subsumed by the creation of new forms of open spaces, particularly under a bioclimatic perspective. This means creating a different nature of public spaces both at a morphologic and functional level, through new urban typologies.

This does not mean that the usual/'classical' urban spaces typologies (streets, squares, plazas, small plazas, markets and fairs, playgrounds, community open spaces, waterfronts, etc.) would be ignored or destroyed but rather updated according to a major contemporary need of urbanites (increasing thermal comfort) and to a main trend of architecture and urban design (consideration of human dimensions and bioclimatic issues).

3 Case study — Poveiros Square

A case study in Porto is now presented by way of reflection about the creation of new public spaces typologies. This space was chosen because it illustrates how materials and vegetation, when carelessly brought together from a bioclimatic perspective, can reduce the liveability and thus the use of a public space in summer. Therefore it constitutes a good scenario for thinking about alternative 'bioclimatic' typologies for compact urban fabrics.

3.1 Characterization and diagnosis

Poveiros Square (Figure 2) is a compact 10.700m^2 pedestrian space with a slightly trapezoidal shape orientated towards the south and bordered by a consolidated urban fabric of high density. This built-up surrounding is mainly composed of terraces defining a regular front around the Square.

The Square's present form dates back some 10 years, to the time that an underground public car park was built. This car parking came to replace the former surface one, releasing that area to pedestrians. Nevertheless, its main effective use is passage through. Its dominant paving is made of

granite stone cubes while vegetation and water surfaces are concentrated in its eastern and northern edges.

Field surveys were undertaken between the 24th and the 29th July 2009. The adopted methodology felt over the correlation of questionnaires and observations (users' behaviours and opinions) with climatic measurements (air temperature and relative humidity) at the time of the interview. These surveys were also made in an adjacent garden, envisioning a compared analysis.

The questionnaires and the observation of users' groups and individuals provided the results with the clearest impact on addressing the human dimensions of public spaces.

Through the questionnaires it was possible to know the users' needs, opinions and preferences. The main outcomes from this are that while in the garden 98% of the interviewees were comfortable and all of them described it as a comfortable space during summer, so people feel motivated to use it during that season, in Poveiros Square they do not; in Poveiros Square 53% of users referred to be usually glared by the pavement and 14% by the surrounding buildings facades; 94% of people considered the garden to have enough trees whereas in Poveiros Square 93% answered that the space has little vegetation; additionally, 95% of the interviewees referred to the fact that the few trees existing at the Square present no effective protection, while in the garden 96% considered that the existing vegetation does present effective protection.

The observations allowed recognising five main types of public space users, according to the categories proposed by Mean and Tims (2005):

- *Displayers* (especially young males such as skateboarders, joggers or unemployed youth, mainly concerned in impressing the opposite sex or their friends, so using the Square as their 'theatre');
- *Urban Safarians* (mainly eclectic students from the nearby Faculty of Fine Arts with the main concern of exploring new authentic places, especially using the Square's secluded café terrace);
- *Public Spirits* (mainly retired people that gaze at other people passing by, that cross the space towards the nearby municipal library, and that are likely to intervene to stop anti-social behaviour);
- *Hoodsters* (mainly unemployed youth and adults living in the Square's contiguous buildings that never leave their own postcode but that like the Square and make high use of it);
- *Home Birds* (mainly elderly women living in the Square's contiguous buildings, who rarely come into contact with the outdoor space, except for essential tasks such as going to the grocery).

Additionally to these five groups one proposes two more groups identified at Poveiros Square:

- Lunchtime Visitors (mainly adults which work in services and facilities nearby the Square and that only use the main Square's café terrace during lunchtime for having a meal or coffee);
- Passers Through (people that use the Square only as a crossing space towards somewhere else, that never use it for other purposes, and that have no bond with it).

The results from the climatic measurements have further confirmed that the garden is a much comfortable and used space than Poveiros Square during summer, and that this is precisely due to differences in pavement facing materials and vegetation: while the square has hard impermeable facing materials and the near absence of vegetation, the garden presents soft permeable natural facing materials and intense vegetation.

To sum up, Poveiros Square presents as main constraints to thermal comfort (1) a dominant impermeable and monochromatic surface that does not benefit the local performance of solar

radiation and water cycle; (2) little number of trees that provide no useful shade for pedestrians as, moreover, they are positioned on the eastern and northern edges (also no shading devises are available, except in the two existing café terraces); (3) the existing water features do not effectively influence microclimate due to their peripheral position and reduced size.

3.2 Virtual improvement scenario

An improvement scenario — i.e. the promotion of spatial liveability and use based on people's welfare and bioclimatic amenities — for Poveiros square is now suggested bearing in mind its main constraints to thermal comfort, bioclimatic parameters, and users' groups.

On one hand, according to the field surveys, Poveiros Square's main climatic constraints to thermal comfort are air temperature and solar radiation. Therefore, the bioclimatic urban design parameters with a potential higher impact on these variables broadly point out to a mixed paving solution and an increase in vegetation.

On the other hand, Poveiros Square presents the typical characteristics of a plaza, according to the definition of Marcus and Francis (1998) as it is "defined as a mostly hard-surfaced, outdoor public space from which cars are excluded", being a place mainly for "strolling, sitting, eating, and watching the world go by". However, according to the same authors, if a space accounts for more vegetated than hard paved area, it would be considered as a park instead of a plaza.

Taking into account these two questions (bioclimatic improvement parameters and typology), which alternative urban typology could one think about to Poveiros Square in such ways that all three requirements are considered and fulfilled at the same time that bioclimatic improvements are added? How to increase vegetation without transforming the square into a garden and simultaneously to allow each users' groups activities to be held?

Due to the proximity of the analysed garden, to create a new garden would even be undesirable as functions could overlap. But it is also true that in the context of the city's wider public spaces' network, Poveiros Square is not a space where expressive, both in quality and quantity, public events (e.g. festivities or fairs) are usual or expected. It has rather a character of local community/block meeting place.

An alternative typology between a square and a garden would then be the most suitable solution for Poveiros Square. The urban oasis (Figure 1) comes forward in this context as a potentially effective answer, as it constitutes a type of plaza that is more heavily planted, and partially secluded from the street (Marcus and Francis, 1998). This seclusion is potentially adequate to encompass the activities of the identified users' groups.



Figure 1. Example of an urban oasis at Lyon, France.

The urban oasis typology would encompass some of the most important design solutions to counter the constraints to thermal comfort presented by Poveiros Square. Bearing in mind the bioclimatic design parameters presented in Table 1, some of these solutions could pass by:

1. Implementing a mixed paving solution by introducing to the 0.40 albedo granite stone other high-albedo facing materials such as whitewashed stone (0.80), gravel (0.72), or green grass (that although with a 0.26 albedo contributes to control glare and to cool down air by evapotranspiration). This would provide permeable areas for underground water storage, reduction of glare and sensible heat at surface, enhancement of convection breezes, and increased air humidity.
2. Combining trees with solid shading devises (e.g. canopies or parasols) disposed randomly throughout the space or in its southern and western edges. This would provide shadow for more hours a day and shade walking paths. As Poveiros Square has an underground car parking, alternative solutions for planting must be found such as choosing trees and shrubs species with roots tending to spread out rather than growing deep, alongside design solutions such as potted trees or raised flowerbeds.
3. Enlarging water features, bringing them closer to the square's central area, and improving their performance with parallel vegetation and ventilation strategies. This will help cooling down air temperatures.

The urban oasis typology would also be suitable for the activities of the identified users' groups.

Although there is not a sharp difference between ways of each group to use the space, there are still subtle different activities and expectations between them. Therefore, the Square design should consider some subspaces for each group to find a place that it is 'their space'.

From the most exposed and 'scenic' subspaces for *Displayers*, passing by the medium-term subspaces allocated nearby the Square's main crossing routes for *Hoodsters*, to the more secluded subspaces for *Urban Safarians*, *Public Spirits* or Lunchtime Visitors, the alternative 'bioclimatic' typology for Poveiros Square should come with consideration to places where groups' activities can better be held.

In what concerns to facing materials and vegetation, always bearing in mind the parameters presented in Table 1, these subspaces differences can be shaped through different levels of vegetation (e.g. the more exposed, the less planted; the more secluded, the more planted) and different levels of paving and materials types (e.g. the more exposed, the less paved and the higher albedo, in order to balance the larger dimension of the space and the less provided shadow; the more secluded, the more paved and the lower albedo).

If properly balanced, all these above mentioned considerations about the benefits of the urban oasis, could upgrade Poveiros Square from a functionally, visually and thermally unqualified square, to a more attractive, liveable, used and meaningful public space. Could such improvement originate a new image of the site, such as suggested in Figure 2? What would its implications be to the city's general urban form?



Figure 2. Poveiros Square: (a) general view; (b) virtual improvement scenario – urban oasis.

The presented case study is important not so much by the case itself (since the presented problems are common to several other spaces and cities) but more, in the context of this article, to the cogitation on how the common way of planning and designing cities can shift from the consideration of usual urban spaces typologies, mainly based on morphologic and functional parameters, to alternative typologies developed towards the human dimensions of public spaces, under a bioclimatic perspective. Faced to the evidence of climate change and the urban heat island, contemporarily the

human dimensions of public spaces ought to deal with comfort, particularly thermal comfort (both outdoors and indoors).

Thereafter, bioclimatic parameters should base these alternative typologies and be regarded as any other projectual parameter (e.g. proportion, shape, furniture, focal points).

4 Conclusions

The intersection of bioclimatic urban design parameters on facing materials and vegetation into common urban design is both a question of planning strategy and a technical-specific issue. On one hand, an intervention must start by encompassing a wide range of considerations envisioning its success (preparation, management, aftercare and monitoring). On the other hand, identifying appropriate facing materials and vegetation for a specific space, from a bioclimatic point of view, is a technical issue that must be considered alongside other technical requirements such as safety, durability, cost, aesthetics, etc.

This intersection can be effective in improving microclimatic comfort conditions. Contemporary urban renewal programs sets out the proper and up to date opportunity for this, by reshaping spaces while maintaining their fundamental character. However, this maintenance of character does not mean that alternative concepts for the renewal of public spaces in compact urban fabrics are not possible. On the contrary, thinking about new solutions might be the key for start designing more qualified public spaces. As far as this article is concerned, public spaces typologies play one of the major roles as they shape a city's general urban form, are the stages of everyday life, and are, alongside buildings, the main responsible for a city's mental map.

The advantages of creating alternative spaces/typologies are twofold: it helps ensuring the success of pedestrian-focused urban renewal programs; it helps adapting the urban form to the environmental and social challenges presently posed to cities.

Firstly, incorporating bioclimatic parameters in the set of concerns that underpin a public space renewal project can help ensuring that thermal comfort conditions of a space encourage people to use it and to naturally establish an emotional bond with it. This is paramount for the success of a renewal project and, therefore, to ensure that the supplied financial and human investments are not wasted. Therefore, this has obvious environmental, economic and social impact.

Secondly, conceiving alternative 'bioclimatic' typologies to the common urban typologies means, on one hand, creating urban spaces adapted to climate change and more able to counter the negative effects of the urban heat island; on the other hand, to promote social inclusion and representation by enriching the townscape with diversity and novelty from the functional and visual point of view. In the contemporary complex and multifunctional urban societies it is important to have diverse public spaces, flexible to the activities of several groups. The more diverse the city public spaces are, the more chances individuals and groups have to find 'their piece of city', potentially increasing civility.

The presented case study focused on the urban oasis typology. However, this is only one of the many typologies that could be considered for improving thermal comfort conditions of a space. The choice should fall over a typology that could potentially provide a space with the more bioclimatic

amenities possible, considering its particular physical and functional characteristics, as well as human needs.

The urban oasis is an example of an already existent mixed typology (square and garden). So why not to think about other new alternative mixed typologies?: streets as less planted greenways; squares, plazas, playgrounds or markets as less paved spaces and less planted gardens; waterfronts as less natural river banks or beaches where pavements are softer and more permeable; sidewalks as less planted trails; and so on.

We believe that urban renewal would benefit from being systematically shaped bearing in mind the intersection of bioclimatic parameters about facing materials and vegetation into common urban design practice. Alternative 'bioclimatic' typologies would be the result of this intersection and would definitely represent a shift in urban planning and urban design for compact urban fabrics.

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Cities, People and the Environment: The Polis Programme in Portugal

Pedro Almeida

CESNOVA, Faculty of Human and Social Sciences – Universidade Nova de Lisboa

Avenida de Berna 26-C, I&D Building, 1069-061, Lisbon, pedro.m.almeida@fcsh.unl.pt

Telephone/Fax numbers: 00 351 217908300 - 00 351 217908308

The Polis Programme was established by the Portuguese State in the year 2000, in order to improve the quality of life of inhabitants and users of the respective cities. An important step towards achieving this goal was planning of urban renewal, based on two key perspectives: urbanistic and environmental issues. This text aims to respond to several questions related to the main objectives underlying the Polis Programme. Did the cities in which the Polis programme intervened actually achieve urban renewal and revitalisation? We should begin by underlining the fact that the Polis Programme aimed to set examples, in a specific moment in time. It should not be seen as a replacement for other urban interventions associated to urban renewal. For instance, interventions in public spaces are always necessary and must form part of a continuous process. Nevertheless, in our opinion, the outcomes of the Polis Programme were highly significant and introduced a new dynamic to the agenda of public policy makers, especially in terms of sustainability, by highlighting the importance of environmental issues and re-introducing elements of Nature into the city. Despite relative incompleteness in achieving its goal, the Polis Programme served as a medium between the public sphere and decision makers, and in many cases succeeded in renewing specific territorial zones, such as waterfronts, urban parks and gardens, thus rendering cities a more pleasant place to live in and to use.

Keywords: Cities; Environment; Polis Programme; Public Space; Urban Renewal

One central thesis of this book is that perhaps
we came back full circle: at the end of nearby a
century of modern planning, the problem of cities
remained much as they had been at the start.
(Peter Hall, *Cities of Tomorrow*)

In the modern world, we are familiar with the undeniable fact that over half of the world's population lives in urban spaces, in other words, in territories that we call cities. Nowadays, cities are the main poles of economic and social development (Sassen: 2006). To be more precise, this is true for "western" societies or, to use a terminology that enables a broader a more rigorous conceptualization of such cities in the global world, to "westernised" societies (Baptista: 2005). This statistic is not the result of a guesswork by urban theorists (Castells, 2006 [1972]) nor by analysts of post-modern phenomena (Lyotard:1989; Santos: 1994; Maffesoli: 2003 [2002]; Bauman: 2007 [1995]). It was the United Nations, by means of the 3rd resolution on the Situation of the World Population, dedicated to the topic of Urbanization (ONU: 2007), that suggested and sustained this paradigmatic alteration in use of the territory. We obviously have strong reasons to confide in UN data.

As a result of this situation, the forms of territorial use and appropriation that have prevailed until now, are likely to become inverted in the 21st century: predominantly urban lifestyles are currently eclipsing outmoded rural social lifestyles and are likely to replace them. We would nonetheless be mistaken if we believed that this will be a rapid process. As the very term, "process", suggests it is a slow, continuous phenomenon that tends to persist over time, as both a norm and rule. Global transformations that have taken place over recent decades, in the first world, second

world and finally in – the non aligned countries –the Third World, are the driving force behind these transformations.

Modern management of cities accompanies this rising demographic evolution, through the State's territorial planning policies and practices, via both the Central Public Authority and Local Public Authorities, whose most altruist goal is to foster the maximum quality of life for users of a city - both residents and non-residents. Nonetheless, the State is not the only agent involved in the visible alterations to the urban fabric. Cities also attract the attentions of private social agents, as a result of the gamut of possibilities they offer. These agents also seek to satisfy their respective goals.

In the present text, we aim to place particular emphasis on Portuguese cities that have been subject to interventions within the framework of the "Polis Programme – Programme for Renewal and Environmental Enhancement of Cities". In order to understand the interventions carried out within the framework of this programme, we must first analyse the aforementioned programme, in terms of its genesis, key orientations and, finally, the goals that it aimed to achieve.

The idea of the Polis Programme, which we consider to be a territorial management instrument, derived from the perceived Strategic Planning success (Ferreira: 2005) in the city of Lisbon, in particular during the planning and interventions implemented within the framework of "Expo '98", in the zone now known as the Parque das Nações. On this basis, the Central Administration created the Polis Programme in 2000, due to considerations that concluded that "A new strategic vision of the environment and territorial planning is one of the main political priorities behind Government action" thus justifying "the adoption of exceptional measures in the field of urban renewal and environmental enhancement of Portuguese cities"[29]. In broad terms, the Polis Programme was created, on an extraordinary basis, in order to replicate the previous successful initiative attributed by the official discourse to the Strategic Planning interventions carried out in the eastern zone in the city of Lisbon, as explained above.

Overall, 40 cities were chosen within the framework of the Polis Programme. Of these, 18 cities were contemplated from the outset, a further 10 cities in a second stage of the programme and finally a further 12 cities were covered by later, smaller scale interventions. The programme was available for cities based in the Portuguese mainland, but Angra do Heroísmo, in the Archipelago of the Azores, and Funchal, in the Archipelago of Madeira, were also integrated into the programme, on an exceptional basis.

The central government's discourse justified setting up this territorial management instrument firstly due to the fact that urban life has become the source of some of the leading environmental problems experienced by populations. In particular problems were identified in terms of the absence of high-quality public spaces and leisure zones and problems related to increasing road traffic congestion difficulties and subsequent degradation of air quality and increased noise levels. A second key reason underlying the programme, was the assumption of various urban-planning errors committed over recent decades, which have adulterated and pulverised traditional historic centres and thus led to the creation of dormitory neighbourhoods on the outskirts of metropolitan areas, where, from the programme's perspective, the quality of life is manifestly insufficient and even unsatisfactory.

[29] Presidency of the Council of Ministers, RCM n.º 26/ 2000 of May 15

As a result, the central government adopted two categories of objectives for this urban renewal programme: a general objective and four specific objectives. The general objective, as mentioned above, was based on the pursuit of interventions aimed at improving the quality of life in cities. Such interventions were to be executed in urban planning and environmental aspects, whose targets, according to the programme's discourse, were to be attained by improving the attractiveness and competitiveness of the main urban poles that play a key role in structuring the national urban system. Nonetheless, the same institutional discourse, from the very outset, stated that the interventions to be undertaken were to serve as exemplary and demonstrative measures, based upon partnerships, in particular between the Government and Municipal Councils, which in the future would serve as a reference for other initiatives to be pursued by local authorities.

At the level of the specific objectives underlying the programme, we can list, as analysed in further detail below, four objectives that were adopted: (i) develop large-scale integrated urban renewal operations with a strong environmental component, (ii) develop actions that would contribute towards renewal and revitalization of urban centres, foster the multi-functionality of these centres and reinforce their role in the surrounding region, (iii), support other urban renewal initiatives that would make it possible to improve the quality of the urban environment and valorise the presence of structural environmental elements, such as riverfront and seafronts, (iv) support initiatives aimed at expanding green zones, and promote pedestrian walkways and cycle lanes and condition automobile traffic in urban centres[30].

In order to achieve a fuller understanding of the details of the Polis Programme, we will focus on three cities included within the programme – Cacém, Covilhã and Marinha Grande[31]. These cities offer a limited sample, of an exemplary and heuristic nature, rather than a broader perspective of the representative significance of the 40 cities included within the programme, given the diversity of scenarios that characterises the Portuguese national territory and its social reality.

Cacém is a large-scale city integrated within a major metropolitan area - the Lisbon Metropolitan Area. Covilhã is a medium-sized inland city (Vaz: 2004) in the centre of the country, wherein factors of interiority played a key role in choosing this city. Finally, Marinha Grande, is also located in the centre of Portugal, but smaller in size, and on the coast. Given that the latter pertained to the second stage of the Polis Programme, we decided that it was advantageous to choose this example, so as to highlight and reveal the inherent differences in the two stages of the Polis Programme, adopted in order to respond to the high number of applications from cities, which easily outstripped the organisers' expectations. In addition to the differences already identified between these three cities, they are also distinguished by the success of their planned interventions, as we can confirm through the discourse of both the central government, via the Coordinating Office of the Polis Programme, that reports to the Ministry of the Environment, Territorial planning, the Territory and Regional Development, and also via local authorities, in particular the perspective of social

[30] These objectives are identified and discussed in greater depth and detail in the Master's degree thesis presented to the Faculty of Human and Social Sciences of the Universidade Nova de Lisboa (Almeida: 2008)

[31] A more extensive, in-depth analysis of the interventions of the Polis Programme in these three cities is available in Almeida: 2008

agents tied to local authorities or statements made by the managers of the Polis Management Companies[32].

The city of Cacém plays a key role not only in relation to its region - the NUTS II Lisbon and Tagus Valley region, but also at a national level. According to the 2001 Census, Cacém has 81,845 inhabitants - the 10th largest city in the ranking of Portuguese cities. Implementation of the Polis Programme in Cacém was justified by its chaotic urban fabric, resulting from a mixture of rapid growth and incipient urban planning, which exacerbated deficient conditions of road traffic and pedestrian circulation for the city's users. This complicated situation in the city of Cacém was worsened by the manifest scarcity of high-quality green spaces, thus rendering this rather grey and unattractive city even gloomier. In this regard, the Polis Programme, acting via the intermediary of the CacémPolis company, aimed to renew and recover the city's public image and quality of life, within the possibilities of the Programme's intervention.

Covilhã - that according to census data collected by National Statistics Institute (INE) occupied the 28th position in the population ranking of Portuguese cities in 2001, with 34,772 inhabitants - is located in the Centre Region and characterised by marked signs of its hinterland location. This interior city has the typical characteristics of a city located on mountain slopes, whose economic development has been primarily due to its historical relationship with the wool industry, and even today its core identity is linked to its being a centre of the country's textile industry. Nonetheless another strategic factor associated to Covilhã is the fact that it hosts the University of Beira Interior, thus conferring, in terms of identity, characteristics linked to the so-called Information or Knowledge Age that, in the global world, typifies highly-advanced or developed societies. The city has a peculiar, sinuous and asymmetric morphology that has decisive implications in terms of travel inside the city by social agents. The historic centre has suffered from a certain degree of abandonment, evident from several buildings already in an advanced state of degradation. The city's green spaces were also considered to be diminutive and insufficient, given its size. The Polis management company in Covilhã was therefore responsible for inverting several of these negative aspects, in order to strengthen the city's positive public image.

Marinha Grande, like Covilhã, is also located in Portugal's Centre region, but on the coast. It is a relatively small city - if we use the statistical guidelines provided by the National Statistics Institute (INE), it occupies the 100th position in the population ranking of cities. The municipality of Marinha Grande has a larger population but the city has the relatively small number of inhabitants (9,130), according to 2001 census data. Inhabitants in the municipality of Marinha Grande are only considered inhabitants of the city when identified in "urban parishes" by the National Statistics Institute (INE) (the municipality's total population is 30,000 inhabitants). It is also important to remember that this city is included within the urban conurbation formed by the cities of Leiria, Porto de Mós, Alcobaça and Batalha, constituted by around 300.000 inhabitants. The city's identity is based upon the glass industry, although a rising and predominant role is now played by the moulds,

[32] Incorporation of the Polis Companies - in order to achieve better articulation between Central Government and Local Authorities and create more effective mechanisms for intervention in urban spaces - was achieved through 100% public-owned public limited companies (*Sociedades Anónimas*) whose only shareholders were the State and Local Authorities, which hold 60% and 40% respectively of the companies' share capital. These companies are to be liquidated after fulfilling their objectives.

plastics and card industry. As in the case of Covilhã, Marinha Grande is marked by visible degradation of several, obsolete and abandoned industrial zones. The main commitment in this city, as formalised in the programme-contract signed between the Coordinating Office of the Polis Programme and Marinha Grande Municipal Council, is renewal of the main water courses, creation and reconversion of green spaces, and fostering pedestrian walkways and cycle lanes, rather than automobile circulation, while strengthening the limited car parking facilities in the city centre, through creation of new parking infrastructures. Nonetheless the respective action programme in Marinha Grande was the most modest of the three projects in terms of the overall intervention and financing.

It is now necessary to make a brief summary of the proposals presented within the framework of the Polis Programme in these three cities and their effective degree of concretisation, emphasising the benefits delivered to the local population in terms of overall urban-planning (viewed from a broader perspective), and in environmental terms in particular, while also pinpointing the objectives left by the wayside during the process.

In relation to the Polis intervention in the city of Cacém, we should first underline the complexity and degree of difficulty associated to intervening in such a territory, characterised by high population density and major road traffic in an already strained and extensive network that has many bottlenecks. Intervening in a delicate urban fabric such as that of Cacém is necessary but also constitutes a challenge.

CacémPolis - the company responsible for managing the Programme in the city - identified seven perspectives, seven action lines, within the core intervention. The first and second action lines were based on environmental assumptions that also implied renewal of the public space. Execution of initiatives related to the main water-course and transforming the Linear Park into the main Urban Park were carried out in accordance with the pre-established assumptions.

The third core action line concerned restructuring of the road network. CacémPolis intervened in various sections of the road network, by renovating roads and pavements, creating new roads, extending others, and upgrading and renewing others. In this manner a “ring road” was created around part of the city’s territory. The most important road intervention in Cacém took place in the Lagar viaduct. We won’t dwell upon possible considerations regarding the solution adopted for construction of this viaduct, but will instead emphasise the synchronism achieved in pursuit of this project with the Portuguese Roads Institute (Instituto de Estradas de Portugal). Given that many building works were taking place in the city, CacémPolis and the IEP achieved a synergy which delivered many benefits for the city, and avoided the need for unnecessary interventions which would otherwise have caused countless additional disturbances to inhabitants. Both bodies therefore achieved the right *timing*.

In the fourth action line - improvement of public spaces - CacémPolis was not able to replicate the smooth coordination it had achieved with IEP when dealing with REFER, thus causing several delays to renewal of the road interface. Although planners forecast that such execution would cause inconveniences to the city’s users, these could have been minimised if they had taken place within the time-frame of the Polis programme. Obviously additional improvements to public spaces are necessary. Another praiseworthy initiative, already concluded, thus symbolising the environmentalist spirit underpinning Polis is the new Popular Nursery School. This social solidarity

institution (IPSS) received a new “environmentally-friendly” building, located next to green spaces with leisure facilities adjusted to users’ needs. Various initiatives were undertaken in order to increase the (quality of) life of pedestrians in Cacém: traffic restrictions in roads, bollards to prevent drivers from parking on pavements, urban furniture that revitalised various public spaces in Cacém. The final project in this action line, still underway, is the construction of CMIA – the Environmental Monitoring and Interpretation Centre, the only city in this study which has actually built such a facility, although all included plans thereof in their respective Strategic Plans. This intervention, which will make it possible to monitor several of the city’s environmental dimensions, was questioned at the time but countered by firm and resolute pressure to ensure that construction went ahead.

In the fourth action line, that foresaw regeneration of existing buildings, various initiatives were undertaken, including re-housing for families whose homes were demolished due to their advanced state of degradation. This was a fairly swift and well co-ordinated process, that only needed to re-house 52 families. Given the fact that many opted for indemnity payments rather than new apartments, various plots of land that had been assigned to this re-housing intervention were left unused. This fact enabled CacémPolis to negotiate with Sintra Municipal Council and the José de Mello Group for the installation of a private hospital in the unused plots of land.

In the fifth and final action line - territorial planning of the growth areas in Cacém - CacémPolis’s field of action was severely circumscribed. This is a question that will loom large in the future. Notwithstanding the good intentions manifested, we are reluctant to conjecture what is likely to happen in practise when these matters are left in the hands of the political decision-makers who will subsequently occupy the key positions in the local council’s public administration.

The interventions executed in the programme seem to be fairly positive, aimed at pursuing wider renewal and revitalization of the city. They are nonetheless insufficient for a city such as Cacém. We will address the question of whether the Polis programme actually enhanced this city, in the conclusions at the end of this document.

Covilhã was another pioneering city - that entered the Polis Programme at the very outset. It is a medium-sized city, in the Portuguese interior, where it assumes – and could further reinforce – undeniable strategic importance in the corridor between the cities Guarda – Covilhã – Castelo Branco (we may also add the city of Fundão to this corridor). Although endowed with significant infrastructures - such as the University of Beira Interior and the Pêro da Covilhã Hospital - it is an ageing city which seems to be unable to cement sufficient powers of attraction to prevent younger people from migrating. To the contrary, this ageing city has lost a significant number of inhabitants over recent years.

The interventions conducted by Polis Covilhã (the management company of the Polis Programme in this city) were based on five perspectives, or action lines, of core intervention: 1) revitalization, enhancement and stimulation of the valleys of Goldra and Carpinteira; 2) articulation between the valleys of the local streams and the city; 3), preserve the industrial heritage assets that the city has secured; 4) reduce dependence on cars in favour of greater personal mobility; 5) guarantee a city open to the surrounding valleys, while safeguarding existing heritage.

In terms of rehabilitation, enhancement and stimulation of the valleys of Goldra and Carpinteira, the Polis programme in Covilhã implemented a series of initiatives in the zone of Goldra,

but abdicated, on grounds of lack of financial resources, from undertaking major initiatives in the zone of Carpinteira, except for reducing pollution in the water courses, in the streams of Goldra and Carpinteira. In the latter regard, the Municipal Council, at its own initiative, also intervened in the city's sewage network. In the valley of Goldra, the Goldra Urban Park was created, although bathing and toilet facilities remain to be built, given that fluvial swimming pools may be used in the centre of the park. The Mártir-in-Colo Park was also created in a formerly degraded and abandoned area, including scenic representation of building traditions from the past and present. The most ambitious work executed in this action line was undoubtedly the Jardim do Lago Park - an environmental intervention which fosters pedestrian use of the city. The existing park was endowed with a lake, permitting use by small leisure boats and was complemented by other initiatives, creating synergies between a high-quality public space and commercial activity, in particular restaurant facilities in the park. These spaces are considered to be extremely positive for the city's public image and for the self-esteem of local inhabitants, in particular the Jardim do Lago Park.

The project to achieve articulation between the local valleys and the city was implemented by creating the aforementioned extensive green areas and renewing some of the surrounding buildings. The Municipal Council demonstrated major dynamism in this regard, and abdicated from selling plots of land that it held for property construction in favour of creating new high-quality green spaces, in particular the exemplary Jardim do Lago Park. Plans to build several elevators - including funiculars, escalators and bridges linking the pedestrian walkways either side of the streams - had to be shelved except for one elevator and one of the many planned bridges, which will be executed in the near future, wherein the respective public tenders for the construction work are currently underway.

In order to valorise, preserve and intervene in industrial heritage assets, we were informed that, with utmost regret, these initiatives will be postponed or implemented in the context of an another programme for which applications may be made, e.g. Covilhã's application within the framework of Comurbeiras.

The action line to reduce dependence upon cars was hampered by the fact that the municipal council was unable to execute the aforementioned project to build funiculars, escalators and bridges.

The city of Covilhã indisputably suffered a major setback due to budgetary restrictions and revisions. The final result fell well below initial expectations. As in the case of Cacém, we will address the question of whether the programme actually enhanced this city, in the conclusions at the end of this document.

The city of Marinha Grande entered the second stage of the Polis Programme and was therefore deprived of the possibility of bidding for more ambitious intervention projects. This summary will obviously take this fact into consideration. There is a clear disproportion between the size of Marinha Grande's population and that of the other two cities considered herein: it has less than 10,000 inhabitants, while Covilhã has over 34,000 inhabitants and Cacém more than 81,000 inhabitants – according to statistics provided by INE. In terms of the total population in the municipality, it is only possible to make a comparison with Covilhã, given that Cacém does not accumulate its status as a city with that of a municipality. On this basis, the gap between Marinha

Grande and Covilhã is much smaller - In 2007 the municipality of Marinha Grande had an estimated resident population of more than 38,000 inhabitants, while the municipality of Covilhã had over 52,000 inhabitants. However, the gap between the resident population in the city and the municipality of Marinha Grande poses many questions, above all whether the vast majority of the municipality's inhabitants actually live in non-urban circumstances. These doubts appear to be legitimate but few answers to this question appear to be available.

The project in Marinha Grande was by far the humblest of the three projects analysed. Nonetheless, although it is unnecessary to identify distinct action lines, this was the Programme that achieved fastest execution and the highest level of compliance with the expectations set in the Strategic Plan. All actions were implemented, with few exceptions. The Resinification building was neither renewed or reconverted, due to lack of sufficient funds for a total recovery cost that was similar to the entire investment foreseen for the other initiatives in the Marinha Grande programme. Most of the cycle lanes failed to move past the blueprint stage. Several of the alternative car parks were not implemented, and the largest car park remains unfinished although the core infrastructure has already been built. It also proved to be impossible to move the city market to new premises and it currently operates in a special tent that has been provisionally erected for this purpose.

It should be emphasised that the initiatives implemented in Marinha Grande were almost all of an environmental nature, notwithstanding certain examples of renovation and re-enhancement of roads, encouraging greater pedestrian use of the city. We will provide further considerations in the final conclusions, although we can emphasise that the public image of the city of Marinha Grande was substantially enhanced.

Having observed, on an exemplary and heuristic basis, these three cities subjected to interventions in the framework of the Polis Programme, we must now trace broader considerations regarding the Polis Programme at the national level.

The interventions within the framework of the Polis Programme aimed to achieve re-conversion of the public image of the respective cities. These interventions were primarily executed in so-called "public spaces", as we can observe in the examples identified above and in other cities subject to Polis interventions. In addition to empirical observation, we can also add the official discourse, obtained from a privileged observer within the Coordinating Office of the Polis Programme at different moments in time, spaced out chronologically (between 2006 and 2010). We believe that the concept of "public space" should be understood and operationalised from an ideal-typified perspective, using a Weberian rationale, given that the space experienced in the real world has belongings and distinctively pertains to someone or specific groups. We would be guilty of ontological facilitism if we did not critique this concept, which transports us to a form of factuality in which the entire space, except that which is private or semi-private, is assumed as pertaining to polar opposites, i.e. pertaining to everyone and to no-one. Empirical analysis leads us to conclude that the public space - as understood and described in various urban studies - is an abstraction. For the purposes of analysis of real world experiences, this concept should be subject to reservations since experienced spaces are appropriated by individuals, in different manners, at different moments in time, inclusively spaces whose social practises extrapolate or even subvert the original functional character previously established by urban planners. We also consider that behind the conception of

the public space itself, there are almost always distinctive logics, even when planned unconsciously and/or accidentally. In other words, there are more or less unconscious specific aspects that condition the use of public spaces and foster an asymmetry of social strata/ segments in view of its use and consequent appropriation (Bourdieu: 1998). In addition to this distinction - based upon negotiation and/ or conflicts at the level of symbolic power - the appropriated space is defined, *a forteriori* by a minimal set of elements, i.e. by the type of use which, as we have suggested, has been traced for it, prior to its creation within the urban fabric. Overall, we can conclude that the public space is a space that, at an abstract level, may be appropriated by various sets of agents within a wide range of possible social interactions, but wherein, however, its real appropriation depends, on the one hand, on its functional layout and on the other hand, the symbolic value of this space and the different capitals that the various social agents combine when discussing the legitimacy of possession thereof, thereby breaking with the traditional nomothetic approach and idealised conception that is so often associated to the concept of the "Public Space". This concept, through critical use, inevitably arises when analysing cities and local populations that experience such spaces on an almost daily basis.

These urban renewal initiatives undertaken in cities by focusing on their public spaces, intentionally engender an alteration to the city's public image and the manner it which it is perceived by different social agents. The city's overall public image is the entire set of physical and symbolic representations that the different individual and collective social agents elaborate and construct in relation to the territory that demarcates the city's respective space. From this viewpoint, the entire urban space is impregnated with meaning (Castells: 2006). We understand, in this regard, that the public space is both the product of social practises and also engenders such practises. Thus, at a symbolic level, a city may be interpreted on a qualitative level, where the interpreted image may be more or less positive or more or less negative – we don't believe in the existence of a neutral position in this logic that, to use Pierre Bourdieu's terminology, is clearly distinctive. In this manner, the interventions of the Polis programme also intended to convey a message, wherein the city's public image would be positively strengthened, evoking or attempting to evoke, as suggested by Lynch (2003), that improvements in the city's public image (in the imaginary universe and awareness of individuals and local populations) generate higher self-esteem for the citizens and users of this urban space.

We believe that rediscovering or returning Nature to the city, as consigned and achieved in the Polis interventions, has positive effects on the construction of a positive image of the urban space and of public spaces. However this process also delivers an environmental and ecological bonus, considering that the environment includes social aspects and above all the ecosphere. In other words, the functions of the Polis Programme's interventions acted within the inevitable intersection between natural and social dimensions, wherein benefits for one dimension automatically deliver gains for the other. It would be imprudent to try to achieve distinct conceptualisation, given that we are simultaneously enmeshed in both dimensions.

It is now time to offer some broad conclusions concerning the Polis Programme – Programme of Urban Renewal and Environmental Enhancement of Cities, created by a Resolution of the Council of Ministers in 2000, aimed at intervening in cities in order to improve their quality of life.

The Resolution of the Council of Ministers specified that the intervention would cover renewal from an urban-planning and environmental perspective of the 18 cities contemplated at the time of the Programme's launch. A further 10 cities were chosen by public tender in the second stage of Polis. Overall there were thus 28 cities to be subject to urban renewal initiatives, included within the "Great Integrated Operations". A further 12 cities were covered, in the framework of the Programme, by other smaller-scale interventions. Overall, as stated above, 40 cities – a significant number – were integrated within the Polis Programme and distributed across the programme's different Components. Only cities located in the Portuguese mainland could apply to the Programme, however two cities from the Autonomous Regions were included on an exceptional basis - Angra do Heroísmo, in Component 2, and Funchal, Component 4.

The Polis Programme is essentially a territorial management instrument set up on an exceptional basis, staggered across two stages: the initial first stage enabled more intensive interventions to be carried out in cities, given that the stipulated funds were considerably higher than those granted in the last stage; the second stage of the Programme anticipated a smaller number of cities than those ultimately accepted for the programme, and the amounts assigned to each city in this stage were therefore significantly lower than those provided in the first stage, therefore only permitting less ambitious interventions to be made in these cities.

Naturally, the first question to answer, inclusively given the Programme's nomenclature, is whether the Polis Programme succeeded in attaining its core objective of fostering urban renewal within cities. Before responding to this question, it is first important to clarify to what extent the interventions undertaken within the framework of Polis could actually renew and revitalise cities. We must bear in mind that from the outset the Programme aimed to intervene by setting examples, and did not aim to substitute continued renewal and revitalization interventions in cities. Furthermore it should be added that the Polis Programme is a programme that has a specific timing, i.e. has a working life reduced to little more than 6 years. Hence, we consider that Polis did not aim to provide a solution to the essentially complex questions facing cities, and at best could provide a contribution towards maximising the quality of experiences associated to living in the city or cities. For the reasons identified above, the response to the first question must be negative. The Polis Programme did not achieve major urban renewal of the cities: however it is important to emphasise one of the largest and most important contributions of the Polis Programme - it succeeded in effectively renewing and revitalising the parts of the cities in which the programme was implemented.

In our opinion, and from the very outset, the idea that the Polis Programme would achieve overall urban renewal and revitalisation of cities, as if it had a kind of magic potion, was little more than that which Baudrillard (1991 [1981]) would define a "Simulation", i.e. in which the discourse, in this case the institutional discourse, claims to possess that which it actually does not possess. As we have verified herein, the Polis Programme did not achieve overall urban renewal within cities as a whole but rather in specific subsections, notwithstanding the fact that a discourse was extrapolated, announcing a new, revitalised city - thereby creating a kind of hyper-reality: rendering localised interventions in cities as being more real than the city as a whole. This is also a "simulation" to the extent that it makes us believe that Nature is once again brought to the city, when in fact the city's natural landscape is a constructed landscape.

Nonetheless, returning to the fact that the Programme aimed to create specific examples, we shouldn't assume its incompleteness but rather the intrinsic virtue of this incompleteness: the Polis Programme engendered public visibility for an environmental awareness that thereby began to set root in the sphere of political decision-makers, at the level of both central and local government, and is now unlikely to depart from the political agenda.

In terms of the logic of the "public space" it remains difficult to understand who carries out such appropriation and in what manner. Direct observation, in certain cases, was not sufficient in order to become aware of this phenomenon in most of the public spaces, in particular in pedestrian zones, and the institutional discourse is insufficient in order to understand this dimension. Obviously, the appropriation of space, inclusively of "public space", continues to observe distinct rules that characterise different social agents, different social segments, bearers of different capitals, etc. But there are obviously those who are unable to appropriate this typology of public space and are therefore relegated to a form of social marginalisation, or almost a symbolic annihilation (Wacquant: 2006).

For the "non-excluded", i.e. all those who can use these spaces and appropriate them as if they were their own, the emphasis is placed on leisure time. As is clearly demonstrated by the interventions executed at the level of the gardens and urban parks, considered to be high-quality spaces, these territories foster or attempt to foster a logic of programming of the everyday lives of social agents in a universal and hegemonic manner, obtained through the capacity of such spaces to generate entertainment activities. Such locations encourage various forms of consumption (including the full range of facilities that may be implemented, e.g. radical sports or other more traditional sports such as cycle lanes) and direct activities (activities that may be paid for such as commercial opportunities made available in these spaces, including bars and restaurants), wherein it is the pleasure, entertainment and ludical activities thereby obtained that foster the idea that each inhabitant is a citizen to the extent that he can consume (i.e. consume goods and products, consume the time periods that exist in the intervals between work or equivalent activities), and therefore is entitled to do so in safety (Baptista: 2005). We are facing an almost liquid form of modernity, with rising refusal to assume constraints or ties (Bauman: 2006 [2003]; 2006 [2005]) in favour of increasingly marked processes of individuation (Rémy: 1994).

In terms of the public image of the city, we face a disturbing question: are we heading towards solipsist cities? Cities themselves have created a kind of brand image (Mons: sd.), the effect of a marketing practise that we could consider to be economicist in nature. The city markets itself via this public image, in particular, and increasingly via a brand image. This trend also applies to the cities studied herein. Enraptured by their aestheticising hallmarks, they regard neighbouring or more distant cities from the perspective of competitive philosophy. Corridors of networked cities that should normally co-operate to boost their development and sustainability, are thereby reduced to a form of competition equivalent to unbridled capitalism (Harvey: 2000).

Cities constituted in networks, in this globalised era, can and should serve as an interface between local authorities and supranational interests (Sassen: 2006). Furthermore, we would inclusively suggest that cities are the prime territory in which the global is rendered local. Nonetheless, shortcomings in terms of the sustainability of operation of cities constituted in networks

in Portugal, undermine the development of these respective cities and the country as a whole, which will thus be increasingly distanced from the front-runners in this global race.

However, while the Polis Programme, on the one hand, fell well below expectations, we nonetheless consider that it achieved reasonable compliance with the goals attributed to the programme from outset: simulation of better, upgraded cities; and also creation of genuine, factual attributes, that would otherwise have been impossible to implement solely within the context of the budget of a Municipal Council. Nonetheless, in our opinion, the current administrative division of Portuguese territory is bankrupt and urgently needs to be revised – notwithstanding the expected continuity of this "project", that has now been entitled Polis XXI. In the context of the Polis XXI Cities Policy, Central Government is responsible for defining policy instruments, establishing the reference framework for their application and setting general criteria guidelines to be adopted in evaluation of the applications presented, in particular those presented by municipal councils, as individual proponents or leaders of groups of local partners. After complying with these requirements, partnership contracts will be signed. The Polis XXI Cities Policy establishes the following core targets for 2015: 60 urban renewal operations; 31 cities and/or networks of cities with Strategic Programmes; 75 innovative urban development projects. Nonetheless, comprehensive additional research will be necessary before we can analyse Polis XXI. This topic is therefore not explored in further detail in the present text, since it goes beyond the objectives set herein. We only refer to Polis XXI, in order to reiterate the exemplary influence of the Polis Programme – given that setting examples was one of its paradigmatic key aspects. The ultimate purpose of the Polis Programme, in these circumstances, will be to ensure continuity of new intervention policies in cities, whose objectives will be based upon improving the well-being of local populations, their day-to-day experiences and urban life in general.

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Urban Sustainability Policies at a Local Level: The case-study of Portugal

André Barros, Henrique Cabral*

Department of Animal Biology, Faculty of Sciences, University of Lisbon

*hncabral@fc.ul.pt

Phone: +351 21 750 08 26; Fax: +351 21 750 02 07

Sustainability, although being an extremely complex and subjective concept, is becoming more and more a key issue on the development of human societies. This subject is particularly important in areas where most of human activities co-exist: urban areas. The sustainability of cities, or urban sustainability, plays an important role on policy-making at different levels: international, national and local. At the international and national perspectives, the approach to this problem and the consequent legislation and initiatives just establish priorities and thresholds; the real and functional objectives and measures are defined and applied locally in the territory, making this perspective crucial to establish functional balance between socio-economical development and environment in urban areas. This paper analyzed the strength of policies that local governments have on urban sustainability, dividing this concept in ten key categories: international initiatives on the theme of urban sustainability; mobility; energy; waste management; climate change; water management; noise; land-use; green areas and environmental education. Local governments reveal a strong support for the initiatives proposed internationally concerning the environment in cities but they do not have a homogeneous perspective of this subject. They act mostly on waste and water managements and reveal less concern in domains such as noise and climate changes.

Keywords: Sustainable Development; Policies; Environmental Management; Urban Areas; Sustainability Indicators

1. Introduction

With recent awareness of societies concerning the environmental impacts caused by their action, sustainable development has become a key issue in governance worldwide. It is still difficult to define this concept, due to its complex and interdisciplinary nature; however, most scientists agree that we can define sustainable development as "… development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987).

An efficient way to achieve sustainable development is to include, during the process of planning, another principle: sustainability (Moles et al, 2008; Hediger, W. 2000). Although hard to define, in practice and on a human perspective, the inclusion of such concept implies the establishment at all times of a balance between three distinct but inter-dependent areas: conservation and management of natural resources, economic growth and social equality and justice, with the purpose of achieving good quality life for the communities. (Bell and Morse, 1999).

Also, it is important to consider other key principles in order to progress towards a sustainable development: (a) always adopt a future perspective on the consequences predicted, for the consequences of development are inter-generational; (b) consider an action-reaction model, in which human actions cause environmental impacts (Ravetz, 2000); (c) always analyze the principle of action-reaction under a precautionary view, proposing measures that can prevent the negative consequences of human development (Gasparatos et al., 2008) and (d) to be aware that any activity made at a local scale may have influence on a global scale.

The interaction between local processes and global consequences represent a very important factor to consider in human development, especially in areas with great anthropogenic

influence, such as urban areas. Cities are indeed the most man-influenced areas in the planet. Capable of impacting not only on the boundaries of its area but also beyond, on their surroundings, these are considered to be open systems (Munda, 2006; Dhakal, 2009). Due to their great influence at a global scale and to their unique features, the unique balance of sustainability is delicate and often uneven in the urban centres. With more importance given to the economic growth than to environmental factors or even social factors, it is necessary to define the principle of sustainability exclusive to cities – urban sustainability - which can be defined as the establishment of good quality life standards based on the capacity of natural resources, achievement of social justice, a balanced economy and a sustainable environment (Mega, 2000). As this balance is dynamic, urban sustainability should never be seen as a goal but as a direction (Ravetz, 1999).

To achieve a sustainable development, we must first ask the question “Which is the best way to use effectively natural resources, protecting the environment and also promoting economic growth and social equality in cities?” (Briassoulis, 1999). The key to find that “best way” is in planning and in designing efficient and integrated policies that promote urban sustainability, since the problems are both complicated and complex to solve (Ravetz, 1999; Hardi and DeSouza-Huteley, 2000). The absence or misconception of these policies can also result in severe problems concerning the environmental performance of urban areas, such as in land-use (Macedo, 2008; Galindo and Muñiz 2005), waste management (Marques, 2008), among others.

However, the distinctive balance of sustainability may be quite hard to achieve, due to the recent economic crisis most societies are experiencing, also causing problems on social justice and equality. To solve this crisis, governments undertake a view on planning and development more focused on stabilizing the economy and promoting its growth while maintaining good quality life, causing the environmental concerns to be overlooked and, in some cases, entirely dismissed. This represents even a bigger challenge to governments and international entities to establish sustainable development in cities as principle.

Therefore, sustainability can be fully integrated in the view of development by raising environmental concerns and with the proposal of measures for increasing the environmental performance of cities. To achieve this goal, regulation and policies with a more environmental view have to be designed, in order to correctly manage the urban ecosystem (Hardi and DeSouza-Huteley, 2000).

Sustainable development is already a great concern on national and international agenda, guidelines and policies packages concerning sustainability on a holistic view have been emerging, such as Agenda 21. Agenda 21 (UN, 1992) has become a great legal instrument for achieving a balanced development. Created during the United Nations (UN) Conference on Development and Environment on Rio de Janeiro, Brazil, in 1992, Agenda 21 allows both governments and private organizations, from a national perspective to a local level, to plan and regulate development with the sustainable paradigm in mind. Since its basis was a holistic view of development, it represented an innovated view of governance. This document has different chapters regulating distinct aspects of human progress; one of the chapters concerns urban sustainability, mainly focusing on promoting sustainable activities developed on cities, such as industry and construction, and on planning resource management, such as energy, waste and water. In addition to this initiative, UN has

developed different documents, some with a global scope, as Shelton and Kiss, 2005, and others more specific (McCaffrey and Weber, 2005), defining guidelines that have major influence on urban management.

The European Union (EU) has also made great efforts to promote sustainable development. With the application of UN's Agenda 21, this document took on a more local influence, becoming an instrument for local governments to plan their development. On Europe, this focusing of Agenda 21 into local development led to the development of the Aalborg Commitments. Inserted on the European Sustainable Cities and Town Campaign, these commitments were signed by local governments and proposed a matrix of development similar to the one proposed on Agenda 21: promoting local sustainability and an effective resource management, always considering a need of governance focused on these strategies (ICLEI, 1994). EU has also defined strategic planning for urban environment (EU, 2006), and different policies that can greatly influence urban management, such as noise pollution (EU, 2002), energy and climate changes (EU, 2008), among others.

Portugal is a South European Country, which joined EU on 1986. Concerning urban sustainability, Portugal does not possess a structured strategy, despite having a general plan for sustainable development (Government Council, 2007). However, there are many regulations on aspects concerning urban areas, such as waste management (Environment, Land-Use and Regional Development's Office, 2006), which are stated as efficient and outstanding in dealing with the problems at hand (Marques, 2008). But, the most innovative regulation this country has concerning sustainability was approved on 2000 and it establishes a plan for good land-use on urban areas – the POLIS Programme (Government Council, 2000). This programme establishes measures mostly for urban requalification rather than urban growth and promotes an environmental view on cities' land use, proving to be extremely efficient. POLIS programme is considered as a good example on the international community. (Partidário and Correia, 2004).

However, most of these policies focus on the establishment of important guidelines for sustainability but they do not, for themselves, lead to sustainability. Only the applications of these policies' principles can lead to a sustainable development, and that application has to occur on a local level (Hardi and DeSouza-Huteley, 2000). As settlements are recognized as the motors of development (Rees and Wackernagel, 1996; Rotmans et al.,2000), governance of these areas can become the central force on regulating this development, thus allowing the application of sustainable development's principles (McGill, 2001).

Legal instruments are, undoubtfully, very important for defining and establishing a sustainable environment. Also, planning and policies are key issues to effectively evaluate sustainability: although some scientific studies concerning this topic, which focus in exposing current status of local development, are very important in showing stakeholders the situation for the selected area and thus allowing them to make more informed decisions (Costanza, 2000), they do not represent the best way to look at sustainability with the necessary future perspective (Gasparatos, 2008); instead, focusing on the process of planning has the potential to give a true view of the sustainability on a long run and truly evaluate sustainability through a holistic view.

The objectives of this paper are:

- To evaluate policies of local governments of Portugal, determining which are more and less common;
- To analyse possible patterns, to evaluate relations between policies and some local characteristics.

2. Methods

In order to evaluate the local policies concerning urban sustainability and urban management, we developed a check-list with different criteria which are directly related to environmental key areas to cities' sustainable development. Check-lists, already used by other authors in the area of sustainability policies (McGill, 2001), are considered an effective tool to measure sustainable development, as proved by Hardi and DeSouza-Huteley, 2000.

The check-list evaluates sustainability according the concept of baseline-led perspective described on Pope et al., 2004, which can be divided into 2 phases: first, the assessment of current situation and then the establishment of policies and orientation of planning process towards sustainability.

In order to assess the local policies on sustainable development in cities, the principle "urban sustainability" was divided into 10 different environmental categories, each one with their own criteria. Categories were adapted from environmental factors considered for the indicator "Urban Environmental Problems", which is part of a list of environmental indicators established by European Union (EU, 1999); in addition, other equally categories were added:

(a) International Initiatives – The signing of Agenda 21 Process or Aalborg Commitments represents a big investment on urban sustainability. With guidelines established by both programs, local governments can organize the actions that need to be undertaken and rank their priorities in development in order to accomplish the objectives set up by Agenda 21 and/or Aalborg Commitments, allowing a balance between economic development and environmental concerns (McGranahan and Satterthwaite, 2003). Local Agenda 21 is not always the central action plan for sustainability; it can also represent just a tool that can be articulated with other action plans (Coca-Stefaniak et al., 2009). Since the analysis presented on this work is baseline-oriented, it is important to have both an action plan and a report of the current status of sustainability in the cities.

(b) Mobility – In the past, urban mobility was associated exclusively with transportation and, in order to match the increasing demand, the stakeholders promoted road transportation and private transportation (Da Silva et al., 2008); however, mostly with the new concepts and perspectives on land-use, the paradigm of urban mobility also changes (Camagni et al., 2002). Therefore, it is essential: to adopt an holistic and integrated view of mobility and its planning, allowing the interdependence and interconnection of proposed measures; to promote the use of public transportation, preferably greener means of transportation; to inform and sell the new proposed paradigm of mobility (Banister, 2008).

(c) Energy – Energy connections with other environmental areas such as climate changes (Dhakal, 2009), transportation (Tsani, 2010), water management (Lundin and Morrison, 2002), among others (Evans et al. 2009). Energy is a fundamental resource for human development, so it is essential to

include in any sustainable system proposal, measures to ensure its efficient management (Nilsson and Bergström, 1995), as well to promote renewable energies (Evans et al. 2009).

(d) Waste Management – A suitable way to deal with waste is essential for management for cities (Rojas-Caldelas and Zambrano, 2008) and still poses one of the biggest challenges concerning policy. The first step in waste management is to develop a waste treatment system (Haastrup et al., 1998) that allows a general perspective of the entire process, since it is collected until its final destination. Also, every process of management has to be based on key concepts as recycling and reuse of waste in different ways (Mazzanti and Zoboli, 2008).

(e) Climate Changes – Climate changes and air quality are key environmental factors to sustainability. For this reason, there are international comities and also international policies (IPCC, 1996) that address this issue; however, since the measures proposed are mainly from other environmental areas, we must focus our efforts on evaluating the current status.

(f) Water Management – water management, as waste management, is a process, besides environmental worries, with both economical and social concerns (Starkl et al., 2009). Although we face a rising of depletion of this natural resource, water management is still based on a more economic perspective, which causes unease to the populations (Kolokytha et al., 2002). Aiming at sustainable use of water, the policies must focus on the development of a holistic system, from supply to residual waters. Additionally, the complementary policies must promote processes that result in a more efficient and rational use of water, including water recycling for non-potable uses (Hurlimann and McKay, 2007).

(g) Noise Pollution – Seen more as social impact (Anderson et al., 2005), it is an environmental consequence (Camagni et al. 2002) and needs to be address as such. Since it is still a recent concern on sustainability, there is not real and efficient planning or policies to deal with this issue.

(h) Land Use – Cities' form, mainly their dimensions, are important issues for policy makers. The urban development tendency has strong influence on other environmental factors (Haase and Nuissl, 2007). Therefore, it is important that programmes on land-use interact with action plans regarding other areas, thus achieving the integrated view of urban sustainability. Another key element on land-use is the promotion of rebuilding urban areas instead of urban growth, since this last one can be responsible for several environmental problems (Galindo and Muñiz 2005).

(i) Green Areas – These areas represent an important part of the urban dynamic (Pauleit et al. 2005) and are extremely useful due to the services they can provide (Jim and Chen, 2009). Therefore, their conservation and management are essential for living on the cities.

(j) Environmental Education – The process of public participation is key step on the process of achieving sustainability (Holden et al., 2008). It is essential, then, for citizens to understand the principles and concepts in which sustainable development is based on and also to understand their own role and their responsibilities for creating a balanced urban environment.

In order to analyse the presence of these environmental areas on local governments' agenda, surveys were made to 33 local governments' policies, a method which has been successfully used with this kind of information (Hardi and DeSouza-Huteley, 2000; (McGill, 2001). Data from the surveys were supported with the information available on the internet sites of local governments and several national governmental agencies, a resource also used before (Keirstead

2009). The questions of the survey are shown on Table 1. This data was then studied through percentage analysis.

The group of the chosen 33 local governments includes all possible differences for the general and non-policies related data, which was collected from the National Statistics' Institute. To ascertain the possible connections between this data and urban sustainability policies, it was compared to the percentage data obtained from the survey.

Table 1. Survey used on data collection, with the environmental areas and the specific questions

A-International Initiaives	A.1) Support International Initiatives which include sustainability of the urban areas, such as Agenda 21, Aalborg Commitments, among others A.2) Documents developed following the support of these initiatives A.2.1. Diagnosis of the current situation A.2.2. Action Plan, with well defined and urban sustainability related strategic objectives
B- Mobility	B.1) Sustainable Mobility B.1.1. Local Laws concerning mobility, such as parking, traffic... B.1.2. Action Plan for Sustainable Mobility B.1.3. Promotion of this type of Mobility B.1.4. Projects concerning the reduction of car traffic in cities' areas B.1.5. Mobility in urban centres focused on light processes, such as walking and cycling (development of pedestrians-only areas and cycling paths) B.2) Urban Transportation B.2.1. Local Laws concerning these transports B.2.2 Network of Public Transportation B.2.3 Promotion of this type of transportation B.2.4 Project for modification of the local government fleet toward energetic sustainability
C - Energy	C.1) Development of an Energy Matrix C.2) Renewable Energies C.2.1 Promotion of the use of renewable energy sources on the infra-structures of the local government C.2.2. Promotion of Sustainable Building: New constructions with renewable energy sources C.2.3. Cooperation with the citizens and/or companies promoting renewable energies C.3) Energetic Efficiency C.3.1. Implementation mechanisms and measures for promoting Energetic Efficiency in local governments' infra-structures C.3.2. Consideration of Energetic Efficiency in the process of Sustainable Building C.3.3 Cooperation with citizens and/or companies promoting Energetic Efficiency
D – Waste Management	D.1) Local Regulation concerning Urban Solid Waste D.2) Promotion of Collecting and Differentiated Treatment D.2.1. Recycling waste not from the 3 standard groups D.2.2. Promotion of reusing these wastes D.3) Strategies focused on Recycling and Reusing D.4) Local/ Regional Action Plan/Management System for Waste Management D.4.1 Description of Current Situation D.4.2 Action Plan towards sustainability in Waste Management

E – Climate Changes	E.1) Report of Current Situation on Air Quality and Green-House Effect Gases Emissions E.1.1. Local Government's Instrument for measuring the concentration of GHE Gases E.1.2. Measurements made by local government's own initiative E.2) Reports with these measures and suggestions of actions to be undertaken
F – Water Management	F.1) Local Regulations F.1.1. Water Supplying F.1.2. Drainage and treatment of residual waters F.2) Local/Regional Action Planning/Management System concerning water F.3) Matrix of Consumption Water F.4) Promotion of decrease of water waste in: F.4.1. Local Government's Infra-structures F.4.2. Citizens' homes and Private Companies
G – Noise Pollution	G.1) Development of a Map of Noise G.2) Prevention and Mitigation Measures of Noise on those areas considered as sensitive G.3) Local Regulation concerning Noise
H – Land Use	H.1) Description of the Current Situation H.2) Integrated Approach of Land-Use Strategies with other Action Plans H.3) Action Plan focused on renovation of the urban centres
I – Green Areas	I.1) Strategies for Conservation and Maintenance of Green Areas I.2) Integration of these areas on the urban dynamic I.3) Local Regulation on Green Areas
J – Environmental Education	J.1) Implementation of Environmental Centres, focused on the information targeted for the population J.2) Initiatives and Campaigns of Environmental Education on the Areas: J.2.1. Sustainable Mobility J.2.2. Renewable Energy and Energetic Efficiency J.2.3. Waste Managemente and Reduction J.2.4 Climate Changes J.2.5. Water Management J.2.6. Noise J.2.7 Green Spaces J.3) Public/Parties Involvement in defining Action Plans concerning Sustainable Development

3. The Investment on the Different Policies

There were strong differences on the results for the environmental categories present on the survey (Table 2). We can observe that the areas with higher importance for local governments are international initiatives, waste management and water management; however, the effort revealed on these three categories, and also on most of the others, does not have a uniform distribution on the criteria concerning these three areas (Table 3).

Table 2. Percentages of positive answers to each environmental area

Environmental Areas	1	2	3	4	5	6	7	8	9	10
Percentages of Positive Answers	68%	56%	48%	66%	38%	61%	36%	51%	59%	47%

Table 3. Percentages of positive answers to each question presented on the survey

Environmental Specific Criteria		Percentage of Positive Answers
A.1.		85%
A.2	A.2.1.	61%
	A.2.2.	58%
B.1	B.1.1	45%
	B.1.2	39%
	B.1.3	67%
	B.1.4	58%
	B.1.5	73%
B.2	B.2.1	55%
	B.2.2	58%
	B.2.3	55%
	B.2.4	33%
C.1		39%
C.2	C.2.1	64%
	C.2.2	36%
	C.2.3	48%
C.3	C.3.1	64%
	C.3.2	36%
	C.3.3	52%
D.1		55%
D.2	D.2.1	88%
	D.2.2	85%
D.3		100%
D.4	D.4.1	24%
	D.4.2	42%
E.1	E.1.1	36%
	E.1.2	42%

E.2		36%
F.1	F.1.1	61%
	F.1.2	61%
F.2		64%
F.3		76%
F.4	F.4.1	52%
	F.4.2	52%
G.1		79%
G.2		18%
G.3		12%
H.1		48%
H.2		45%
H.3		58%
I.1		61%
I.2		97%
I.3		18%
J.1		36%
J.2	J.2.1	39%
	J.2.2	64%
	J.2.3	73%
	J.2.4	36%
	J.2.5	64%
	J.2.6	30%
	J.2.7	27%
J.3		55%

Portuguese municipalities reveal a great tendency to join initiatives on an international level concerning urban sustainability but, the commitments imposed sometimes do not translate that tendency into a real effort, since the score for the elaboration of a report concerning the current situation and of an action plan are lower than the one referring to the integration of initiatives. In fact, the holistic view of planning, with both present and future perspectives, is not a common tool for the local governments' area, since most questions related with this issue recorded values below 60%, with only the water management plan surpassing this limit with the result of 73%. This lacking on planning, especially the ones using an integrated and holistic view of urban sustainability, may really hinder the assimilation of such principle.

Waste and water management are environmental areas which have been part of Portuguese local governments' agenda for many years; Therefore, the importance revealed on this study of these issues does not come as a surprise.

Concerning waste management, there is a lack of concern on analysing the current situation, since this element is considered essential for only 24% of the municipalities analysed. So, planning concerning this subject can become more complex; one the other hand, half of the local

governments have a holistic view of the waste problem and develop mechanisms to deal with it, such as local regulations, action plans or management systems. This lack of evaluation of the present situation results from the long time waste management has been a concern for local governments, allowing them to have already efficient mechanisms concerning this issue; however, failing to access the current status can make these governments fail to realize the changes on the local paradigm and, thus, causing the reduction of efficiency of the established plans. The remaining actions reveal the importance of waste management on a local perspective, mainly recycling, with both high values on the promotion of collecting and reusing waste that do not belong to standard categories (paper, plastic and glass) and with a perfect score for standard recycling. This reveals the clear determination of reducing waste production through waste recycling and, thus, a more sustainable view on general consumption of resources.

Water management is more focused on the whole process since distribution until treatment, since the mechanisms to regulate it are a great concert of the governments. Although it may be considered an important issue on sustainability of the exploitation of this resource, making a more efficient use of water is the least important worry on the local governments' mind, with only half of municipalities working on this matter both for public and private use, values that can be justified with the strong economic view of this resource (Starkl et al., 2009). This leads to environmental issues being overlooked and thus not enabling the adoption of a true holistic perspective on the subject.

Mobility is the most uniform category, varying from 33% (B.2.4) to 73% (B.1.5). The results reveal that although a structured plan is yet to become a generalized tool, there are plenty incentives and opportunities for sustainable mobility and for Public transportation thus, showing that Portuguese cities are well adapted and organized considering the new paradigm of mobility (Camagni et al., 2002). Although these results reveal a solid investment on sustainable mobility, the elaboration of an action plan represents a significant gain, since it allows a more global picture of the subject and promotes the connection and interdependence of mobility and public transportation.

Despite the effort that Portuguese local governments reveal on questions of mobility, the land-use on cities do not show the same development, with only just half of the municipalities focusing on a perspective of urban rebuilding rather than urban sprawl. This lack of perspective of this new paradigm is emphasized with the scarce evaluation of the current status of urban areas; however, urban sprawl may not pose a great threat, since some municipalities have their cities still on a development phase. But, the most important result concerning land-use is the lack of articulation of plans concerning this issue with other action plans, failing to understand the real capacity of development centralization land-use.

Although urban growth and organisation is not an important concern for local governments, on the new urban form, green areas are considered as key components, as we can see not only through the great percentage of integration of these areas in the urban dynamic, but also with the importance given by local governments to their conservation and management. Despite this clear tendency to promote green areas, the local regulation has yet to become an ordinary undertaken measure, revealing a management based on a case-specific perspective.

As mentioned before, energy and climate changes are relatively new environmental areas concerning sustainable development; thus, it is expected the low score obtained on these categories

compared to others. The energetic issues, although lacking on a perspective of the big picture, reveal a growing concern with both energetic efficiency and use of renewable energies on new buildings, thus, giving greater weight to the new tendency of sustainable construction. The results also determine that energetic concerns are highly considered on public infrastructures, making local governments adopt a role model for the community; nevertheless, the effort to collaborate with the citizens is yet too low but the tendency revealed to work on this subject is encouraging. About climate changes, the municipalities are revealing good efforts on monitoring air quality for their own initiative and are also showing some concerns on analysing these results and establishing some measures to improve air quality, through the development of connections with other environmental areas and the apprehension of this issue and its central position on sustainability, integrating it with other environmental areas.

As previously observed, noise pollution is an underestimated environmental issue by local governments. Despite the generalised effort to map the noise on the cities' area and to understand its dynamic, the effort on solving and mitigating this problem, mostly on sensitive areas, with the development of a local regulation concerning noise, still includes too few municipalities. Although it does not cause serious environmental problems, overlooking this problem can hinder life quality on cities and cause significative social impacts.

Although it is extremely important, public awareness on environmental issues is still disregarded by some local governments, with only good investment revealed on education concerning waste, water and energy. The fragmented perspective of sustainability transmitted to the community leads to isolated actions, causing many problems and difficulties to achieve a sustainable development; this view can also jeopardize the process of public participation: citizens do not understand the issue of sustainability nor are fully aware of the key environmental concerns underlying on this perspective. Consequenly, it is no surprising the public participation rate on the development of action plan is only 55%, with the aggravating factor that some of the communities that participated are not misinformed.

4. Influences and Patterns Concerning Urban Sustainability

In order to understand the dynamics of urban sustainability, we have to be aware of the causes for its variation, to identify what influences it and how they do it. To accomplish that, the municipalities were characterized according to their geographical position, population density, surface of urban centres present on the municipality area and expenses concerning environment.

Firstly, to understand the influence of distinct cultural features on different regions of Portugal, the municipalities were categorized in three groups: North, South and Lisbon-Setubal Complex. This last category represents a region that traditionally belongs to the South but, since is it exhibits very unique characteristics, we considered it as a separated group.

The results (Table 4) reveal that, in most categories, the hierarchy of environmental areas concerning the investment made on municipalities is similar between groups; however, this does not mean the effort is focused on the same areas.

Table 4. Percentage of positive answers for North, Lisbon-Setubal Complex and South categories

Environmental Areas		1	2	3	4	5	6	7	8	9	10
Percentage of Positive Answers	North	58%	48%	48%	68%	24%	62%	30%	52%	55%	23%
	Lisbon - Setubal Complex	91%	74%	70%	70%	79%	74%	45%	70%	67%	84%
	South	55%	38%	27%	59%	12%	45%	33%	30%	55%	34%

The northern municipalities, although having the same score for the support of international initiatives as the ones on Lisbon-Setubal Complex, show a lower effort on developing both a report on the present situation (55%) and an action plan (45%). For the remaining categories, local governments of the northern region overlook questions as mobility, mainly on planning and on new sustainable transportation (27% for both); climate changes, on an uniform way; noise, revealing a general lack of action on mitigation this problem (9%), and environmental education, with no score above 45%, showing a disregard for sharing information and for teaching people on the topic of sustainability, having also a reduced community's involvment on the process of urban management. However, local governments of the North reveal a great concern about the problems of waste (68%) and water management (62%), with the areas of investment being the same as on a national perspective. Nevertheless, the investment on green areas should be higher, mainly on conservation and management of these areas, since the northern region has a tradition of contact of the community with Nature and also the adoption of a rebuilding view of land-use (55%) and the opportunities this generates. The local governments of this region are also starting to develop great efforts on the questions of energy (48%), mainly through the investment on public infrastructure concerning both renewable energies and energetic efficiency (both 64%).

The Lisbon-Setubal complex, as stated before, has unique and special characteristics, encompassing the larger urban centre of the country. Results show that urban sustainability is a great concern in comparison with the other two defined regions, presenting leading values for all the defined environmental areas. Besides this remarkable values, this region differs from the North and South Regions, since its local governments give great importance to both the climate change category, developing efforts to do their share of actions to counter this problem (73%); and to environmental education, presenting greater values (100%) for energy, waste and water management, and also on public participation, which reveals a big effort to involve the community on the problem of persecution of urban sustainability (also 100%). The municipalities of this area are also leading examples on mobility, mainly through investment on public transportation and the associated infrastructure (both 91%) and the adaptation of urban mobility adapted for by foot circulation (100%), and on energy, with great focus on planning (64%) and also on adapting public infrastructures for energetic efficiency and for use of renewable sources (both 82%).

These results reveal a great response to the opportunities this nucleus provides concerning urban management and also to the underlying problems that exist, answering to the issues of great urban growth and great anthropogenic influences with land-use policies centred on renovation of

urban area (38%) and with great importance given to green-spaces and to their conservation maintenance (48%).

Finally, the South Region is the one that reveals more weaknesses on urban sustainability, scoring low values on all analysed issues; however, it is areas such as energy and water management that the obtained results are worrying since they are key issues: concerning energy, mainly renewable energy, the South part of Portugal has a great potential for solar energy, due to the warm and dry climate typical of this area; however, the results for both public (45%) and private (9% and 27%) effort on renewable sources of energy show that this opportunity still has little expression; about water management, it is important to develop efforts with the purpose of efficiency and reduction of its use, since it is a specialy scarce resource on this region. Such problem does not seem to worry the local governments, since only a few really invest on this specific issue (27% for public and 18% for private institutions). Southern municipalities do not integrate yet a holistic view of land-use policies (18%), not being able to reconcile this with the dynamics of mobility and with the integration of green areas; nevertheless, they do reveal a tendency to turn to urban reorganization rather than urban growth (45%).

One of the distinctive characteristic of Portugal is the differences we can see between the coastal area and the inland areas, which include urban sustainability, as we can see on Table 5: The differences are astonishing: all scores varying from 28% up, emphasizing once again that the sustainability is still off-balance. Portuguese coastal area is a much desired place for tourism, which is a very profitable activity and, therefore, this areas tend to develop their own economic trends and to generate great profits; so, with the visibility these areas have and since there are enough funding, sustainability is essential for development established on these region. On the other hand, inland areas are less targeted for tourism; so the pressure to have a balance growth is lower and the development is solely focused on creating good economical and social levels of life standards, leading local governments to overlook the environmental part on sustainable development.

Table 5. Percentage of Positive Answers to Inland Region and Coastal Region

Environmental Areas		1	2	3	4	5	6	7	8	9	10
Percentage of Postive Answers	Inland Region	62%	39%	33%	58%	20%	52%	27%	35%	52%	31%
	Coastal Region	79%	82%	79%	80%	76%	77%	55%	82%	73%	79%

The urban space, the population and the expense concerning environmental actions are features which also influence the effort on urban sustainability policies, mainly on mobility and energy.

The least populated municipalities, such as Mora and Arraiolos reveal lack of concern on mobility, mainly on the issues about planning and promotion of sustainable mobility; for the other environmental categories, there is a clear relation between high populated regions and a great concern over urban sustainability, with the medium and low populated municipalities revealing less concerns with environmental issues. These results are understandable, since local governments of municipalities with less population suffer fewer pressures for social justice and equality but suffer more pressures for environmental growth and urban sprawl, overlooking environmental issues.

Larger urban centres such as the ones that exist on Sintra and Torres Vedras, present challenges concerning sustainable mobility that lead the local governments in charge to develop great efforts on this subject. Such answer is also applied on energy, confirmed the tendency of energy being a rising concern on local governments' agenda; in this case, this concern can be explained with the local governments adopting a perspective of sustainable building.

Money directed onto environmental actions is also a key factor on the effort to undertaking sustainability, since this issue follows a perspective of Great Spenders-Great Policies.

5. Conclusions

Urban sustainability is yet to become a generalised concern on the growth of cities. Management of natural resources, such as water and energy, is the key area local governments tend to focus their actions on, lacking to both understand urban sustainability as a whole and to realize the new challenges and opportunities rising in the present world, as mobility and climate change. Another thing local governments fail to see are the benefits planning can bring both on stating actions and objectives and on allowing a holistic view of the sustainable development.

Local governments' agenda is not the same for every municipality, since there are differences and influences from different areas, demographic, cultural and spatial, that can influence the perspective about sustainability. Then, to evaluate the present situation, we have to understand the intrinsic dynamic of the local area and, thus, establish priorities on what actions should be undertaken.

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Methodology to Identify Dispersed Occupation on a Local Scale[33]

Jorge Carvalho, Carina Pais

GOVCOPP – SACSJP

University of Aveiro, jcarvalho@ua.pt, pais@ua.pt

Phone/fax numbers: +351 234 372 484/ +351 234 372 500

The study of urban dispersion on a local scale requires the adoption of operational concepts. This research uses the notion of "Base Land Unit" (BLU), which represents a functional and experiential reality. The current paper presents an explanation of this concept and a methodology to distinguish BLU of dispersed occupation from other types of Units (concentrated, unbuilt…). The developed methodology comprises three different methods: Identification of Building Ensembles by Digital Method; Calculation of the Disaggregation Index of Continuous Building Ensembles; Criterion for Identifying BLU of Dispersed Occupation. A detailed description of each phase is presented, as well as the results of its application in the case studies of the Research Project (Évora and Aveiro-Ílhavo).

Keywords: Dispersed occupation, local scale, methodology.

1. Urban Dispersion on Several Scales

The shape of urbanization in the past few decades is quite different from the traditional one, its traits are:

- global webs of economic relations;
- urban man's great mobility in everyday displacements;
- spread of buildings and new developments throughout the territory.

As a result, emerging urban territories have been classified as *generic, extensive, dispersed, diffuse, discontinuous, fragmented…* This limitless city is conceptualized by several authors, as the *Global City*, the *Metàpole*, the *Edge City* or the *Città Diffusa*" (Font, 2004:12).

The vast majority of analyses focusing these new urban territories use large concentrations, large cities as their referents. However, some of the phenomena identified – namely constructive and functional dispersion and fragmentation – are common to most growing cities, including small and mid-sized ones and even to some cities facing economic and demographic decline.

It is, after all, a widespread phenomenon resulting from financial, economic and cultural globalization, as well as the growth in mobility allowed by the private car (Carvalho and Pais, 2009).

Although dispersed occupation occurs on several scales, this Research Project intends to study the phenomenon only on a local scale.

2. Base Land Units

To define conceptually "Local Scale", the starting point is the broader concept of "Land Unit" (LU), defined as a portion of land that reveals itself as a unit, from a geographical, historical, functional and/or administrative perspective.

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The concept relies on perception/recognition and can be considered at different scales (e.g. World, Europe, the Iberian Peninsula or Portugal). A Land Unit can also be assumed in a voluntaristic way, as for example, in a hypothetical creation of Administrative Regions in Portugal (Carvalho, Pais *et al.,* 2008; Carvalho, 2009; Carvalho e Marinho, 2010).

The recognition of Land Units is more difficult in urban territories that, because of its fragmentary and dispersive expansion dynamics, are not consistent with the administrative limits.

The complexity associated with the delimitation of urban Land Units is not only applied to the city scale, it can be also found in the "wider ensemble in which the city is integrated"; and also in each one of the "city parts". The terms "city", "wider ensemble in which the city is integrated" and "city parts" result from the adoption of a hierarchical territorial scale that can be useful to understand and also manage urban territories.

Despite the mentioned difficulty, and taking into consideration the need of an adaptation to each particular reality, the three terms can be related to well known Land Units: Metropolitan Area or Urban Conurbation, Extended City, City Part and Base Land Unit (BLU).

In this Project, "Local Scale" corresponds to the Base Land Unit scale. BLU is a concept that integrates and almost coincides with other well known ones, namely that of the neighbourhood, in its everyday meaning, and that of the neighbourhood unit.

The latter stems from American sociological studies concerned with weakening social rapports among neighbours. Clarence Perry formulated it in the 1920's and the majority of modernist planners, those of the Garden City and those of the Athens Charter (Mumford, 1982:541-542) adopted it. It aims at strengthening neighbourly relations, along with effective and rational public (or collective) service, namely in what concerns facilities.

BLU scale/territorial scope is thus conceptually linked to a demographic dimension suitable for good basic facilities service, often named local facilities. Adopting conclusions drawn by a recent study on the matter (Carvalho and Marinho, 2009), the reference, preferable population may be that of 3.000 users (residents or employed in the area), admitting an interval between 1.000 and 5.000 with natural consequences on the facilities to consider.

The BLU concept differs from the neighbourhood unit for introducing non-segregationist cautions (Carvalho, 2003:191) and taking on a broader meaning, as it does not necessarily refer to an exclusively residential area – it may also encompass central or industrial ones, techno-centres, a dispersed settlement area, or even an agricultural and/or forested area within the Extended City.
The concept is mostly based on functional and experiential characteristics and, consequently, a single BLU may encompass very distinct morpho-typological patterns.

Considering that dispersed occupation expresses itself not only through the existence of isolated buildings, but also through small fragments of concentrated buildings which are only recognized as urban dispersion when looked at on a broader scale, the possibility of using a unit more detailed than BLU was refused, because it wouldn't allow the recognition of this reality.

Thus, the analyses carried out so far highlight BLUs as the most suitable unit to identify dispersed occupation on a local scale.

The adoption of BLUs as the study unit also has the advantage of enabling the recognition of multiple morpho-typologies of urban dispersion, taking into account their agro-forestry uses and their collective practices.

3. Base Land Units Delimitation

To delimit BLUs, with operative and/or analytical purposes, it is necessary to adopt differentiating attributes. A detailed description of these attributes, as well as of the best methods for their identification, is presented in Carvalho, Pais and Gomes (2010).

BLUs, as experiential units, are mainly delimited through their uses, their functional/structural organization and, consequently, the presence of barriers and boundaries. The legacy of the “neighbourhood unit” concept, and the idea that BLUs’ area is defined according to a minimum public service/ number of residents, makes “dimension” other essential attribute to its delimitation (especially in the analysis of residential units).

The methodological sequence adopted to delimit BLUs starts with a preliminary identification of the Extended City, an area that integrates the city centre and its nearest surroundings, including agro-forestry interstitial spaces.

To do so, one uses a method called "Empirical Knowledge on Cartography and/or Aerial Photography", which consists in gathering a set of privileged territory experts that, knowing the research conceptual framework, delimit territorial units on cartography.

Through this method it is possible to sketch a first delimitation of the Extended City, based on the recognition of key barriers/boundaries and dominant land uses, with particular attention to the presence, or absence, of buildings. Additionally, physical networks that structure the territory are also considered in this preliminary delimitation, as well as the existence of infrastructure and services that, by their characteristics, should be integrated in the Extended City area.

After this first approach, one should delimit and define building ensembles within the Extended City. To perform this task a method called "Identification of Building Ensembles by Digital Method" was created; its explanation will be further presented in the current paper.

The application of the “Digital Method” results in three types of building ensembles: "continuous", "dispersed" and "rarefied". Their spatial definition and typification is a very precise reference to the following steps of the methodological sequence.

Next, the final delimitation of the “Extended City”, “City Parts” and “BLUs” is held through "Empirical Knowledge on Cartography", complemented by statistical data and taking into account the results of the "Identification of Building Ensembles by Digital Method" previously performed.

The "Empirical Knowledge on Cartography" is very helpful at this stage, allowing the identification of two essential attributes: existing barriers/boundaries and land uses, facilitating also the recognition of networks that internally structure the Territorial Units, which is crucial to BLU.

The use of statistical data supports the empirical method, providing precise information about the social characteristics of the residents and about the size of the population and number of buildings in each Unit. It also provides information on services and infrastructure provision.

After de delimitation of BLUs in an Extended City, one intends to characterize its occupation, which, considering the objectives of this Research, means distinguishing BLUs of dispersed occupation from other types of units (unbuilt, concentrated...).

To accomplish this task a methodology that comprises three different methods was developed:

- Identification of Building Ensembles by Digital Method;
- Calculation of the Disaggregation Index of Continuous Building Ensembles;
- Criterion for Identifying BLUs of Dispersed Occupation.

A detailed description of each phase is presented next, as well as the results of its application to the Research Project's case studies (Évora and Aveiro-Ílhavo).

4. Methodology for Identify Base Land Units of Dispersed Occupation

4.1 Identification of Building Ensembles by Digital Method

This method resorts to Geographic Information Technologies (ArcGIS) and consists of an aggregation of buildings, based on maximum distances between them, to which marginal strips of road sections directly serving them were added.

This aggregation allows the identification of continuous, dispersed and rarefied ensembles, each reporting to a successively larger distance between buildings.

The distances considered in the abovementioned exercise (which will be explained further on) are presented in the Table 1.

Table 1 – Distances and Areas Considered in the Method

	Continuous Ensembles	**Dispersed Ensembles**	**Rarefeid Ensembles**
Buffer radius of each building	10m	45m	80m
Buffer radius of road sections that marginate buildings	40m	80m	120m
"Islands" and "Peninsulas" Size	≤ 5.000 m^2	≤ 10.000m^2	≤ 20.000m^2

It should also be mentioned that:

- Only buildings with covered areas of at least 30m^2.
- Ensembles of less than five buildings are disregarded.
- Areas corresponding to "islands" and "peninsulas" are added (small spaces inside each ensemble).

The method is essentially digital. However, it demands some manual checks and additions, namely regarding the inclusion of road sections that are part of the ensembles' internal structure and of "peninsulas" (areas partially interiorized in the ensembles).

One should bear in mind that each building's buffer, multiplied by two, equates the maximum distance between two buildings to include them in the same ensemble.

The criterion behind the distances defined was that of two buildings belonging to the same ensemble whenever the distance between them allows enough space for one lot and the construction of one building (and no more), characteristic of the urban fabric in question.

Specifically, to generate Continuous Ensembles, is applied a buffer radius of 10m (distance between buildings = 20m), translating the following situation:

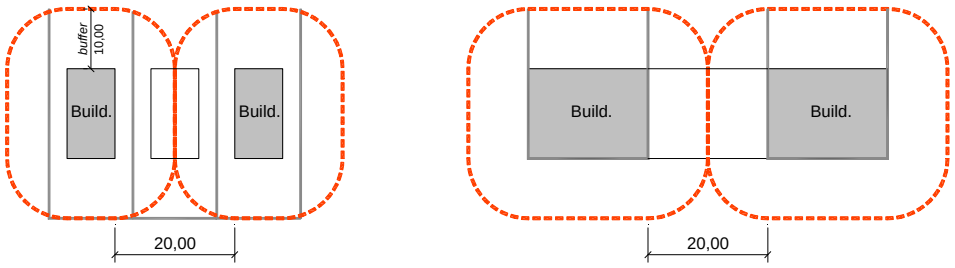


Figure 1. Buffer radius in Continuous Ensembles.

To generate Dispersed Ensembles is applied a buffer radius of 45m (90m distance between buildings), based on parcels of 50m x 100m = 5.000m^2 (minimum area for horticulture use)[34] , as presented in the next Figure.

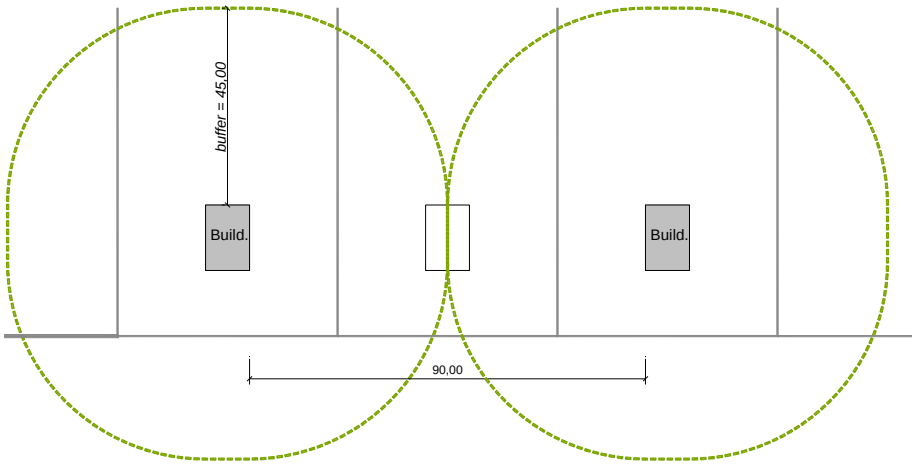


Figure 2. Buffer radius in Dispersed Ensembles.

To generate Rarefied Ensembles is applied a buffer radius of 80m (distance between buildings = 160m), based on parcels of 15.000 m^2 (85m x 170m), dimension between the minimum area for horticulture use (0,5ha) and the one for tillable land (2,5ha)[35], which can be translated in the following scheme:

[34] Decree n.º202/70, of 21 de April
[35] Idem

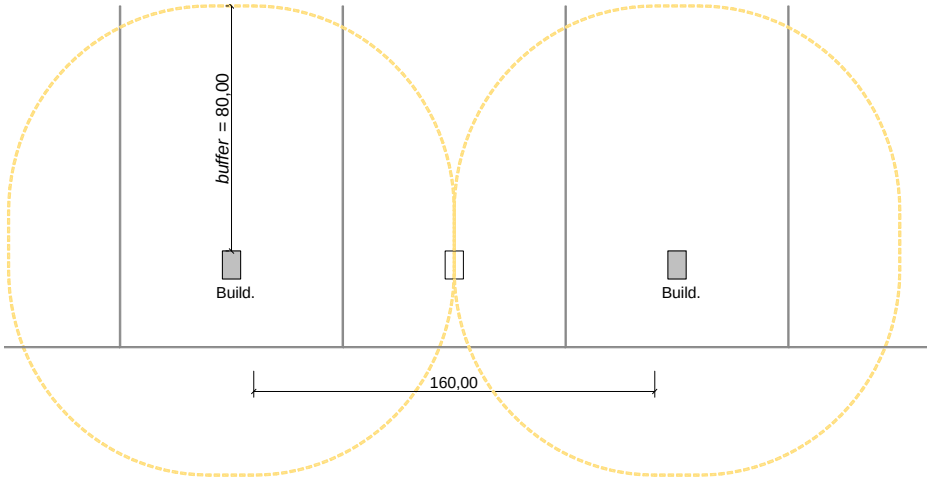


Figure 3. Buffer radius in Rarefied Ensembles.

The road sections that surround buildings belonging to the ensemble or those essential to its internal connectivity are included in the initial ensemble area.

The road buffer consists of two strips, one on each side of the way's axis; its respective depths coincide with those of the buildings' buffers, in standard situations for each ensemble typology, as shown in Figure 4.

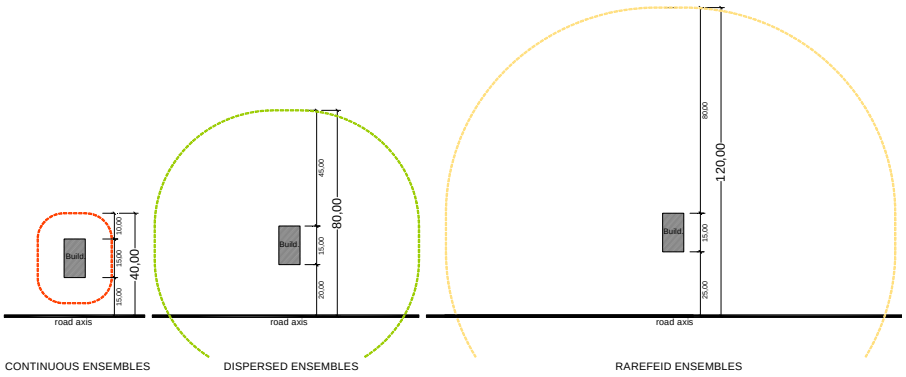


Figure 4. Road buffers in Continuous, Dispersed and Rarefied Ensembles.

In relation to the majority of digital methods of building aggregation developed by others, this one is different in the following aspects:

- It considers three different types of buffers, allowing the identification of three distinct types of building ensembles; while other methods consider a single aggregation buffer.
- It considers a 10 meter buffer to identify Continuous Building Ensembles, which is a very small radius when compared with other methods (that usually use buffers of 50 meters).
- It includes the roads' influence area around buildings, considering that these sections correspond to an existing building capacity.

- It disregards the small unbuilt areas located inside the ensembles, assuming them as public spaces supplementary to built occupation.

The building ensembles that result from the application of this method can be studied in-depth, calculating parameters such as area, perimeter, quantity of building area, implantation area, among others, for each one of the ensembles.

With the aim of studying dispersed occupation, the results of applying the method to the case studies (Évora and Aveiro-Ílhavo) enabled, in the case of this research, to conclude that the presence of Continuous Ensembles is not always synonymous of concentrated occupation. For example, in Aveiro-Ílhavo most of the Continuous Ensembles located outside the city centre are linearly extended and occupy agro-forestry areas, corresponding to a specific type of dispersed occupation. At the same time, one can note the existence, in both cities, of very small Continuous Ensembles, isolated or surrounded by Dispersed and Rarefied Ensembles that also contributes to urban dispersion.

4.2 Calculation of the Disaggregation Index of Continuous Building Ensembles

Having recognized the existence of Continuous Ensembles that, on the scale of the Extended City, correspond to a dispersed occupation, it became necessary to find ways to distinguish them. To do so, an indicator called Disaggregation Index of Continuous Building Ensembles (DI) was created; the index takes into consideration:

- The Ensemble's Area, assuming that the shorter an ensemble is, the bigger its disaggregation within the Extended City is.
- The Building Occupation (implantation or construction index of the buildings incorporated into an ensemble), assuming that the shorter the building occupation index is, the bigger the disaggregation of an ensemble is.
- The Ensemble's Shape, assuming that the bigger the relationship between perimeter and area ($P/\sqrt{A}$), the bigger the disaggregation of an ensemble is.

DI's mathematical formula is based on the articulation of three indicators related to each of the aforementioned aspects. The construction of these indicators assumes minimum and maximum benchmarks, namely:

- Area Indicator (AI) – an aggregate ensemble has an area of 100ha or more; and an ensemble with maximum disaggregation is the one that has an area of 1ha or less.
- Building Occupation Indicator (BI) – an aggregate ensemble has an implantation index of 0.5 or over; and an ensemble with maximum disaggregation is the one that has an implantation index of zero (abstract value).
- Shape Indicator (SI) – an ensemble reaches the minimum disaggregation when the relation $P/\sqrt{A}$ is equal to 3.6 (figure corresponding to the shape of a circle); and an ensemble reaches the maximum disaggregation when $P/\sqrt{A}$ is equal to 13.6 (given the difficulty of setting a referential, this value resulted from practical experiences).

The DI is the result of a long experimental work that included the construction of each indicator and their pondered sum.

The adopted Disaggregation Index of Continuous Building Ensembles is presented in Figure 5 and consists in an indicator sum (area + building occupation + shape), assuming, however, that the area (AI) is the most import characteristic of a disaggregate ensemble.

The division of the sum by three (and not by four) corresponds to the ambition, faced with practical cases, to set the DI value between zero and one (since the indicators never reach their maximum values at the same time).

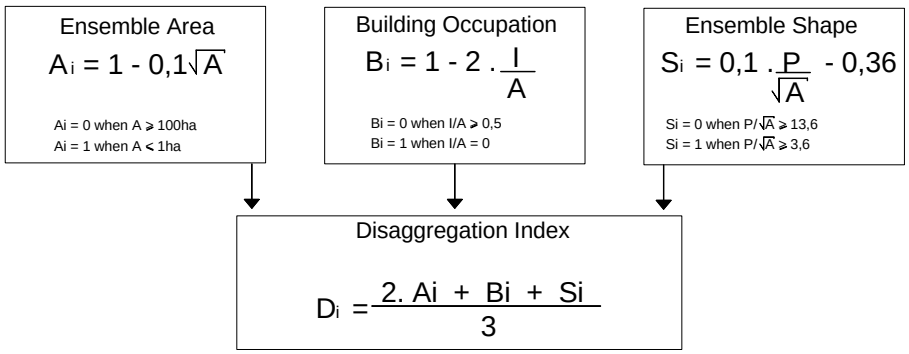


Figure 5. Disaggregation Index of Continuous Building Ensembles.

Two observations are worth making:

- The indicators that compose the DI, individually considered, can also provide important information about an ensemble.
- Theoretically, these indicators may be applied to Dispersed and Rarefied Ensembles; but to do so, they would have to be tested and adapted, probably assuming different mathematical expression.

4.3 Criterion for Identifying BLU of Dispersed Occupation

Through the methods presented so far in this paper, one can identify within a BLU:

- Continuous Building Ensembles more or less aggregated;
- Dispersed Building Ensembles;
- Rarefied Building Ensembles;
- Unbuilt Areas.

Considering the area of each ensemble in a BLU it is possible to create an indicator (called "Degree of Urbanisation") in which the area of Continuous Ensembles with a high aggregation index gives a maximum contribution to the degree of urbanization; and Unbuilt Areas are considered null.

However, alone, this indicator can interpret distinct situations as being similar; for example, a BLU composed by Continuous Ensembles surrounded by Unbuilt Areas can obtain the same Urbanization Degree than a BLU where Dispersed Ensembles are predominant.

Knowing that this indicator is not sufficient to identify BLUs of dispersed occupation, one considers that this type of BLU should ensure, in addition to a medium/low Urbanization Degree, a significant presence of Dispersed Ensembles and/or Continuous Ensembles with high Disaggregation Index as well, to prevent confusion with situations mostly concentrated, rarefied or unbuilt.

After conducting several experiments applied to the case studies, the adopted criteria are:

- A BLU of dispersed occupation is the one that has an Urbanization Degree of 0,07 or more and equal or inferior to 0,35, according to the mathematical formula presented in Figure 6.
- Concomitantly, a BLU of dispersed occupation must have, at least, one of these conditions:
  a) The Dispersed Ensemble's area within the BLU should be superior to the Continuous Ensembles area.
  b) The Average of the Disaggregation Index of Continuous Ensembles integrated in a BLU should be higher than 0,7.

$$UD = \frac{[Cx(1-di/2)] + (Dx0,4) + (Rx0,2)}{\text{LBU Area}}$$

C - Continuous Building Ensembles
di - Continuos Building Ensembles Disaggregation Index
D - Dispersed Building Ensembles
R - Rarefied Building Ensembles

Figure 6. "Urbanization Degree" - Mathematical Formula.

The "Urbanization Degree" of a BLU, presented in Figure 6, considers the three types of building ensembles which may exist within a BLU in the following way:

- The Continuous Ensembles' area contributes totally to the Urbanization Degree when their Disaggregation Index is zero. When this Index approximates the value 1, the Continuous Ensembles area contributes only with 50%. Thus, it is assumed that the lower the Disaggregation Index of Continuous Ensembles, the greater the Urbanization Degree is.
- The Dispersed Ensembles' area contributes with 40% to the Urbanization Degree of a BLU (therefore, less than the area of the more disaggregated Continuous Ensembles).
- The Rarefied Ensembles don't characterize an urbanised BLU, so they are the ones who influence this indicator less. Specifically, the Rarefied Ensembles' area should contribute only 20% to the Urbanization Degree, which implies, for example, that a BLU occupied by Rarefied Ensembles and Unbuilt Areas will obtain a UD close to the minimum values.

5. Application of the Methodology to the Case Studies

5.1 - The Research Project's case studies are two quite distinct cities. Évora is generally regarded as a concentrated city; while Aveiro-Ílhavo is usually associated to a more dispersed or diffused territory. The "Identification of Building Ensembles by Digital Method" in this two Extended Cities confirmed the enormous difference between both; however, it highlighted a reality that doesn't exactly match this dichotomy, in fact the Dispersed and Rarefied Ensembles occur mainly in the surroundings of Évora.

The results of the method's application, presented in Figure 7, show, as one would expect, that Évora is characterised by the presence of a large Continuous Ensemble that aggregates all the central urban area (historic centre and closest neighbourhoods).

Surrounding this central area, there are many small and isolated Continuous Ensembles, together with large Dispersed and Rarefied ones.

In Aveiro-Ílhavo the situation is rather different. There is a concentrated and Compact Continuous Ensemble (Aveiro city center, in the strict sense) and another ensemble, concentrated but not compact (which corresponds to Gafanha da Nazaré). In the north (Cacia area) the predominance of Dispersed Ensembles is evident. The rest of the Extended City is dominated by the presence of Continuous Ensembles organized linearly, that in distant areas from the Centre are surrounded by Dispersed Ensembles and by Unbuilt Areas.

In Aveiro-Ílhavo one should also note the nonexistence of Rarefied Ensembles, even in the most remote areas of the Extended City.

5.2 – Facing the need to differentiate types of occupation, namely through the analysis of their Continuous Ensembles, the already described Disaggregation Index (DI) was applied. In this particular research, the Continuous Ensembles were clipped according to the existence of strong physical barriers (water lines, highways…). This prior task was done before the DI application and through “Empirical Knowledge on Cartography”.

Results obtained, presented in Figure 8, demonstrate the effectiveness of the Disaggregation Index to differentiate Continuous Ensembles. Particularly, the results show:

– A single maximum aggregation situation (near zero value) that corresponds to Évora’s historical centre. In Aveiro-Ílhavo no ensemble has a disaggregation index similar to this.
– At the next level (disaggregation between 0.2 and 0.5, are the ensembles bigger than 40ha, that can be associated to a traditional concentrated occupation; in particular neighbourhoods surrounding Évora’s City Walls (Horta das Figueiras, Malagueira, Vista Alegre and Sra. da Saúde) and, in Aveiro-Ílhavo, the central nucleations of the two municipalities included in the Extended City, in addition to other areas (Barra, Costa Nova, Esgueira and Gafanha da Nazaré).
– Ensembles with a Disaggregation Index between 0.5 and 0.7 that (by their characteristics and their surroundings) seem to integrate a transition between concentrated and dispersed areas.
– Ensembles with high disaggregation (above 0.7) that correspond generally to small building ensembles, in some cases with irregular shapes and extended perimeters, surrounded by Dispersed or Rarefied Ensembles, or even Unbuilt Areas; not fortuitously located in the most remote and isolated areas of the Extended City.

5.3 – The identification of BLUs of dispersed occupation in Évora and Aveiro-Ílhavo, presented in Figure 9, proves the effectiveness of this methodology. Some cases, which in an empirical analysis were seen as dubious, are also positioned near the established mathematical limits. Therefore, the “Urbanization Degree” application should be tested in these “border cases” to verify the established limits, defining, if necessary, intermediate classes between dispersed, concentrated and unbuilt BLUs.

In particular, the application of the “Urbanization Degree” revealed, in the Évora case, that the BLUs of dispersed occupation are located, as one would expect, throughout the surroundings of the

city center, confirming the administratively established urban perimeter. Mostly, these units integrate Dispersed Ensembles, sometimes combined with small and disaggregated Continuous Ensembles.
One should also note the existence of two BLUs of dispersed occupation (Estrada de Lisboa/Sto. Antonico and Boa Morte/Garraia) with a very low Urbanization Degree (near 0.07). Therefore, these two cases must be analysed in a more precise and rigorous way.

The three BLUs that constitute the historical centre (Sto. Antão, S. Mamede and Sé e S. Pedro) achieve the highest degree of urbanisation, between 0.85 and 0.9. In fact, these BLUs do not get the maximum Urbanization Degree only because they integrate unbuilt areas along the City Wall.
In Évora there is an unbuilt BLU (with a degree of urbanisation under 0.07), which corresponds to the "Verde Monumental", a heritage area that integrates some convents and ensures ecological connections with the city surroundings.

In Aveiro-Ílhavo, the Urbanization Degree does not vary as widely as in Évora.
Specifically, the BLUs with an UD over 0.5 correspond to Aveiro center, Gafanha da Nazaré and Barra. In the next level one can find the BLUs that compose the centre of Ílhavo, Aradas and the expansions of Aveiro's central area to the south, crossing the National Road (EN109).
BLUs of dispersed occupation are mainly located in distant surroundings of Aveiro and Ílhavo centres and in the north part of the Extended City.

There were several situations very close to the established limits to distinguish the dispersed occupation (Cacia, S. Bernardo or Gafanha do Carmo are some of the BLUs whose Urbanisation Degree is near the mathematical limit between the concentrated and dispersed occupation). However, in general, the results of the application of this indicator, assessed from an empirical point of view, seem very reasonable.

Identifying BLUs of dispersed occupation through the presented methodology is therefore a starting point for more detailed analysis to verify the results obtained. The following Figures show the outputs of the three aforementioned phases.

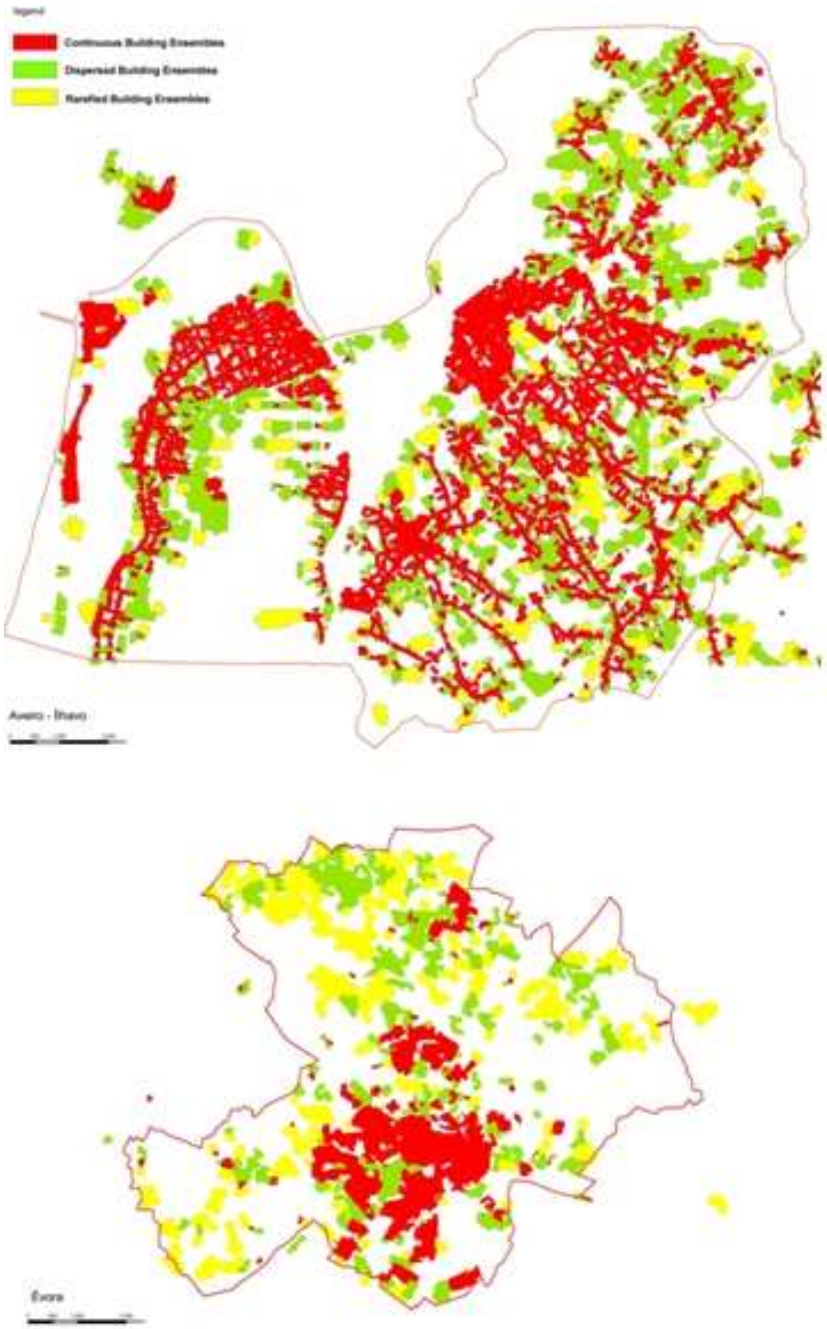


Figure 7. “Identification of Building Ensembles by Digital Method” - Overview of the application results to Aveiro-Ílhavo and Évora.

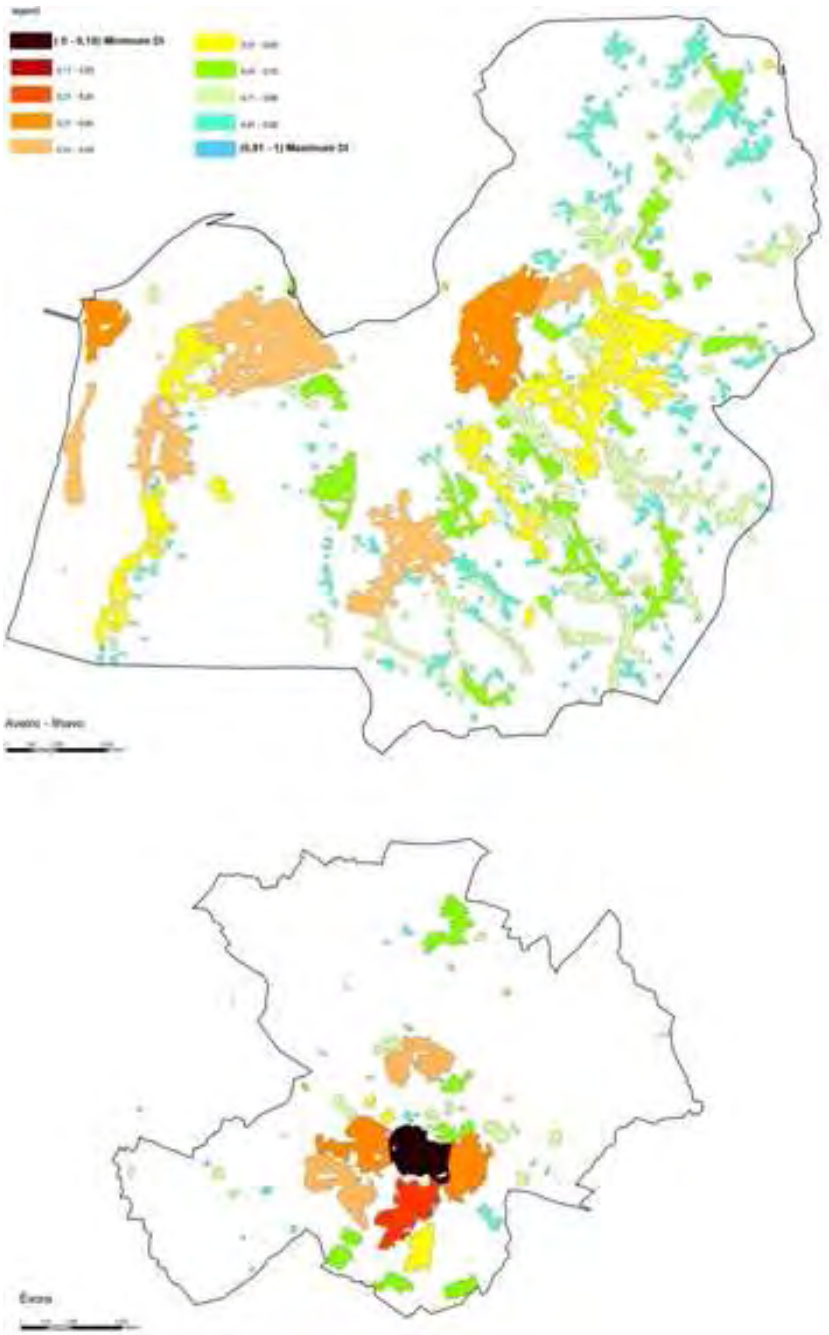


Figure 8. "Disaggregation Index of Continuous Building Ensembles" - Overview of the application results to Aveiro-Ílhavo and Évora

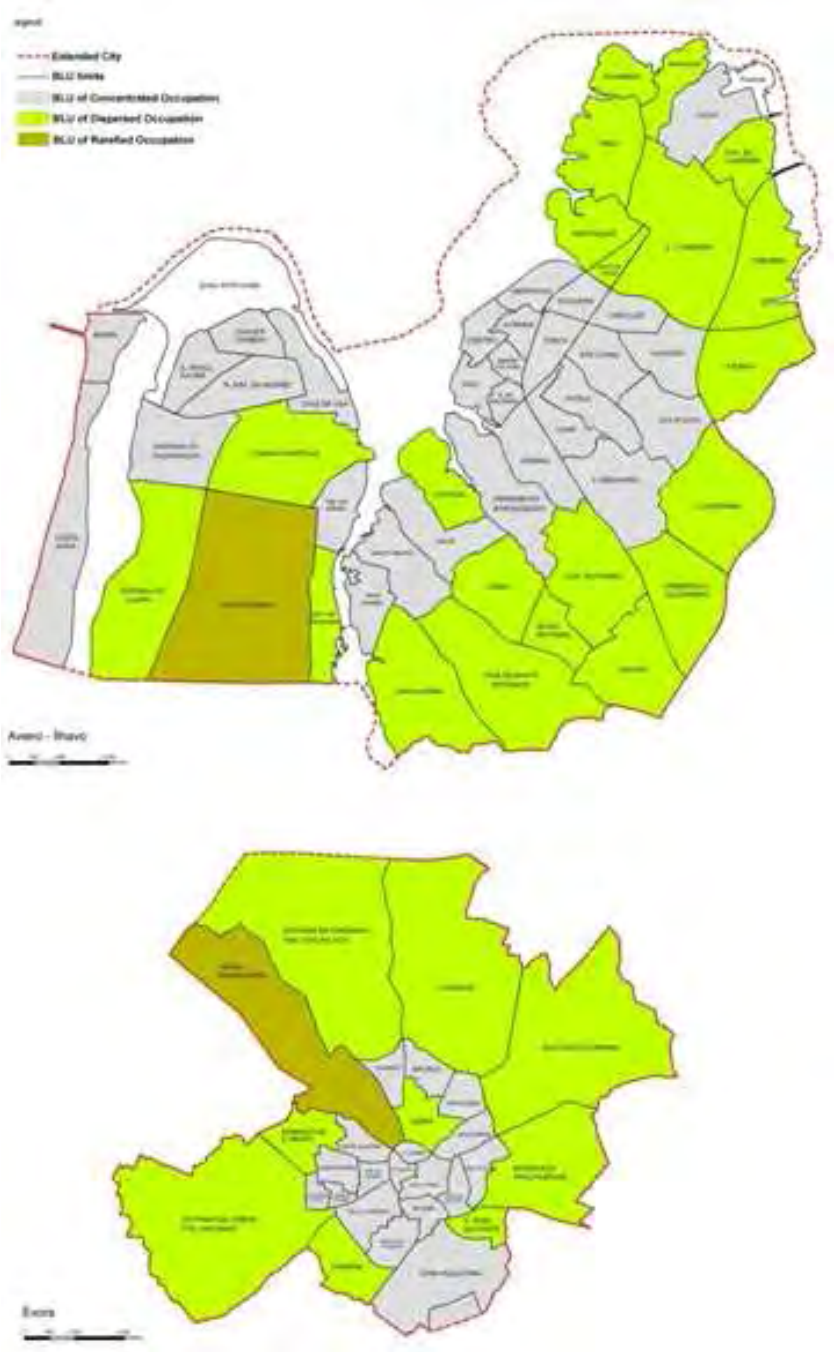


Figure 9. "Urbanization Degree" - Overview of the application results to Aveiro-Ílhavo and Évora.

6. Concluding remarks

The presented methodology is effective for identifying BLUs of dispersed occupation and, consequently, BLUs of concentrated occupation and unbuilt BLUs.

This methodology can be used on a national scale, assuming, however, the need of a prior identification/delimitation of BLUs (as described in this paper).

One should note that the delimitation of a BLU of dispersed occupation gives way to a new challenge, to characterise and typify it, finding specific dispersion morpho-typologies.
This will be, therefore, the next step of the current Research Project.

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The Urban Green Structure: Form and Function

Andreia Quintas, Maria Curado

Department of Geosciences, Environment and Landscape Planning. Faculty of Sciences of the University of Porto

CIBIO – University of Porto, andreia.quintas@fc.up.pt, mcurado@fc.up.pt

Phone/fax numbers: 00 351 933725649 - 00 351 220 402 009

The urban systems are characterized by its components, including their nature, organization, form, function and the interrelationship among each other and with other elements. These components may designate natural elements (such as natural features or green areas) or constructed elements (such as buildings and infrastructures). Urban systems have a biophysical component, but also a human dimension, constituted by the people who inhabit and use the urban space. The Urban Green Structure (UGS) is one of the subsystems that compose the urban system. It comprises areas, values and systems essentials to the urban balance, and includes not only natural values but also cultural values, since the urban environment is strongly influenced by the human presence. The UGS has a vital importance in the city, presenting multi-functionality, which relates to the three domains of sustainability: ecology, society and economy. These areas also contribute to the organization of the urban system and improve the image of the city. This work aims to study the relationship between the function and form/structure of the Urban Green Structure, with the analysis of the various typologies of spaces that compose this network (identified according to their function) and its organization in the city (based in its structure and form). It has the UGS of the municipality of Porto as the first case study, which was analyzed according to the social and ecological functions it fulfils, and its organization in the city, based in landscape metrics research.

Keywords: Urban Green Structure, Urban Systems, Multi-functionality, Urban Structure, Landscape Metrics

1 Introduction

1.1 Urban systems

Cities are complex entities, which consists of a "*set of intertwined elements, systems and functions*" (Llardent, 1982: 50 *in* Loboda and De Angelis, 2005: 129). Due to its complexity, urban areas have been analyzed by researchers and planners as real ecosystems. In this perspective, they can be defined as "*a biological community where humans represent the dominant or keystone species and the built environment is the dominant element controlling the physical structure of the ecosystem*" (World Resources Institute, 2000: 141 *in* Wali *et al.*, 2003: 2).

As all systems, urban areas have a structure, function and their own dynamics, resulting from interactions among its components and between them and the outside. The urban processes and development are dependent of these diverse and numerous internal and external relationships (Oliveira *et al.*, 2006).

The urban structure is defined by its constituent elements, while its function is associated with the variety of existing services (Pickett and Cadenasso, 2008).

The cities are structurally organized into four main components: the buildings, the built infrastructures, the technical infrastructures and green infrastructure (Sandström *et al.*, 2007), which are complemented by the social element. "*The quality of the urban environment depends on physical elements and socioeconomic conditions as well as on the culture and values of urban communities*" (Alberti, 1996: 388).

The urban areas provide various services and opportunities, which transform the human living in a more "*pleasant experience*" (Hasan, 2008: 6), becoming attractive clusters for the population,

who leaves the rural areas and migrates to urban and peri-urban environments, searching for a better quality of life. Currently, about half the human population (more than 3 billion people) live in cities, and it is expected that, by 2030, this number will become the double (UNFPA, 2007; UNUIAS, 2003).

Urban areas grow, both in population and in surface area, expanding themselves in the territory and encompassing neighbour towns and villages. They no longer have a municipal dimension, but a more comprehensive scale; they are no longer merely cities, but metropolis.

Although the cities represent a source of opportunities for its residents and users, they generate problems, arising from the urban growth and the constant population increase. To face these serious problems, is necessary to respond and find solutions with urgency, as fast as cities are evolving.

Thus, cities and urban areas are particularly interesting areas of study, due to the multiplicity and concentration of elements they comprise, and because it is where are being produced more quality of life problems, which is imperative to resolve. "*Urban areas are therefore important strategic locations for pursuing the goal of promoting all dimensions of sustainability*" (European Commission, 2006: 3).

It is necessary to implement a planning and management policy of cities and urban areas, taking into account the subsystems integrated, sustained by its components and their potential, in a holistic and conjugated way, in order to generate sustainable growth and a higher quality of life of the urbanites. "*In the case of the urban environment, it is both possible to define the city as one single ecosystem or to see the city as composed of several individual ecosystems*" (Bolund and Hunhammar, 1999: 294) and the promotion of inter-relationships between urban subsystems is essential for equilibrium the city.

1.2 Urban Green Structure

One of the urban components with strong potentialities, due to the multiplicity of functions it fulfils, is the green structure or ecological structure. Despite humanity becomes increasingly urban, yet it still relies on nature for its survival (Bolund and Hunhammar, 1999) and, according to McGranahan and Marcotullio (2005: 811), "*as long as people continue to live in urban areas, it is important for their well-being that the urban air be healthy to breathe, that there be sufficient water of adequate quality to meet domestic needs, that the urban landscape be pleasing to the eye, that the urban climate be comfortable, and generally that the urban environment be healthy and pleasant for people to live in*".

The green areas, in the urban context, do not fulfill merely an ecological and/or environmental role, presenting an important social and even economically value. The benefits of green areas have been demonstrated in several studies (for example: Loboda and De Angelis, 2005; McPherson, 1992; Bolund and Hunhammar, 1999; Ferguson, 2002; Chiesura, 2004), proving its value in the ecological, economic and social domains, that form the three pillars of sustainability. Thus, it can be said that these spaces are promoters of urban sustainability and quality of life.

Regarding the ecological level, green spaces provide habitats that allow the conservation of the biodiversity and the maintenance of the natural genetic found, both of flora and fauna. These are spaces that promote the exchange of matter, organisms and energy, providing the performance of the natural processes, essential to the city's ecological balance and avoiding the occurrence of

catastrophic events, such as floods and landslides. These are also areas that supply environmental services, allowing a better quality of air, water and soil, contributing to the microclimatic amelioration and noise mitigation, among others benefits.

The integration of green areas in the city allows a greater connection between man and nature. But these areas possess other social benefits, since they create greater opportunities for social activities and uses, such as recreation and leisure, sports and education. These are spaces that promote sociability and learning, contributing to an increase of the physical and mental health and the society development. These spaces result from the urban development processes, but also evolve according to the city's history, acting as landmarks of its culture.

Regarding the economic factor, the urban green spaces can provide products, such as raw materials, food and energy. They are responsible for the environmental services, mentioned above, reducing the expenditure on prevention and costs of the recovery of the landscape. These spaces also provide employment and services.

In the planning perspective, a linkage between residential and services areas, through a structure of high quality green spaces, has the effect of improving the accessibility and attractiveness to job centers and local infrastructures. Thus, contributes to improving the image of the city.

The urban green areas also have an important role at the aesthetic level, allowing the city's beautification and valorization of the spaces.

In general, the evaluation of the numerous advantages provided by the urban green areas is a very difficult task, due to the nature of these benefits (and its multiplicity) and the difficulty of assigning them a specific value, measurable and comparable (Saz-Salazar and Koster, 2008).

The Urban Green Structure (UGS) is composed by the spaces, values and systems, which are essential to the balance of the urban system. Due to its composition and functions it fulfills, it constitutes an opportunity for an integrated planning of the territory, seeking a sustainable urban landscape.

However, in planning policies, this structure often appears in the background, and it is seen more as a constraint than as an opportunity and a potential for the urban development. And, in general, it is treated separately from other urban subsystems, instead of a joint and articulated approach.

In Portugal, between the years 1999 and 2009 (since publication of the Legal Regime of the Instruments of Territorial Management, through the Law-Decree n. 380/99, September 22, until one of the last amendments, by Regulamentar-Decree n. 11 / 2009, May 29), the Urban Green Structure was an element of obligatory identification in the elaboration of the Municipal Master Plans. However, by the end of 2008, only a small number of municipalities had considered this category of urban soil, and identified the Urban Green Structure (Quintas and Curado, 2009).

In order to achieve an appropriate urban planning, it is necessary that the green spaces can correctly carry out the functions that they provide, being properly planned and managed (Cavalheiro and Del Picchia, 1992), with the integration of the natural element with other urban elements and sub-systems. "*The quality and viability of cities depend largely on the design, management and maintenance of urban green as well as on open and public spaces that make up an important social constellation and offer a visual representation of urban quality*" (Levent and Nijkamp, 2004: 1).

1.3 Objective

This article aims to analyze the potential of the Urban Green Structure in the urban system, by investigating how this network is organized in the city, and the roles it plays, in a comparison between form and function.

It also examines how this structure relates to other urban elements, with the objective of provide clues to understand how this functionality can be enhanced, in order to fill needs of the society, providing a better quality of life for the city's residents and users.

Due to the complexity of the subject, this article will address more specifically the spaces that comprise the Urban Green Structure, in a perspective of the different typologies that they can assume, through a comparative analysis of its form / structure and function, both in an ecological and social level.

The first case study is the city of Porto, which is the heart of the Metropolitan Area of Porto, the second most important urban center in Portugal.

2 Methodology

The comparative analysis of the Urban Green Structure of Porto, in a perspective of form and function, was carried out in this research, based on the UGS defined in the Municipal Master Plan of the municipality of Porto (2006).

The Urban Green Structure is studied from a landscape ecology viewpoint, in which each of the constituting spaces is considered as a patch, and its typologies as a class, in an urban matrix. "*Landscapes as ecological units with structure and function are composed primarily of patches in a matrix*" (Forman and Godron, 1981: 733).

The landscape can be studied though spatial metrics of analysis, which can be distinguished into three main types, related: to the patch (or individual space), class (or typologies) and landscape. According to the classification defined by McGarigal *et al.* (2002), and which serves as a basis for the Fragstat software, the landscape metrics can be divided into seven categories: a) area, density and edge, 2) shape, 3) core area, 4) isolation and proximity, 5) contrast, 6) contagion and interspersion, 7) connectivity and 8) diversity. But they can be much more specific, with the analysis of the composing elements or characteristics of the individual patches (Cook, 2002).

"*The size and shape of the patch and its edge are particularly important patch characteristics that can affect species habitat, resource availability, and competition*" (Alberti, 2005: 172), but also influence the ability of space to accommodate and provide social activities. According to Ferguson (2002), in general, larger green areas can also contribute better to reduce climate change. However, this relationship may not be direct, because the functionality is also dependent on other factors, such as the composition and location of the patch.

Here, the landscape metrics associated with the size and connectivity of the patches will be discussed in greater detail, particularly in relation to the individual spaces (patches) that comprise the Urban Green Structure of Porto and the typology (class) they represent.

This analysis consists of two steps:

1. In the first phase, it is designed a Typological System, in which new types of spaces constituents of the UGS are defined, based on the function they perform in urban areas. This Typological System results from an analysis of various bibliographic information, including studies and systems of green spaces, defined in different areas and distinct scales, with a subsequent adaptation to the reality found in the city of Porto. It is concretized in a typological map of the UGS of Porto, where it can be visualized how the various typologies are spatially distributed.

2. Subsequently, and based on the defined typologies, a comparative scheme is made, relating them with the functions performed, representing the level of relevance of the functions that each typology perform.

In this second steep, the typologies of UGS spaces are analyzed in greater detail, and the following three types of analysis are performed:

2A) Analysis of the landscape metrics, at the level of patch (the UGS constituent spaces), class (typology) and landscape (Urban Green Structure of Porto), based in the Fragstat 3.3 software (McGarigal *et al.*, 2002);

C2) Analysis of the ecological function performed by the typologies of UGS, and its relationship with other urban elements of natural character;

C3) Analysis of the social function performed by the typologies of UGS, and its relationship with other social elements; in this article, are analyzed more specifically those related with recreation and leisure.

The analysis typology / function (described in C2 and C3) is cartographically represented in a map, with the support of the ArcGIS 9.3 software, where can be observed patterns and determined needs and opportunities, providing clues for urban landscape planning management, based on the potential of the Urban Green Structure.

The system presented here has a generalist character, based only on the typologies of spaces that integrate the Urban Green Structure. It serves as a basis for further investigation, being conducted at the moment, about the patches individually, since each space has a unique character, with a particular composition, organization and functionality. The functions and relevance of the urban green areas can thus be subject to further analysis, based on parameters such as area, origin, species composition, structure, etc. (Rehackova and Pauditsova, 2004), providing indications for the role they play in the urban environment and how this can be promoted.

3 Case study: the city of Porto and its Urban Green Structure

The city of Porto is the core of the Metropolitan Area of Porto, the second most important urban centre in the country, formed by a process in which the "*urban sprawl agglutinated a set of peripheral urban areas moving in an oil slick way*" (Caetano *et al.*, 1999).

With a prime location, standing in the northwest of Portugal, near the Atlantic Ocean and the Douro River, Porto has a long history, to which are attached the green spaces, since they have evolved and grown according to the development of the city and the needs and tastes of the population and the time periods (Madureira, 2002). Porto has a wide variety of gardens and green

spaces, whose characteristics are related with the identity of the city and reflect the bond between population and nature (Andresen and Marques, 2001).

According to a study made by the municipality, the city of Porto can be distinguished into four main areas: the Historic Centre (comprising the parishes of Miragaia, São Nicolau, Sé and Vitória), the Traditional Centre (composed by the parishes of Bonfim, Cedofeita, Massarelos and Santo Ildefonso), the Occidental Zone (comprising the parishes of Aldoar, Foz do Douro, Lordelo do Ouro and Nevolgilde) and the Oriental Zone (comprising the parishes of Campanhã, Paranhos and Ramalde) (CMP, 2003).

With an area of 4.129 hectares, Porto has an Urban Green Structure with an surface area of 818,776 hectares, representing about 20% of the area of the municipality and a ratio of 38 m^2 of UGS per inhabitant (in a population of 216.080 individuals in 2008, according to INE – National Institute of Statistics).

In a highly urbanized municipality, all the soil is classified as urban, according to its Municipal Master Plan (MMP) (2006). This planning instrument also identifies the Urban Green Structure as a category of urban soil. In accordance with the regulation of MMP, the UGS has the following objectives "*the preservation and promotion of the ecological and environmental components of the municipality territory, ensuring the protection and valorisation of the relevant heritage and landscape elements, the protection of the areas with greater biophysical sensitivity and the promotion of the leisure and recreation systems*" (Resolution of the Council of Ministers No. 19/2006, February 3).

The Urban Green Structure of Porto is not evenly distributed over the whole municipal territory, and the peripheral parishes have a greater amount of spaces belonging to the UGS, with the largest areas (Figure 1). The presence of the Porto City Park (UGS space with larger surface area), distributed by parishes Nevogilde and Aldoar, with a surface area well above the remaining spaces, contributes to the higher rate verified in these parishes.

The parishes belonging to the Historical Centre and Traditional Centre are the ones with the lowest values of UGS, which, in the case of São Nicolau and Santo Ildefonso, not reach the 3m^2 per capita (Table 1).

4 Results

4.1 Typological System of Spaces

The urban green areas are very different, both in the form and the function that they fulfill, and, according to that diversity, they can be differentiated into distinct typologies. The adoption of a typological system is related to the need to systematize the spaces according to their characteristics, in order make a comparative analysis between the various classes that they assume, including their locations, their structure and organization within urban environment. The typologies also reflect directly the study area and analysis scale.

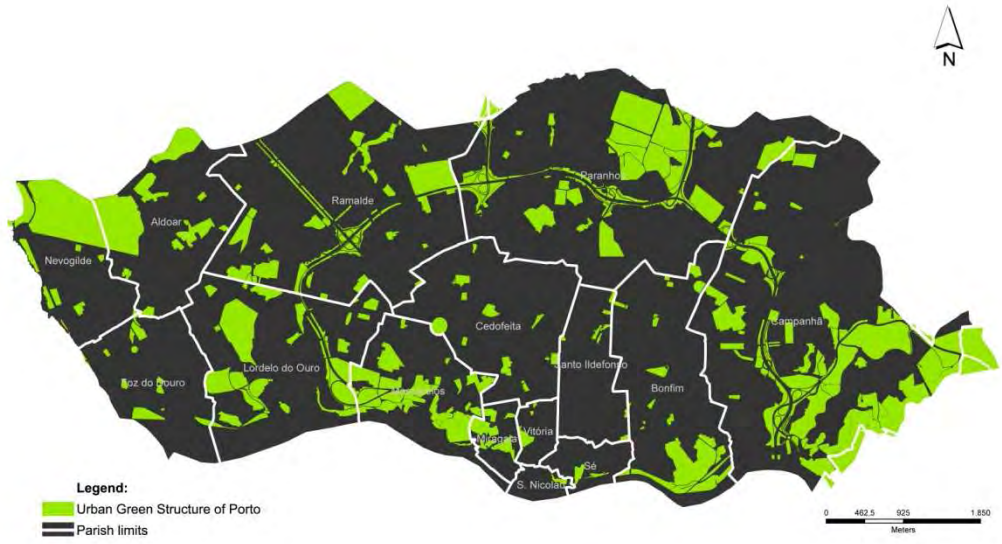


Figure 1. Distribution of the Urban Green Structure in the parishes of the municipality of Porto.

Table 1. Surface area of the Urban Green Structure per capita and per parish area in the municipality of Porto

Parish	**Zone**	**Parish area (ha)**	**Resident population (pers)**	**Population density (pers/m2)**	**UGS area (ha)**	**% UGS per ha (-)**	**% UGS per pers (m^2/pers)**
Miragaia	Historic Centre	42,652	2 810	65,88	10,843	25,42%	38,59
São Nicolau		25,039	2 937	117,30	0,867	3,46%	2,95
Sé		48,535	4 751	97,89	2,29	4,72%	4,82
Vitória		32,842	2 720	82,82	2,518	7,75%	9,26
Bonfim	Traditional Center	309,657	28 578	92,29	43,265	13,97%	15,14
Cedofeita		270,663	24 784	91,57	12,897	4,76%	5,20
Massarelos		194,505	7 756	39,87	64,024	32,92%	82,55
Santo Ildefonso		123,654	10 044	81,23	3,682	2,98%	2,97
Aldoar	Occidental Zone	240,839	13 957	57,95	87,771	36,44%	62,89
Foz do Douro		188,502	12 235	64,91	20,497	10,87%	16,75
Lordelo do Ouro		364,24	22 212	60,98	82,39	22,62%	37,09
Nevogilde		184,209	5 257	28,54	83,51	45,33%	158,85
Campanhã	Oriental Zone	804,336	38 757	48,18	293,426	36,48%	75,71
Paranhos		716,876	48 686	67,91	220,078	30,70%	45,20
Ramalde		582,552	37 647	64,62	96,671	16,59%	25,68

Several typological systems can be found in the literature (for example, Cooper and Francis, 1990; Bell *et al.*, 2006; Esbah, 2005; Carr *et al.*, 2005; Randup, 2009), and its study served as a basis for this work, with an adaptation to the site-specific conditions of the case study.

Thus, the following typologies of spaces were identified, according to their functionality in the urban system:

a) Civic Spaces - these are areas of centrality, social gathering and sharing, having, in general, a great importance in the organization of the city. Its main function lies in the crossing, interconnection and sharing, both of space and people. This typology may include, for example, squares and avenues.

b) Recreation Green Spaces - these areas mainly fulfill social functions, such as recreation, leisure, social meeting, education or sport. This typology may include parks, gardens and other recreational areas, whether public or semi-public.

c) Private Green Spaces - these are areas with a private character, which usually have a high ecological or cultural value or are fundamental in the organization of the city; on several occasions these spaces are related to the history and culture of the city. This typology may include parks or private gardens, backyards or green spaces associated with multifamily housing.

d) Production Green Spaces - these are areas whose primary function is the production of goods and raw materials, such as food, wood and biomass. This typology may include spaces for farming or forestry, such as: urban agricultural areas, community gardens and urban forests.

e) Equipment Green Spaces - these are spaces that are associated with infrastructures and equipments, being more related to the ornamentation and decoration, fulfilling mainly an aesthetic function.

f) Protection Green Spaces - these spaces are associated with the ecological and environmental protection. This typology may be associated with natural elements such as water lines or areas with high slopes, areas of high biological value, or they may be space-channels.

g) Urban voids - these are left over spaces, which remain fragmented in urban areas, usually resulting from urban development operations or consisting on abandoned areas. Although they do not exhibit a social function, in general, these are areas with high ecological value.

These typologies of green spaces that comprise the UGS of Porto are also distributed in a quite heterogeneous way, although scattered throughout the municipality. The Production Green Areas are mainly located in the parish of Campanhã, in the east of the municipality, where are also the largest areas of Urban Voids. On the opposite, there is a predominance of the Recreation Green Spaces in the parishes located in the west. As for other types of spaces, they have an identical distribution among the parishes of Porto, which indicates equity in the functions performed, at territorial level (Figure 2).

4.2 Analysis of shape and function - Functions associated with the typologies of green spaces

The green areas have a wide variety of functions in urban areas. The perspective of these spaces and the benefits by them provided has changed over time, according to the ideologies, needs and historical events occurred at distinct periods.

These benefits provided by the green areas to the city may directly or indirectly serve the human population on their needs. These functionalities are verified at various levels, from the ecological and environmental, to the social and economic development, contributing to urban sustainability.

In this study, it is considered that the green areas have six main functions, at the urban level: ecological / environmental, social and recreational, cultural, productive, urban structure and aesthetics. These functions are complemented by others, performed direct or indirectly by these spaces. In the following table, these six functions presented above are compared to the previously defined typologies (Table 2).

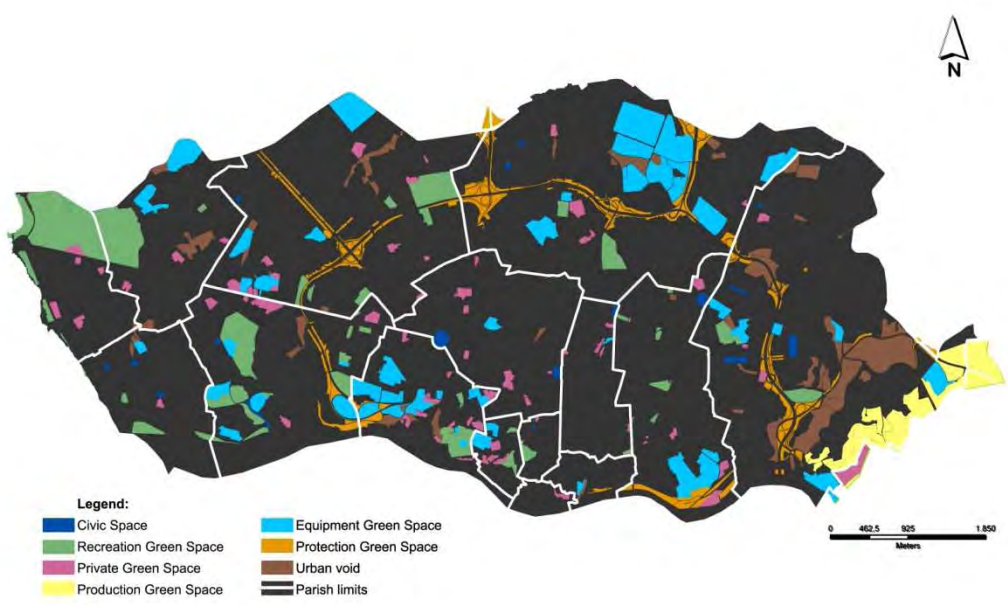


Figure 2. Typologies of spaces of the Urban Green Structure of Porto.

Table 2. Schematic comparison of the main functions that the typologies of UGS spaces can fulfill

Function **Typology**	**Ecologic / Environmental**	**Social - recreational**	**Cultural**	**Economics - Productive**	**Urban structure and organization**	**Aesthetics and image of the city**
Civic Spaces	+	++	+		+	++
Recreation Green Spaces	+	++	+			++
Private Green Spaces	+		++			+
Production Green Spaces	+		++	++		
Equipment Green Spaces	+	+	+		+	++
Protection Green Spaces	++				++	+
Urban Voids	++					

In this article, the social and ecological functions of the Urban Green Structure spaces are analyzed in greater detail, through a study of form, function and organization in the city. The study here presented focus only on the scale of spaces typologies, being necessary a detailed analysis of each individual space (patch), where each parameter of characterization is studied more specifically. The functionality of the spaces is dependent on their composition, form and structure, but also on the relationship between these factors.

This study, aiming to analyze the relationship between structure and functionality of spaces, was conducted in the following three aspects:

A) Analysis of the landscape metrics at the level of patch (the constituent areas EEU), class (typology) and landscape (Urban Green Structure);

B) Analysis of the ecological function performed by the typologies of UGS;

C) Analysis of the social function performed by the typologies of UGS.

4.3 Analysis of landscape metrics - the size and connectivity of the parcels

A green structure is formed by elements which act as patches and corridors of the landscape (Baschak and Brown, 1995). These different patches have distinct characteristics, such as the area, shape and location, which promote and affect its functionality.

The Urban Green Structure of Porto is comprised of various typologies of spaces, and it is divided into 464 individual patches. These are distributed among different typologies, according to the following table (Table 3).

Table 3. Analysis of the size of patches of UGS, based on classes (typologies) of space

Typology	Number of Patches (NP)	Minor Patch Area (m2)	Major Patch Area (m2)	Mean Patch Size (MPS) (m2)	Total Class Area (m2)
Civic Spaces	18	865	29.914	8.638	155.493
Recreation Green Spaces	41	742	799.838	49.182	2.016.487
Private Green Spaces	80	675	41.441	8.307	664.614
Production Green Spaces	13	4.978	183.816	60.286	783.729
Equipment Green Spaces	50	3.545	199.841	47.040	2.352.003
Protection Green Spaces	226	2,7	34.914	4.218	953.342
Urban Voids	36	1.018	499.892	35.058	1.262.117

Through the analysis of the landscape metrics associated with patch size, the table shows that the Protection Green Spaces are those with the smallest areas, though they are in a higher number. The Production Green Spaces have a smaller number of patches, but present the larger dimensions, lying mainly in the east part of the city. The Equipment Green Spaces are those with the higher proportion in the UGS, being followed by Recreation Green Spaces. This latest typology has a mean patch size

rather high, and comprises the largest patch of the UGS: the Porto City Park. The Civic Spaces are those with the lower proportion, having, in general, rather small areas (Figure 3).

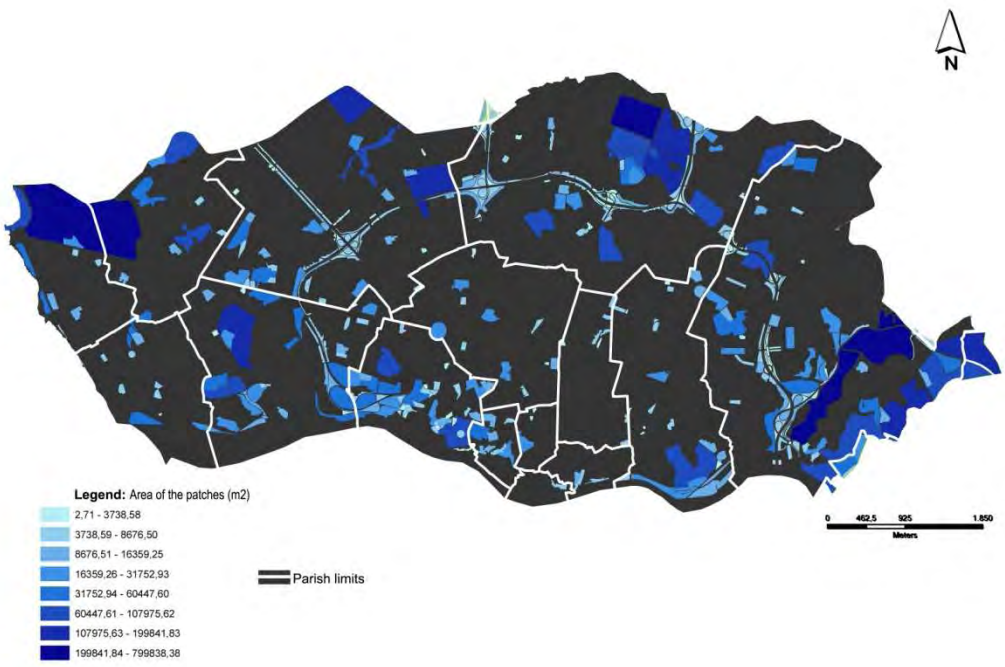


Figure 3. Area of the patches belonging to the Urban Green Structure of Porto.

The connectivity (and fragmentation) is a very interesting metric, especially when it comes to structures, being responsible for the existence of interconnections between the elements, and allowing the realization of trades and flows of matter, energy and organisms between the patches, along the landscape. Socially, the connectivity between the patches is also essential, allowing the access and movement of people.

The following tables (4 and 5) show a comparative analysis between the different typologies of spaces of the Urban Green Structure and the landscape metrics under evaluation, relating both to the class (typology) and the landscape.

The metric Total Class Area (CA) refers to the area occupied by all the patches belonging to each class. Concerning the Urban Green Structure of Porto, it is shown that the classes Equipment Green Spaces and the Recreation Green Spaces occupy the highest proportions. While this metric is specific to the class, the Total Area (TA) is a metric of landscape that measures the area occupied by the Urban Green Structure as a whole.

The Distribution Proximity Index (PROX) is a metric that distinguishes the parcels that are isolated from those that are part of a complex, taking into account both the patch area, and the distance to nearest neighbor patch, assessing the level of connectivity and fragmentation. It is shown that the Production Green Spaces are the ones with the highest values for this metric, but the patches that belong to this typology occupy very limited areas, in the east of the municipality. The Civic Spaces, although its role in the interconnection of spaces, by themselves do not have a high connectivity value, requiring the presence of other spaces to fully assume their function.

The Patch Cohesion Index (COHESION) metric measures the physical connectedness of each class of landscape, while the Connectance index (CONNECT) refers to the physical continuity of a class (or a patch) across the landscape, taking into account the number patches of a landscape and its relationship with other patches of the same typology. For these two parameters, there is a great relevance of the Production Green Spaces, which have the higher values, while the Equipment Green Spaces have the lowest values. At the landscape level, the metric Contagion (CONTAG) assesses the degree of contiguity, in this case of the Urban Green Structure of Porto.

Table 4. Comparative analysis of the connectivity metrics, for the typologies of spaces in the Urban Green Structure of Porto

Typology	**Total Class Area (CA)**	**Proximity Index Distribution (PROX)**	**Patch Cohesion Index (COHESION)**	**Connectance Index (CONNECT)**
Civic Spaces	155.463	128.983	989.326	0,7246
Recreation Green Spaces	2.016.561	4.988.162	996.711	0,1773
Private Spaces	664.677	706.748	990.678	0,2331
Production Green Spaces	783.721	98.809.271	997.411	87.912
Equipment Green Spaces	2.351.996	898.280	996.193	0,0816
Protection Green Spaces	951.847	996.193	987.242	0,2785
Urban Voids	1.262.087	4.193.647	994.736	0,2903

It is important not only the size and connectivity, but also the diversity of the different spaces and typologies along the urban landscape, in order to provide more functionalities and opportunities. The diversity of typologies of spaces was analyzed based on the following landscape metrics shown in Table 5. Here, the Patch Richness (PR) metric is based on the number of different typologies of patches present in the landscape under analysis.

Table 5. Comparative analysis of the connectivity and diversity metrics, for the "landscape" in the Urban Green Structure of Porto

Total Area (TA)	**Patch Cohesion Index (COHESION)**	**Connectance Index (CONNECT)**	**Patch Richness (PR)**
8.186.352	994.253	0,2853	70.000

4.4 The ecological function in the typologies of Urban Green Structure of Porto

In the analysis of the ecological role played by typologies of the spaces belonging to the UGS, it was assessed the relation of this function with other elements in urban areas. Thus, a comparison of the UGN with natural elements (such as water lines and the existing green spaces) was made.

Regarding the water lines present in the municipality, there is a geographical correspondence between them and the areas of Urban Green Structure, as was expected. This associating is more pronounced in the more peripheral areas, where there are larger patches, than in the city center, where the strong impermeability and smaller green patches did not permit the existence of a strong structure. It is also apparent that the spaces with an ecologic main function have a greater relationship with the existence of water lines, being this relation essential for the correct performance of this function (Figure 4).

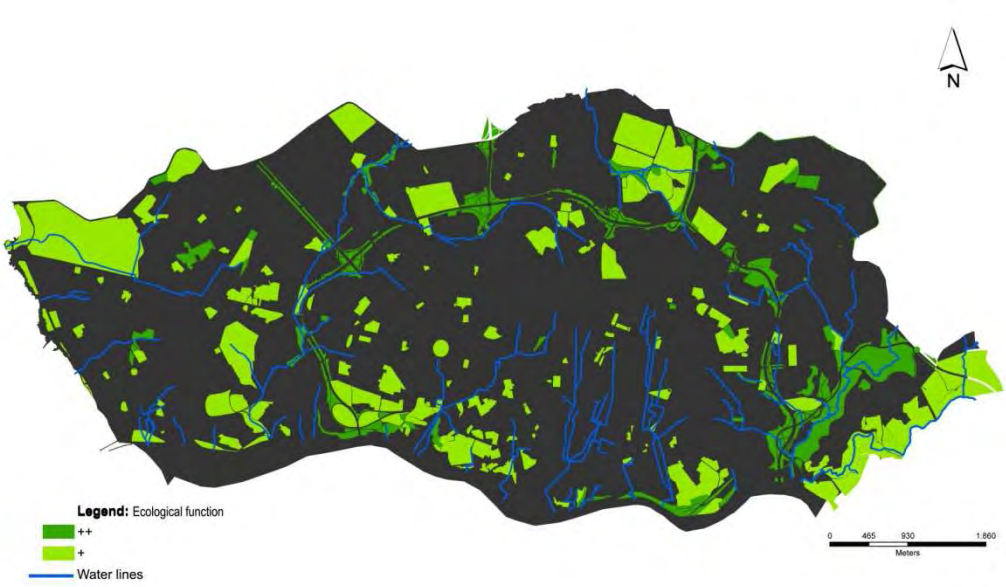


Figure 4. Comparative analysis of the ecological function performed by the typologies of UGS and its relation to the water lines.

The Urban Green Structure of Porto was also compared with the existing green spaces (total) in the municipality, being here presented the results for four parishes, belonging to each zone in which the city can be divided: Sé, Santo Ildefonso, Aldoar and Paranhos.

In the following figure (Figure 5), it can be seen that the Urban Green Structure reflects not only the location, but also the proportion of green spaces in each parish. In both, in the central parishes the spaces are smaller and more fragmented and in the parishes of the periphery there are larger areas with a greater connectivity.

In both analysis (water lines and total green spaces), there is a correspondence between the Urban Green Structure and areas of higher natural value, which means a good definition of this structure in the municipality, thus, promoting the correct development of the ecological functions that it can fulfill. These are only two parameters available to assess the ecological value of the Urban Green Structure, relating the three levels: the individual patch, the distinct typologies, and the structure as a whole. This functionality also depends on other factors, currently under evaluation.

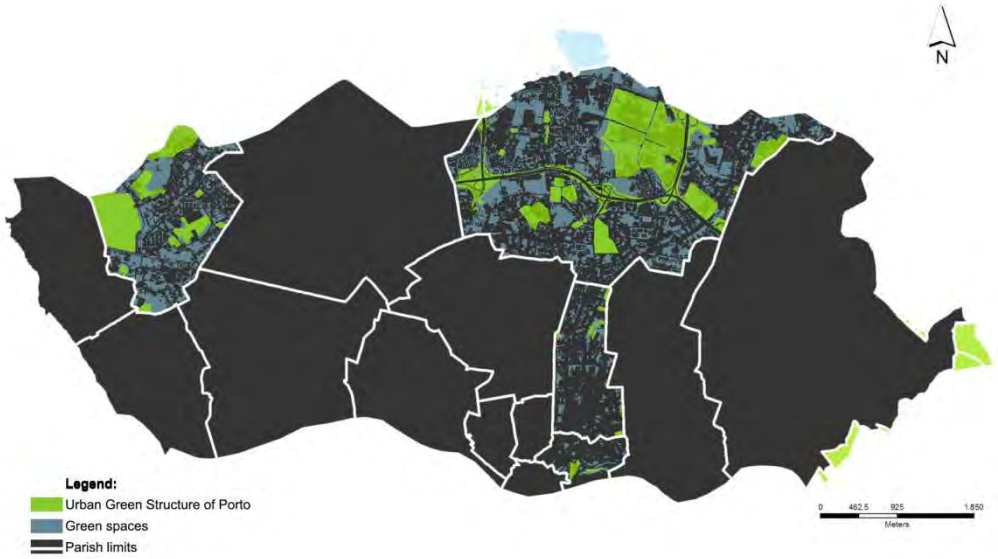


Figure 5. Comparative analysis of the ecological function performed by the typologies of UGS and its relation to the green areas in four parishes of the municipality of Porto: Sé, Santo Ildefonso, Aldoar and Paranhos.

4.5 The social function in the typologies of Urban Ecological Structure of Porto

In the analysis of the social function, three levels of functionality for the different typologies of UGS spaces were defined. These were spatially compared with the urban elements and infrastructures related to recreation, such as libraries, cinemas, museums, theaters and other places for events and exhibitions (Figure 6).

"*The recreational aspects of all urban ecosystems, with possibilities to play and rest, are perhaps the highest valued ecosystem service in cities*" (Bolund and Hunhammar, 1999: 298). In this paper, besides the patches of the Urban Green Structure, was also considered the presence of corridors, such as tree-lined streets, both existing and proposed in the Municipality Master Plan. The tree-lined streets are elements that, among other functions involved, provide the connection between the spaces, having an important ecological and social value.

The map shows that in the western part of the municipality, the typologies of Urban Green Structure have the highest recreational values. The urban elements and infrastructures with recreational functions are mainly located in the city center and are often associated with the Urban Green Structure. The presence of tree-lined streets helps to create connections between the Urban Green Structure and isolated recreational elements, promoting the cultural character of the city and improving the access of the population to this type of equipments and services.

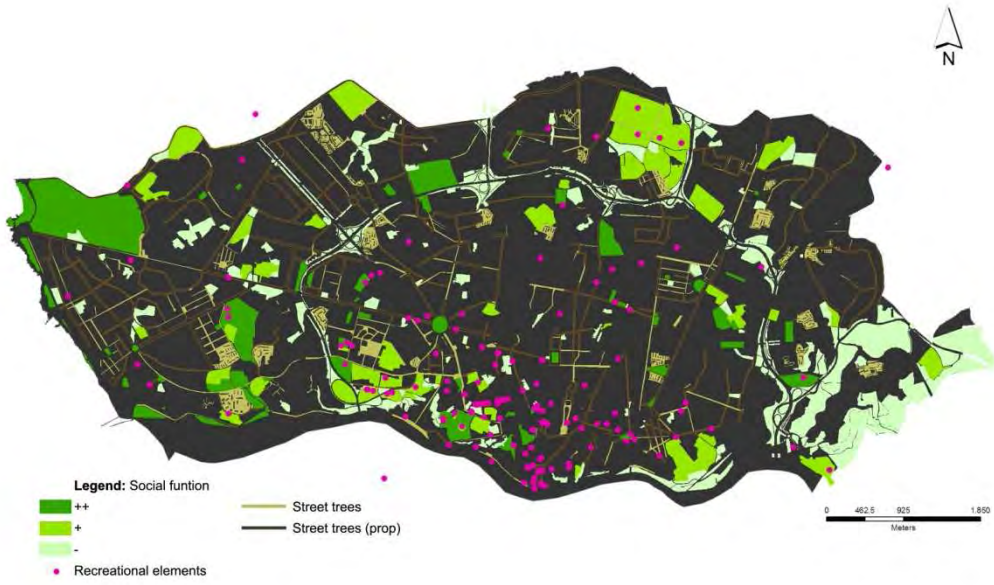


Figure 6. Comparative analysis of the social and recreational function in the typologies of UGS and its relation to the recreational infra-structures.

5 Conclusion

The Urban Green Structure, which is composed of key areas essential for the urban balance, plays a multifunctional role in cities, contributing to the urban sustainability and the quality of life.

The composition, form and structure of the constituent areas (patches) are factors responsible for the correct performance of these functions. The analysis of landscape metrics proves to be a useful tool to assess these parameters, particularly, in space, and these can be compared with other analysis and studies. The typologies reflect the distinct characteristics of the patches that compose them, both in terms of the function, as the form and organization in the city.

Also the way in which these areas are linked each other and with the surroundings, particularly with other urban elements, structures, infrastructures and sub-systems, will determine this role. "*The future of earth ecosystems is increasingly dependent on the patterns of urban growth*" (Alberti, 2005: 168).

In this article, was discussed in deeper detail the relationship between the Urban Green Structure and some natural and socio-recreational elements in the city of Porto. It was shown that there is complementarily between the two, and this relationship should be encouraged and enhanced, so that these functions can occur in a more balanced and accurate way.

The research here presented relates to a special level: the "typology" of spaces belonging to the Urban Green Structure. However, it is necessary a further deepening in the assessment, with an study at the individual patch (space) level, analysing not only its shape and location, but also its content and composition. This way, the main factors responsible for the performance of each function can be determined. It is also essential to analyze other features and functionalities related to the Urban Green Structure, such as the cultural value, the aesthetics or the urban organization, and in a more specific and precise way, since each of these functions is closely related to the others and dependent on them.

It is important to improve of the quantity, quality, dynamics and accessibility of the green spaces, in a holistic and coordinated planning perspective, in the form of an element such as the Urban Green Structure. So, it is necessary to give a greater importance to urban green areas and Urban Green Structure, through further studies, providing more data about these areas, in an urban environment. This information should be shared with the population and local authorities, so that there can be an increased community involvement in the development and management of green spaces. Participatory planning is essential to promote a sustainable urban development, ensuring the active involvement of all users and beneficiaries of the city's green spaces, which should be treated in accordance to their needs and desires, promoting a better quality of life and a sustainable urban development.

The Urban Green Structure cannot be seen as an obstacle or a constraint to the urban development, or being treated merely as a design on paper, imposed by legislation. It is an essential urban sub-system, which should be accurately planned and managed, in order to perform the functions it plays, in an articulated way with other sub-systems and urban elements. "*The quality of green spaces helps to enhance the identity of towns and cities, which can improve their attractiveness for living, working, investment and tourism. Therefore, urban green can positively contribute to the competitiveness of cities*" (Levent and Nijkamp, 2005: 2).

It is essential that it exist a policy of urban and landscape planning, articulated and integrative, taking into account all the urban sub-systems, combining their skills and taking advantage of the way they interrelate, promoting a more sustainable use of resources, and developing sustained solutions to achieve improvements in quality of life and urban progress.

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The Impact of commercial activity on the form and structure of the city – the case of Portuguese medium-sized cities

Miguel Saraiva, Paulo Pinho

CITTA, Research Centre for Territory, Transports and Environment

Faculty of Engineering, University of Oporto, dec08020@fe.up.pt; pcpinho@fe.up.pt

Phone/fax numbers: 00 351 225081903 - 00 351 225081486

The present document aims to sum up the first year of research in the on-going doctoral thesis, which dwells on the balance between commercial activity and city realm. Both these entities have lately witnessed new stages of evolution, which reflect themselves in changing variables and patterns. Initially, commerce was considered as an after-the-fact consequence of the urban form and structure pre-existence, but because it has the ability to change and adapt more rapidly than the city, as well as having large economic and social power, the flow of influence can be inverted. The research tends then to know whether the two entities are convergent or divergent in their patterns and what overlaps in their dichotomies, bearing in mind that, although evolving separately, they must have to some degree common variables that can be assessed for further understanding the urban realm, finding solutions for regulating and balancing estimated forms of distribution, proposing integrated political and technical mechanisms, and ultimately strengthening the use of commerce to reshape urban spaces. Aware that medium-sized cities are now at the core of a network-base territory, are synonyms of equilibrium, sustainability and innovation, and places of opportunity and (inter)national projection, the literature review focuses on four distinct points of view: city's, commerce's (three fronts: traditional retail, new commercial formats and web-based), citizen's and planner's (merging the above and finding research tools). The "thesis" that substantiates the research is then proposed. The last point presents the early makings of a working methodology, which presently is being developed.

Keywords: commerce; medium-sized cities; downtown-revitalization; urban morphology; consumer

1 Introduction

As is common knowledge, cities have evolved through time, symbolically, economically, morphologically, as they adjust to a new paradigm of sustainability and image(ability) in the network-oriented structure of regions. Yet, they still have to look to their midst, to their inner functions and to their inhabitants dispositions in order to fully fulfil the grandeur design of urban existence. The interaction created shapes spaces, dictates functions and determines physical form.

To fully grasp the city's meaning is impossible. Usually, achievable focused analyses on specific grounds are taken, but as of late integration is more pressing, as the awareness of an all-around relation between areas of expertise is more evident. Cities are not merely artefacts (Karaman, 2001), but organisms (Moudon, 1997).

Economic activities constitute a large slice in city-shaping. The power they possess to command physical development has many times surpassed planned development. Public-Private-Partnerships, incentive programs, or individual performances by promoters represent a fresher approach to the urban problem, in response to the declining power of the state, and ease the gathering of several areas of expertise in addressing these issues.

In the light of this, sooner or later, commercial activity must be taken into account, as connected to the formation and organization of urban spaces and street life, influenced by the private economic sector as well as being strongly connected to the individual and his choices, from the fulfilment of natural needs to the delivering of entertainment and pleasurable experiences, branded

before as one of the causes for the city's demise as well as being heralded, in present times, as one of its saviours.

Despite being largely studied, commerce's grasp is mainly economical, and its connection to the city is considered an after-the-fact, in a sense that consequences and statistical data are known, but not justifications. There are also few government strategies focused on commerce, and only occasionally has the shopper been treated as a part of the process. Interpreting physical (geographical and morphological), social, economical, political and historical variables, it may be understood whether commerce and city are convergent or divergent in their evolutionary patterns, and exactly what overlaps in their dichotomies.

Portugal presents a particular case, being prone to the new formats of commercial development, albeit with a strong retail tradition in downtowns, none the more than in medium-sized cities, unexplored markets for larger developments, which present new roles in the context of urban relations.

The understanding of the relation between commerce, city and consumer may further help the usage of commerce as an instrument of good urban planning, as well as to make a preventive approach, preparing cities for the estimated patterns of organization, that is, preparing and proposing urban policies to face the challenges ahead, always bearing in mind that integrated approaches are needed to succeed.

2 The Context – City's point of view

Cities evolve fitting, piece by piece, changes in their form (Lamas, 1989). This change, spontaneous (or organic), or according to a plan, is not random (Levy, 1999), and occurs at various levels (street, neighbourhood, territorial). Also there are constant elements that assure the formal continuity of the city (see Poete or Lavadon *cit in* Lamas, 1989). The analysis of these contexts, their relations, and the conditions (historical, cultural, social, economical) in which they occur constitutes the essence of a place. Karaman (2001) has divided the sense of a place in topology, morphology and typology. The interdependence between these aspects makes up the "language" or "imageability" of a place.

Taking into account the regeneration of form as an integrate part of the modern urban process, understanding form and structure of a city is understanding its morphological elements, and activity and circulation patterns in the "typology" component.

Urban morphology analyses the evolution of the city, the distribution of functions and the study of patterns and trends, identifying and dissecting its various components, supplied from a wide variety of disciplinary, linguistic and cultural backgrounds. Moudon (1997) defines it as the "study of city as a human habitat", which makes sense, as a city is materialized by the environment man has made for himself. The same authoress presents form, resolution and time as guiding principles. Robertson (1999) and Scheer and Scheer (2002) present other approaches. Growing concern for tools, digital and of town map analysis (Oliveira and Pinho, 2006) is also on the agenda.

The 20th century was marked mainly by three schools of urban morphology. The British owed its being to Conzen (1960, 1975) and presently the works of Whitehand can be cited (2001, 2007). Cozen's division of townscape in town plan, building fabric, and land and building utilization, has led British school to be essentially focused on cartographic representation, venturing eventually in

architecture and planning. The Italian schools is characterized by a more organic approach, fathered by Muratori and latter by Cannigia (and Maffei, 1993), defending that not only buildings are the product of a process of learning from the adaptations of previous building types, but that the built form is modified according to changing social and political-economic conditions as well. Finally, the French school is mainly architecturally-oriented, emphasizing the importance of built space for sustaining social practices.

Presently, these theoretical considerations are set up against the context of medium-sized cities. The definition of what can be considered a medium-sized city is yet not consensual and its role has changed accordingly, taking first a mere demographic connotation (see Marques da Costa, 2002), then a synonym of quality away from large cities. In the early 80s their intermediate role stood out, as able to correct regional unbalances and promote regional and economic development, but the view was still very hierarchically oriented (Almeida, Valença, 1995; Ferrão, Henriques, Oliveira das Neves, 1994). After the fist programs to address medium-sized cities and induce their dynamics (PDMs, PROSIURB), the 1990s brought the focus to sustainability, and these cities appear as centres of knowledge and resources, attractive for investment. The disadvantages lie if they are not able to achieve a critical mass of economy, knowledge and infrastructures. Presently, programs such as POLIS XXI, InteligentCities or CIUMED approach a network-based territory and medium-sized cities are (or aim to be) places of opportunity, innovation, specialization and globalization. It is proposed that their commercial understanding would constitute a major contribution and strengthen their performance at a territorial level, also aiding to a greater global cohesion, as their role in the global economy increases.

3 The Catalyst – Commerce's point of view

3.1 Evolution, changing formats and changing roles within the city

Commerce, one of the oldest activities in existence, has evolved with the city itself and gone through various changes. This historical time-line has only meaning in a time/space context, as the city and commercial forces weave each other according to existing frames that are constantly being updated. The evolution of commerce can be approached from the first early settlements to present day shopping centres, from trade in waterfronts to the development of shopping streets (Davis, Baxter, 1997), from the appearance of the first department stores to the suburban cult (Edge cities of Garreau, 1991). This historic frame is contemplated to its fullest in the ongoing doctoral thesis, but falls out of the range of this article. For the Portuguese case, the works of Fernandes (*et al*, 2000; 2003) or Salgueiro (1992; 1996) can be consulted, as well as Lamas (1989) as a connection of economic activities to the city's morphology.

Commerce has shifted its importance amidst the city realm. Slowly it progressed from a mere necessity, to the conveyor of knowledge and culture, to the catalyst of development, to the maker of economic value, to a social role, until today, where it may be considered to produce its own impact on the urban form and structure, surpassing the view that it was a mere consequence of existing phenomena. The growth of suburbs, the creation of ring roads and new city zones, the regeneration of derelict areas are all proves that commerce may lead urban processes.

Presently, the modern age of commerce has changed its perspectives. Based on Cachino (1994) four main aspects can be noted; (i) the concentration of capital (which creates a paradox because although there is more spending and more shop-floorspace, there are less shops at a neighbourhood level, and less people habiting each neighbourhood because of diminishing house aggregates, so capital increases globally but decreases locally); (ii) the changing type of establishments, as well as order and payment methods, leading all to specialize or increase their array of products (Borchert, 1998, notes, to stay in the middle is to die); (iii) the changing patterns of location (to be discussed ahead); and (iv) the alteration in the ambience of consumption, much dependent on the shopper, less specific and less conformed with the established order.

A choice was made to focus on three different categories of commerce: (i) (regenerated) traditional retail, more entwined physically and psychologically with the city (so with the most potential of influence), but lacking competitiveness and adaptability, having yet not found its place in the commercial hierarchy[36]; (ii) shopping centres, with enormous attractive, economic and urbanistic power, and, supposedly, with strength to "pull" traditional commerce in its wave[37]; and (iii) electronic commerce (e-tailing through web), as connected to the previous two[38]. Other forms of commerce, physical or not, albeit important in their own sense, have less palpable impact in a downtown urban area, and so were discarded in this approach.

The Portuguese scenario denotes some interesting statements. Although its traditional heritage is enormous, it is also one of the European countries with most shopping centres per capita (there are more than 100 large scale and more opening presently), 43% of these in the metropolitan areas of Oporto and Lisbon[39] (leaving room for medium-sized cities). Even so, at local level, recent data (Mendes, 2004; OdC, 2002b) shows supermarket establishments (Lidl, Pingo Doce) increasing their share, beating hypermarkets. Although 12% of the Portuguese population buy solely in traditional types, only 4% do it solely on modern, so a settlement in between is reached. In terms of electronic commerce, around 40% of the population uses internet, and of these, 80% have purchased online and 70% have searched products online that they have consequently purchased at the store[40].

3.2 The geographical sense of commerce

The study of retail geography tackles the changing patterns of spatial organization and the dynamic evolution of commercial spaces. Although its theoretical basis are on the 60s and 70s, it has grown significantly with the use of GIS-based methodology, allowing for the assessment of spatial patterns with a visual pallet. There is a double edge-sword related to shop and space. Which came first and which influences the other? On selection depend, on one hand, the return of investment, which affects the economic equilibrium of regions and creates driving power for other investments (regeneration), and on the other, social habits, urban livelihood and morphological impacts. So the

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[36] Robertson, 1999 and Hankins, 2001 discuss the commercial street in, respectively, more practical and theoretical approaches. The struggle of the Portuguese retailer can be seen in OdC, 2000a.

[37] Gillette, 1985 provides a good time-line. For Portugal see OdC, 2000b. Documents of the International Council of Shopping Centres can also be consulted.

[38] See Currah, 2002 or, in the Portuguese case, ANACOM, 2004; OdC, 2001 and 2002a.

[39] Diário de Notícias, 9th September 2009.

[40] The documents of the Observatório do Comércio can give further numerical insight, as well as INE, 2009; Pereira, Teixeira, 2008 for shopping centres, and, for example, Monteiro, 2009; ACEP, NETSONDA, 2009; or ANACOM, 2004 for data on electronic commerce .

retail location choice must not only generate impacts *after* commerce (in an economical choice by promoters) but *through* commerce (in an integrated choice using good planning).

Retail location selection rose as a discipline by Nelson's (1958) breakthrough book. The variables that affect location may drive from (Axenov *et al*, 1997; Hernandez *et al*, 1998) an external environment (politics, economics, technology), an internal environment (specifications of each place and of each company), the location mix (needs between companies and business opportunities), and the consumer exigencies. Clarkson *et al* (1996), debate the four major theories that constitute the background of current modelling: (i) the Central Place Theory (formulated by Christaller, 1933; debated its current use in Skogster, 2006; Krugman, 1998; Borchert, 1998), (ii) the Spatial Interaction Theory (where a trade-off occurs between distance and attractiveness), sprung by Reilley's (1931) and Huff's (1964) theories; (iii) the bid rent theory, and lastly (iv) the principle of minimum differentiation, which is related to clusterization. Besides these four theories, the disciplinary background of current location assessment relates essentially to statistic and mathematical modelling, to geography, to transport modelling and, of course, to empirical and traditional models. These theories also explain the hierarchical organization of a place in terms of their shopping disposition, from Proudfoot's 1937 and Berry's 1960 models (*cit in* Salgueiro, 1992; Cachino, 1994 or Davies and Baxter, 1997) to more modern updates. For example Proudfoot's divided the city's commerce in CBD, outlying business centre, principal business thoroughfare, neighbourhood business centre and isolated store clusters. Many of these models may be considered obsolete with new commercial formats and mobility and demand patters, but the truth is that cities still retain the heritage of many of them. More recently Shoumaker (see Fermandes *et al*, 2000), has abandoned the hierarchy system and focused on type of functions and commercial establishments, while Levy and Weitz (2006, *cit in* Burnaz and Topcu, 2006) only allow for three basic types of locations for commercial places: CBD, shopping centres or freestanding locations. Van Nes (2005) divided the shopping areas in Amsterdam in eight typologies, and GECIC (2005) presented the average geographical commercial pattern of the Portuguese medium-sized city. Local legislation on commerce also affects dispersion patterns.

Nowadays there are various techniques for assessing location planning, ranging from checklists to sophisticated algorithms, from simple analogy forecasts to very complex spatial interaction models with many exploratory variables, firstly only concerned with share calculations, moving later to assessing other variables. Articles such as Mendes, Themido (2004) or Yrigoyen, Otero (1998) present such models. In the literature review of the on-going research an attempt was made to summarize the most important models of the past six decades. The types of models studied were analogue-based, gravitational, analogue-based regression, discriminant analysis, multi-criteria decision analysis, genetic algorithms, Voroni Diagrams, GIS and other modelling tools, and lastly Space Syntax, based on Bill Hillier's theory[41].

These location decisions aided by the models create geographical patterns, which should be presented statically (trough maps as shown in Cachinho, 2002 *cit in* GECIC, 2005) or dynamically,

[41] See Hillier, Vaughan, 2007, and other Hillier's works; Penn, Turner, 2002; or Ratti, 2004, for a debate upon the theory

through GIS or similar technology[42]. These methods must take into account a prior decision related to the creation of the working database, in terms of which variables to measure, which area to consider, and what type of commerce to dwell upon. Earlier extensive analysis of this kind are Guy's (1976), Lee and McCracken's (1982) and Kwan-yiu and Kong-sut's (1971).

4 The Dweller – Citizen's point of view

Whatever choice is made in terms of commercial location and format, it only works if the consumer is willing (presuming he has a choice) to shop at a certain place with a certain character. This act of shopping is (still) a search process, and presently the shopper wishes to make a right decision and derive emotional satisfaction from it, contradicting traditional principles of convenience, price or proximity (Sinha, 2003; Ziethaml, 1988; Tauber, 1972).

Every shopper will pass through a process where he searches (via internet, in store,...), sees, sometimes touches and feels the product, and then makes his selection. According to social, economic, location and other principles, the literature has presented several classifications of shoppers, from Stone (1954), Lesser and Hughes (1986), Sawicki (1989), to Sinha (2003). The social aspects have changed, the new consumer is unfaithful, demanding and time-maximizing, and the relationship with the store seems to be the most important aspect (Sinha, Uniyal, 2005). Zeithaml (1988) discusses different behaviours of the same shopper at different stores, and Sinha (2003) different attitudes towards the same product at different stores. Behaviour can also be influenced by surrounding shoppers (Amir, 1998; Belk, 1974). This can be connected to space syntax principles. In this regard, Sarma (2006) discusses the relation between social stratum of the Indian population and their shopping related movement.

Presently, studies (such as Melo *et al*, 2001) show that consumers are spending less on essential items (food and clothes) and more on health, cultural and educational types. Consumers also easily adapt to new experiences, so, as stereotype behaviours change when store contexts change (Otnes, McGrath, 2001), environmental-induced emotional states have positive association with in-store behaviour of shoppers which in turn impacts vice-versa (Tai, Fung, 1997).

Direct observation, interviews and manipulation in store variables to observe changes in sales patterns (see Sinha, Uniyal, 2005) are techniques that can be used to develop typologies and market oriented approaches, but also, and here is the rub, to mould shopper behaviours to suit the retailer's requirements, induce longer durations and increase spending.

The point of view of consumers is clearly non-hierarchical (Fernandes *et al*, 2000), they receive things at face value, so cognitive approaches should be taken. A shop should then fix the weight between merchandising, ambience, services and price, according to the behavioural segment of the shoppers it most wishes to attract (Sinha, Uniyal, 2005). The triangle made by the person, its behaviour and the physical environment (of the store), (O'Neill, 1992), is then the backdrop for decision making.

A report by the European Commission (Ipsos Belgium, 2009) presents consumer's opinions for the European space. In the Portuguese context, GECIC (2005) presents 18 variables to take into

[42] As used in CASA research centre: http://www.casa.ucl.ac.uk/

account when tackling consumer's preferences and Melo *et al* (2001) compare attributes that are valued by shoppers according to various shopping types.

Varanda (2004) dwells on social networks, namely the relationship between actors and the structure of the global network as fundamental to the success of commercial projects.

5 Merging City and Commerce – Planner's point of view

5.1 Interpreting form and function in the urban structure

The city has been described as a place of many changes and interactions, balancing economic values, social perspectives and environmental issues through a series of planned or unplanned (market driven) choices by policy makers and economic empowered decision-makers. These, albeit planners and promoters' attempts at imposing certain trends, along with consumer's exigencies, have breathed a new life and a new pattern into commercial activity, shifting its focus on recent years. Current approaches fail to go fully beyond the economic perspective, fail to consider smaller retailers that go against modelling principles, and fail to see that the connections are not merely geographical, among other flaws.

Presently measuring form and function is neither easy nor consensual. Data is difficult to measure, calculate and quantify, its treatment is subjective and a compromise between precision and scale must be gained (Talen, 2003; Smith, 2007). Connected or not, commerce and city, evolve cyclically and continuously, and depend on an amount of forces impossible to quantify in their totality. Many ways of measuring cities have been proposed, from Jane Jacobs (1961), to Lynch (1981) to Tallen (2003) (this last one presenting the aggregate city, the geographical city and the elemental city). A choice must then be made, creating a model with an organic scale (social, economic and physical nature) and a temporal scale, balancing a demand side and a supply side, pushing the investigatory work beyond what is morphology and what is retail geography. The connection of both has been proved to work before (as in the case of regeneration of downtown areas through shopping centres in English cities – see Lowe, 2004, 2005), but the eagerness to developed has led often to commercial and urbanistic mistakes. Guy (2004) urges for the rethinking of the "town-centre fist, come what may" perspective, for a wider and integrated focus, shopper- and city-wise.

The current view of a viable and sustainable city engulfs many characteristics (of administration, planning, marketing, economic performance, etc) to which a commercial-related view can easily be attached, and, further still, be the most important instrument to achieve it. Recent Congresses of Urban Commerce have expressed just that, in documents as the Manifest of Barcelona in 2004 or the Memorandum of Oporto in 2006. Even so, few actions seem to result, and the burden of enlivening city centre commerce is all set in the politician's and planner's shoulders. But also the UACS report (2002) stresses that, for the Portuguese scenario, there is a lack of coordination at a higher level that needs to be overcome, as there is one department that regulates the city (and investment programs for the city, like POLIS), and another which regulates economic activities (and investment programs for these, such as PROCOM).

This being said, one may inquire whether there is really that a strong connection between commerce and city, and whether commerce may be an effective tool in the regeneration of urban

centres, or is it just an imposition that the literature wishes to obtain. But the literature so far reflects clearly that commerce may follow the city in a first stage, but city spaces may be more prone to survive depending on the success of their tertiary tissues.

5.2 The regeneration perspective

With the clash of new and traditional forms, city centres presented economic declines, characterized by falling turnovers, deteriorization of physical environments and a rising of vacancies. But, as known, this demise led to new lucrative hypothesis and a wave of renascence of the urban landscape, with higher functions claiming existing buildings and older residential areas for upper middle income housing and new forms of commerce (Roberts *et al*, 1999), promoting cultural diversity and specialized opportunities for economic growth.

The first response to the decline of commercial facilities in the inner-city was applied in relative isolation, with limited investment and limited business development. Instinctively, alternative forms (vintage, second-hand) also occupied city centres. Ultimately, the "regeneration thesis" (Whysal, 1995) appeared in the nineties (although based in US principles ranging from the 1950s – see Gillette, 1985 or Sawicki, 1989) with the simple notion that larger new stores could be used as catalysts for wider shop regeneration. Development schemes would (or should) be complemented with grants and private sector initiatives. Even so, Robertson's (1999) study on small-city downtowns in America showed that strategies concerning commerce were poorly used and rated as methodologies of downtown-revitalization, surpassed by main street approaches, pedestrian improvements, office developments among others. So, is there sufficient memento to create spill over dynamics? Wysall (1995) and Bonneville and Bourdin (1998) think so, although it is not a question of number of shops, but range and mix. And, although more risky and influential to the centre of gravity of cities, downtown malls may bring economic, employment and even touristic advantages.

The European Congress on Commerce and City (see Balsas, 2001) presents three ways in which commercial development and urban regeneration processes can be launched, financed and implemented: (i) urban regeneration operations with a restructuring of a commercial area or a shopping centre, this one an anchor for pedestrian flows and activity (Lowe, 2004; Guy, 2002; Thomas and Bromley, 2002), although Guy (1994) himself and Monbiot (2000) present disadvantages; (ii) town centre management initiatives, enhancing attraction by stimulating anchor projects, easing access, improving environmental, cultural and leisure amenities and regulating restrictions over design and leasing arrangements and (iii) national programs to deliver partnership or funding arrangements, due to the long operational time frames and the high financial burdens (see Geste-Idev, 2000 or Balsas 2001). This should mainly focus around commercial development and preservation, in national programs for modernization, in the revitalization of old and historic centres, in the adjoining amenities and infrastructures (such as transport management), as well as on other social and environmental concerns.

On this regard, Portuguese urbanism always handled commerce as a second hand activity, just easing its normal functioning and presenting facts but never presenting propositions, or mechanisms of implementation or management. It was always a reaction, never a preventive approach, as noted by Fernandes *et al* (2000) or Salgueiro (1996). The PDMs (municipal plans) in

the 90s brought some, albeit few, concerns back to commercial planning, and it was only with the European structural funds that concrete actions were taken. The first QCA (Community Support Framework) had SIMC (System of Incentives for Modernization of Commerce), the second had PROCOM (a commercial urbanism program whose success was questioned – see Balsas, 2001) and the third had URBCOM, more successful, which introduced the necessity of decentralization in terms of aiding the applications of individual companies, the formation of management structures in city centres and in the support of actions of professional competence-gaining. Presently there are two programs, MODCOM and MERCA, both more attuned to small or medium-sized proximity enterprises. As the programs are very recent, there is not yet an analysis of their performance.

5.3 Assessing impacts

After analysing the evolution patterns of both city and commerce, it should be important to know how each type of commerce can impact on the surrounding environment, and the techniques that allow the measurement of such an impact. An example is the British, where despite the restrictions in the construction of malls, there still occurred the same problems of loss of population and vitality in the city centre. So the problem might as well not be in the shopping centres themselves, but in their location in the urban tissue (hence the importance of retail geography) or in the characteristics of the commercial mix (hence the importance of a planning for commerce).

There are several analysis on markets or shopping centres (see GECIC, 2005), but these are subjective and economical, and reveal very little in terms of real impact. Again, the English examples show impact assessments, because additional commercial and leisure space can only be constructed if proved not to harm the vitality and viability of existing town centres. But, although they aim beyond the mathematical approach, reports fall short, only making brief considerations on land use (seeing pre-existences and supposing how they can be influenced), on the impact on jobs, community, etc, but without the technical focus of economic impact. The report by the Pegasus Planning Group (2008) is an example of such. Studies on whether the new commerce space adds to diversity, to the improvement of functions, to the enhancement of consumer choices in a close to home location, to the increasing of attraction, and if they are a catalyst for investment, employment and regeneration are hard to measure and undertake, so seldom are seen.

In Portugal, both GECIC (2005) and Melo *et al* (2001) impact studies tried to go beyond the economic sphere. Both use a large array of variables, the first producing an “index of competition”, the second grouping the variables through a multi-criteria approach. The ones that most explain the system are the management units, the price range, the themes displayed and the flexibility. The more instable ones, that is, the ones whose variance most affects others and themselves, are the location, the anchor store, the consumer habits, the type of promoters/investors and the type of commercial distribution. Also, the variables whose influence is increasing are the flexibility, the type of promoters/investors, and the consumer’s habits and incomes.

5.4 Research tools – using space syntax

A Gis-based methodology allows the conjunction of the modelling power with visualization capacities, therefore a better understanding of the changing patterns of both cities and activities in time and

space. But through this approach the morphological properties related to clusters of commercial spaces may be understood but not the reasons for their chosen locations.

As of late, Space Syntax tools have been trying to prove that movement can largely account for the configuration of space itself and the land uses therein (Hillier, 1996), and so can help understand the reasons for retail geography, but also the potential for commercial developments in streets. Activities and land uses that seek and benefit from movement, such as commerce, gravitate to locations which the grid has made movement rich, locally or globally, or to the vicinity of such locations, while others will naturally seek low movement locations. But Hillier also notes that shops can attract but not change the integration value of the line, because this is unrelated to activity, so it is how the urban system is put together spatially that is the source of everything else.

Using syntax, Hossain (1999, *cit in* Sarma, 2006) saw that commercial spaces whose sales (movement) were generated by the own store had the tendency to be clustered together, although surviving in isolation. But functions with movement just attracted coincidentally are more dispersed, although in spatially strategic locations, and are affected very much by competition and changes in flows. Van Nes (2001, 2005) reached the conclusion that size of shops depended on the scale of the built environment, the street net and the compactness of the grid, and that location, variety and movement depend on the degree of connectivity to the vicinity, and the strategic, topological and metrical location in the area and in the city as a whole. Changes in the grid (as the construction of a ring road) would also affect values of integration, and so location of shops. Jingnan (2009) finds, in the Chinese scenario, that the city's commercial centre exactly corresponds with the city's syntax centre, the same thing happening at the local scales. Other findings stressed that almost all large-scale stores are directly located within the sub-local syntax centres, in places with high road local integration, that is, connected to roads and bus routes.

Even so, Ratti (2004) presents space syntax inconsistencies and Teklenburg *et al* (1994) only suggests its usage in a global phase of the design, only concerned with layout, because it gives information on accessibility, hence providing a smaller set of reference points. Lastly, Joosten and van Nes (2005) deny it when considering the dispersal of shops and cafes in Berlin. For them block typology is the only influencing morphological factor, as shops tend to be concentrated on areas characterized by high floor space index and build up street sides (full block typology areas).

Either through grid or block typology, the main theory of using such design principles centres itself on the fact that it is the morphology of the city that affects shopping activity and not vice-versa.

6 Formulating a hypothesis

6.1 Drawing conclusions from the literature review

Commercial activity has uncured in severe changes in the past decades. Changes in the supply side relate to the changing structure of retailing as an enterprise and changes in the urbanistic promotion of space. On the other hand, changes in demand relate to changes in consumer behaviours, but also to a dispersion and shift in urban form and structure.

The contextualization of these changes has so far been mainly perceived by analysing numerical data and location, which of late has been substituted by attractiveness. The quantification

and modelling of such variables requires choices not easily made, and may lead to the interpretation that it is the morphological realm and the people's choices which affect store location and not vice-versa. Yet there are vast examples that contradict this statement, and for these, known models fail. The literature review only tackles slightly economic and social impacts of regeneration schemes, and some impacts on land use and transportation. Approaching the problem on this perspective requires costs, integrated and continuous approaches, in the pursuit of a true "environment". The importance attributed by the political sphere, the continuous rise of modern formats, and the existing literature have proven commerce to be a fundamental economic motor, and a shaper of the urban realm. In order to use it to mutual advantage integrated political and technical mechanisms should be thought of. These must take into account the consumer, and the city should be structured in a hierarchy that maximizes commerce as a community equipment, favouring mix-uses, mainly commercial/residential. Integrating policies making public space more functional and attractive, including partnerships between actors, financial incentives and other measures, such as mobility issues, promotion and marketing, as well as city centre management, should also receive attention (UACS, 2002).

Filling the gap of lack of available information and using commerce as an instrument of planning can help strengthen the definition of medium-sized cities who aim ambitiously at balancing the territory, at the same time opening doors to an economical, social, cultural and technological integration in the European context, but still offer unharmed heritage and natural resources for an improved quality of life. So the approach to be implemented must take these perspectives into account: the variables (customer and promoter-wise) that allow the dispersion of shops (tackled by the models), the structural changes of the city itself (morphology), the after-the fact variables (which known models fail on assessing), and lay foundations for the junction of these perspectives, so that regeneration intents may be more efficiently pursued in urban spaces.

6.2 The Hypothesis

From one year of work in the doctoral research, and the conclusions above, two main strategic objectives can be presented, as the basis for the investigation to be pursued: (i) to know whether the two entities (commerce and city) are convergent or divergent in their patterns, and what overlaps in their dichotomies; and (ii) prepare cities for the estimated patterns of organization, namely finding solutions for regulating and balancing the forms of distribution, by proposing urban policies, tools and the proper interaction between actors that can do so, in order to face the challenges ahead.

A set of distinct guidelines can further be presented, as assumptions to approach these goals:

- Medium-sized cities are now at the core of a network-base territory, and are synonyms of equilibrium, sustainability and innovation, presenting themselves as places of opportunity and (inter)national projection;
- The evolution, location and type of commercial activity is linked to the form and structural changing patterns of the city, and both to the social realm;
- Initially commerce can be considered as a follower of urban form, but because it has the ability to change more rapidly than the city and more easily adapt to new conditions, as well as having large economic and social power, the flow of influence can be inverted;
- Commerce can be successfully used as an instrument of urban planning;

- Planning should not interfere with market logics, but only channel procedures for a more sustainable urban realm

And therefore, a question can be asked that sums up the present research, and serves as the catalyst for the work ahead: How can commercial activity (which is perceived to be not merely an after-the-fact consequence of the urban form and structure pre-existence) be interpreted beyond the economical scope in order to fully comprehend its measure of connection to said form and structure, bearing in mind that both entities evolve separately, but that they must have confluent patterns that can be assessed for the further understanding of the urban realm, and the proposal of integrated political and technical mechanisms?

The research hypothesis is then: Commercial activity dispersion is connected to a certain extent to city form and structure, there can be common ground in their evolutionary patterns and, if so, then commerce can present strength enough to revitalize and reshape urban spaces, through economic, social, physical and land-use impacts, that can be channeled to a set of planning guide-lines supportive of decision making.

7 Presenting a working methodology

It is yet too soon to know for certain to which path the investigatory work may lead the researcher. Even so, choices narrow and one is aware of the measure of existing evidences and the potentialities they offer.

First an attempt was made to narrow down possible case studies. For that, first a demographic criterion was used, limiting Portuguese medium-sized cities between 20.000 and 100.000 inhabitants. Cities in the metropolitan areas of Oporto and Lisbon, as well as in the archipelagos were dismissed, and, on the other hand, a few cities which did not fit the demographic interval were considered, as they appeared relevant in a structuring and regional sense. These cities were then further characterized by their territorial frame in the regional plans, the presence of shopping centres and the European structural funds projects approved in their midst. Some 20 odd cities are now under scrutiny, for a selection of 4 case studies.

Consequently, a first reflection upon a way to consistently characterize the commercial sector was made. Six categories were chosen: (i) Type (whether traditional, shopping centre or connected to web); (ii) Integration (individual, shopping street, shopping block/area, shopping gallery, shopping centre, among others); (iii) Implementation in the city (through models of location, through regeneration approaches,...); (iv) Brand (individual, franchise,...); (v) Retail category (multipurpose, single isolated purchase,...); (vi) Specific characteristics of the store (share, size, workers, perks, ...). The division of the multitude of commercial types in retail categories seems the hardest task, and has been tackled by Guy (1976) or Eaton and Lipsey (1982, *cit in* Sarma, 2006).

After this, one needs to interpret the city in itself, that is, to know what exactly to measure to fully grasp how commercial spaces affect form and structure, what patterns flow together, which impacts or consequences they deliver to the urban realm and how these can be obtained, and in what form to mould the to be proposed policy measures, so that the capacity of their implementation is maximized.

So, how to proceed? One may look at the entire cityscape and fail to grasp its simple details. One may also focus on its details and fail to grasp the whole. To be focused on the relation alone of commerce and city is not simple, for both entail almost every other characteristic of the urban scenario. The boundaries have definitely been established, but the real measure of the form and structure of the city, the variables most likely to shift according to commercial spaces and that lead to regenerative successes of the urban realm, have yet to be determined, or better still, have yet to be quantified for the present work, from the vast amount of variables one knows that influence such cause. Hopefully, the next steps of the investigatory work will bring about these conclusions, and at this point an idea, more than a real definition, of a methodology is presented, as a seed to a work which is being constructed piece by piece, as it should not fail to be so.

But whatever is achieved, a space where commerce is performed will always have to deliver a dual experience: a place to socialize and a place to facilitate commercial interaction. The rest are just backstage manoeuvres to achieve good urban planning and good business.

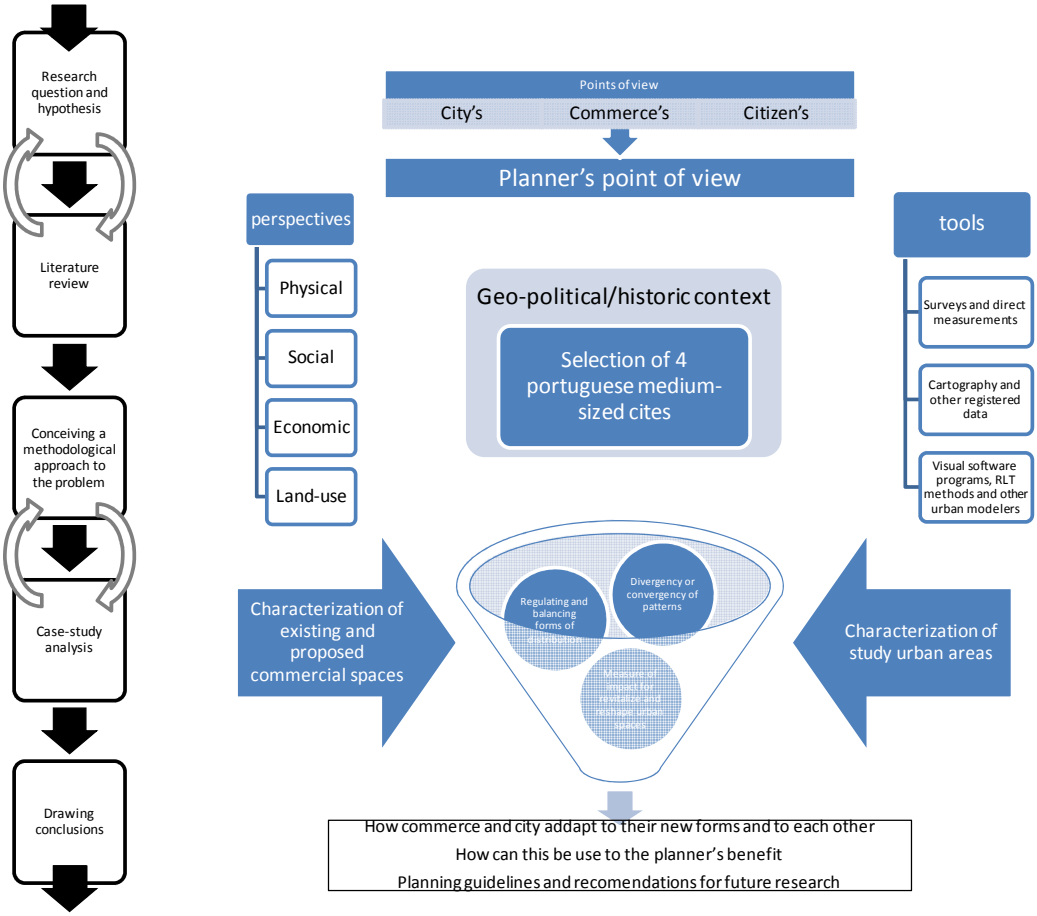


Figure 1. Working methodology.

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Socio-environmental controversy in Brazil: The New Guarituba Project

Juliano Geraldi

Centro de Estudos Sociais

Universidade de Coimbra, juliano_geraldi@yahoo.como.br

Phone numbers: 00 351 911703395

The illegal occupation of spring areas is a major urban socio-environmental problem in Brazil. In the Metropolitan Area of Curitiba, among the committed areas by inappropriate use, the Guarituba (Municipality of Piraquara) stands out for the number of occupants (approximately 40,000 inhabitants) and the location in an area of strategic importance to the environmental preservation and the water supply system. More than the conflicts between environmental and planning laws, there is the construction of a social-environmental controversy, which opposes the right to housing and the right to the environment. The implementation of the "Projeto Novo Guarituba" (New Guarituba Project) – trying to articulate land regularization, sanitation and environmental protection – makes possible seeing the action of the interested actors in the use of spring areas. Instead of simply divide the actors between for and against the project, the paper analyzes, with the concept of discursive multiterritoriality, the actor's regime of justification and the concertation spaces used for project approval. It is identified the existence of four discursive territorialities that had been called: mercantile, preservationist, pragmatic and structuralist. The paper emphasizes the multijustification as negotiating skills, the participation as a renegade politic and the role of media. It is concluded that planning – or the State itself – is still the major public deliberation space.

Keywords: social-environmental controversy; regime of justification; discursive multiterritoriality; New Guarituba Project.

1 Introduction

The illegal occupation of spring areas is a major urban socio-environmental problem of Brazil. The problem arises from a fragile relationship between the state, society, market, legislation, planning, and effectiveness of the intervention tools. The lack of better opportunities to meet the housing needs ultimately send the poorest segments of the population to areas of lower economic value, directly related to areas of greatest environmental risk. The continuity of this process implies serious risks, not only for the maintenance of the current supply sources but also for social and spatial exclusion of the resident population in these areas – because they have no access to adequate urban infrastructure.

At a first glance, the relationship between environments versus housing may be considered controversial because it interposes two fundamental rights expressed in the Brazilian constitution: the right to housing and the right to environment. The construction of this controversy has made enemies, two fronts of social mobilization that should be side by side. The main goal of this paper is to deconstruct that dichotomy controversy, as it is apprehended that the spring areas concerns are divided not only in favor of the environment and against the housing or for housing and against the environment. The presentation of housing as an environmental enemy seems to suffer a great opportunism in blaming poverty on the environmental problems. We should not forget that the illegal occupation of the spring areas is not only done by the popular housing, but also by the high standards housing, trade, industry, agriculture, etc, due to a tenuous relationship between the state's lack of control, low economic value and strategic location of these areas (metropolitan areas, national connecting lines, proximity to economically attractive cities, etc.).

One can observe the existence of a large number of actors who have an interest in the occupation of the springs as a place of social reproduction. The actors present their speeches in accordance with their own interests in the occupation of that territory. These speeches can often be contradictory, which shows that the actor can be placed in various forms in the exercise of power to materialize their desires, as it is not the speech itself that represents the interest, but the very political praxis on the territory. The different speeches have served thus to control the different actors so that the first could exercise its political program on the territory.

It is concluded that the analysis of the different forms of speeches can determine a prospect on the regime of justify the interests of the actors on the territory. In analyzing the occupation of Guarituba case (Piraquara County, State of Paraná, in the Metropolitan Region of Curitiba – Brazil. Figure 1), the actors' regime of justification in the implementation of the New Guarituba Project and the spaces used for consultation among the actors, the task is to demonstrate the complexity of the debate between housing and environment in Brazil.



Figure 1. Guarituba. Source: Cohapar, 2007a.

2 The Guarituba: an introduction to Brazilian springs

The springs are hydrographic basins for public supply and, thus, have quality criteria to which its waters must meet. These criteria were defined for the State of Paraná, by Law No. 8.935/1989, which prohibits the installation of highly polluting industries, hospitals, garbage dumps and high density ground plotting in these areas – referring the others criterias that characterize the water in their physical-chemical standards, to the Resolution No. 20/1986 of the National Council of Environment (Conama). When analyzing the Legislation, we conclude that there is enough margin for ground plotting – as long as its implantation do not compromise the water physical and chemical criteria established by Conama resolution, and as long as it is approved by the supervisory body, which may reject it or request changes (Paraná, 1989). Nevertheless, the legislation of the 1980s was seen as

restrictive in an attempt to comply with the metropolitan planning prepared by the State of Paraná bodies through the 1978's Integrated Development Plan (PDI) which had as one of the directives the non occupation of the eastern portion of the Metropolitan Region of Curitiba for the water preservation. However, (i) the partial implementation of the plan (featuring the State's effectiveness for action in the proposed legislation and planning); (ii) the very restrictive nature of legislation linked to the lack of supervision; (iii) the great pressure on land use due to the region growth in the 1980s and 1990s, has led to the occupation, during that period, of the areas responsible for 70% of water supply in the region (Lima, 2004). The Legislation and planning had built the environmental protected areas as nobody's land, free to be occupied by the dynamics that were deployed there without any state control.

The need to restrain the process of illegal occupation in spring areas led to a rediscussion on the water conservation law in the State of Paraná, changing the paradigm from total restraint to the proper use of soil in these areas (Geraldi and Loyola, 2007). That work resulted in the adoption of the State Law No. 12.248/1998, the "Special Law for the Water Sources Protection of the Metropolitan Region of Curitiba." The legislation has also defined the UTP of Guarituba, a Territorial Unit of Planning Zone (Figure 2), that had its land use and occupation zoning established by the State Decree No. 809/1999, aiming at controlling the density and economic activities compatible with the environmental fragility that characterize them (Lima, 2004). When replacing the restriction of use paradigm to a more compatible use with the real city, the legislation attempted to provide a legal basis for the state to intervene in a space characterized by irregularly occupied areas, with poor patterns of urbanization, infrastructure and housing (Comec, 2006). The UTP of Guarituba has a population of aproximately 44,000 inhabitants (which means being greater than 90% of Paraná Municipies) in a social condition of great socio-spatial exclusion compared to the rest of the region (Geraldi and Loyola, 2007).

The PDI review in 2001 has transformed the public supply policy into a structuring factor of regional development by linking the water preservation to the land management (Schussel, 2000). That turns the spring protection into a priority to the transformation of the Metropolitan Region of Curitiba into a competitive, solidary and sustainable metropolis (Comec, 2001). Thus, the State needs to initiate an intervention policy in these areas, in order to ensure water supply for the region over the next two decades – which reduces the need for the sanitation company to seek fresh spring areas 100 km far from Curitiba (Andreoli *et al.*, 2000). The possibility of the water sources depletion and the consequent lack of water, increase the political importance of areas such as Guarituba that stand as obstacles to the metropolitan development.

3 The New Guarituba Project

Among the springs areas occupied in the Metropolitan Region of Curitiba, the Guarituba is notable for the number of occupants and for its strategically important location in areas for Curitiba's supply system and for the Region. Given this situation, the Government has launched the New Guarituba

Project[43]. The intervention area, smaller than the UTP, has 32,000 inhabitants, 60% of them characterized by low income (Cohapar *apud* Geraldi and Loyola, 2007). Of the total number of lots (6397 lots), more than half do not have sewage collection, 30% do not have water supply and 51% do not have electricity supply – getting their supplies through illegal connections.

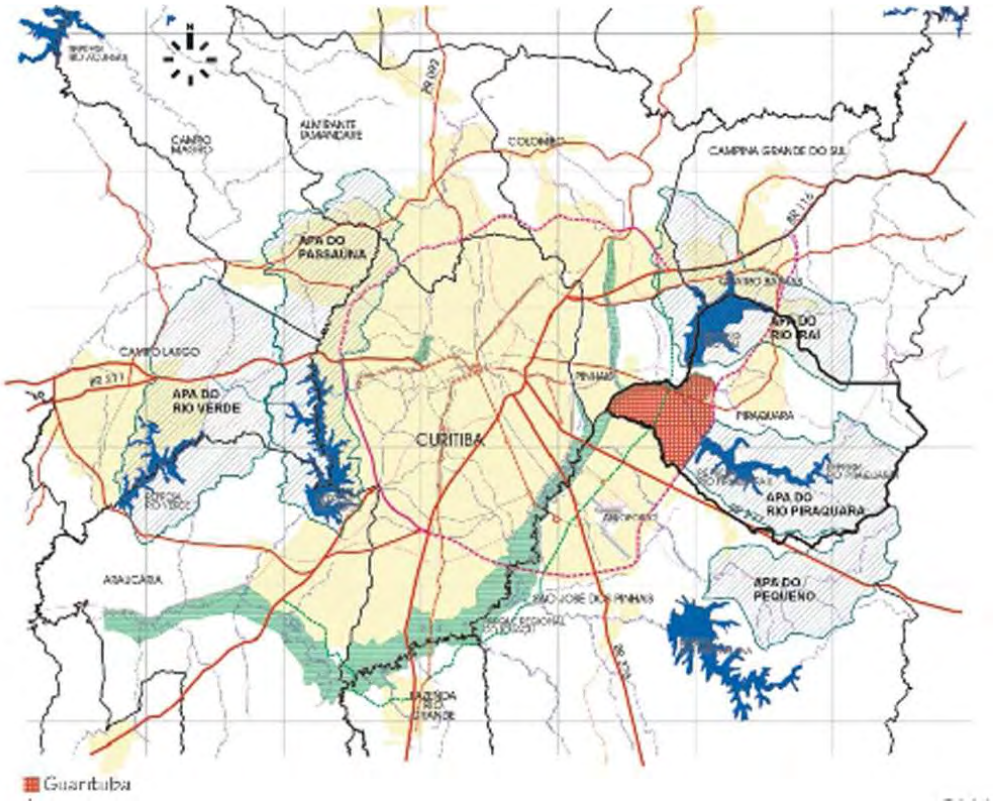


Figure 2. Guarituba's location on Metropolitan Region of Curitiba. Source: Comec, 2006.

Initiated by the municipal council in 2005, with the legalization of illegally occupied public lots, the project has gained expression in 2007 when it was included in the Accelerated Growth Plan (PAC), by the Federal Government. At that moment, many decisions about the project – especially on land regularization and infrastructure issues – had already been agreed between the city hall and the state government. The first major step was the approval of a new zoning for the UTP of Guarituba by State Decree No. 6134 of March 29th, 2006, after the intervention approval by the Spring Management Council (Figure 3). Based on the decree, the Environmental Institute of Paraná (IAP)

[43] As we might expect in government projects, the New Guarituba Project has had – and still has – many names, according to the administration's policies and government levels. It has been called the Social, Urban and Environmental Development Plan of Guarituba (Comec, 2006), Environmental Restoration and Urbanization Plan for Guarituba (Cohapar, 2007a) and PAC Guarituba, the last one due to the Accelerated Growth Plan of the Federal Government and in wide use in the current phase of the project – due to the fact that the PAC is one of the flagships for the presidential election of 2010. The New Guarituba name is related to Mayor Gabriel Jorge Samaha's political platform, known as Gabão, with its political base in Guarituba. The City Hall project was launched in 2005, however, has only gained expression in 2006 with the assistance from the State Government and became a project of national expression in 2007 with the inclusion of the Federal Government.

has issued the Preliminary License No. 12.116, in September 200, for the commencement of works (Geraldi and Loyola, 2007).

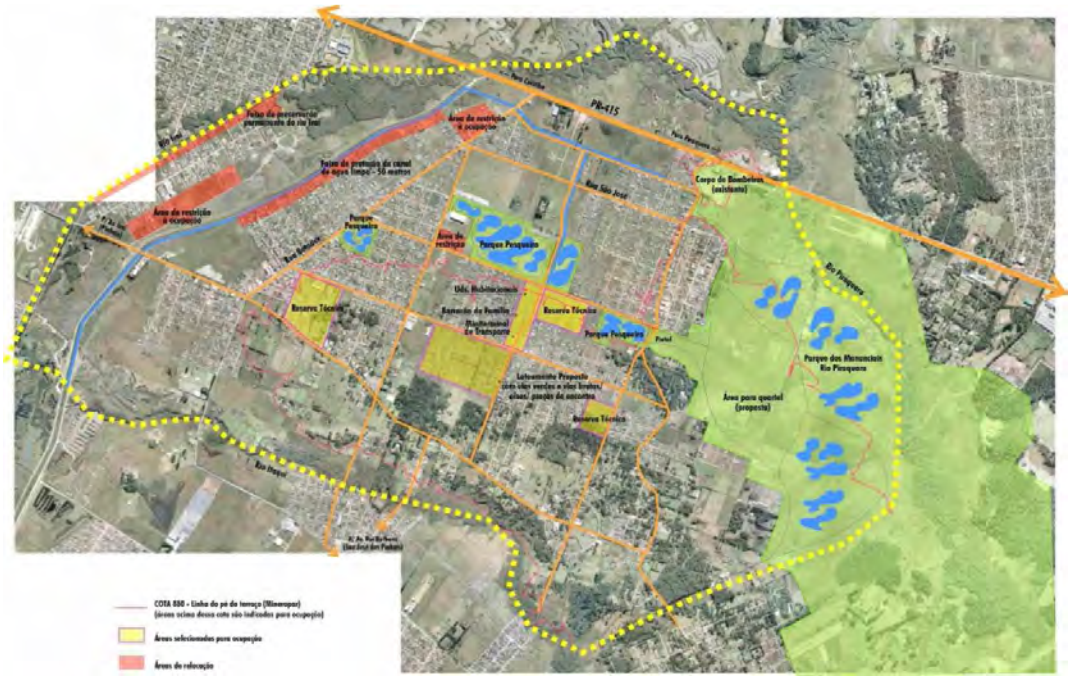


Figure 3. Approved guidelines. Source: Cohapar, 2007a.

The project is a joint effort of 13 State Government entities, besides the city hall and the Federal Government, the last one through the Ministry of Cities and the Federal Savings Bank (financial agent of the project). The interventions are estimated to cost R$ 97.1 million (approximately € 40.4 million), being R$ 59.4 million (approximately € 24.7 million) from the Federal Government. There are six main actions goals (Cohapar, 2007a):

i) improve the population's quality of life;

ii) interconnect the project to other areas and public policies, such as health and education;

iii) promoting the community's organization and participation;

iv) develop a model of conflict resolution, rescuing the dignity and self-esteem of the population;

v) transfer the lots property / ownership to women;

vi) restore the environment with the direct involvement of the community.

The objectives delimited the physical interventions – the main subject of the project – that had the following guidelines (*Ibidem*):

i) relocation of population living in inappropriate areas;

ii) restoration of environmentally degraded areas;

iii) development of infrastructures in the occupied areas;

iv) land regularization in occupied areas;

v) establishment of recreational áreas.

The identification of inappropriate areas – permanent conservation areas (protected by federal law), irregular occupations and plotting, areas of restricted occupation due to flooding, areas affected by macro drainage works and road system (enlargement of streets) – corresponds to the relocation of 803 families in new urbanization area to be developed on Guarituba itself. The implantation of micro drainage, electricity network, a water supply and sewage collection network and urbanization of the occupied areas will be accompanied by the construction of water front parks and water retention parks, which will serve concomitantly as recreational areas and as a ways of controlling the pressure for new occupations.

Despite the great transformation of the urban structure in the area and of the proposed objectives, the society's participation in the discussions of the project is detailed. The intervention proposal has been presented at an event attended by 3,000 people in April 2007. The community's participation strategy is institutionalized through a Joint Committee, with eight members (four from the public power and four from the society), which will have the responsibility to disclose the project interventions to the families (*Ibidem*). The local population is included, thus, in the project implementation stage, through their representatives from the dwellers' associations and other leaders, in order to be informed of all the works stages (Cohapar, 2009).

4 For a multiple cartography of the regime of justification: the discursive multiterritoriality and the concertation spaces

The actors are not predominantly divided between the environmental preservation and housing rights, or otherwise, for or against the New Guarituba Project. However, the controversy delimitation is already presented in this dichotomy, where the existence of one should necessarily come into conflict with the other. There stands therefore, the existence of the controversy, as it justifies a specific form of conflict resolution that has its own legitimacy – legitimacy given by an actor's technical expertise that is privileged in certain concertation areas. It is argued that the discursive nature of the Guarituba controversy is obtained by perceived risk to the detriment of the actual risk (Jasanoff, 1998). The controversy as a perceived risk is constructed, therefore, by a supposed realist epistemology, where the justification of authority is derived from expert communities (*Ibidem*), and it will be that specific community that will have greater legitimacy to influence public policy. In that process, the actors and their expertise should be justified through a proper regime, and their reasons for the politicies to be in one form or another. The legitimacy of the reasons – and therefore the maintenance of the regime of justification – is obtained by the generalization process of justification between the interlocutors (Boltanksi and Thévenot, 1999). Thus, the regime, on the other hand, would be based on a legitimate greatness, former of a sense of justice and the debate on those greatnesses orders of these quantities would create common worlds of justification (*Ibidem*).

However, it is hypothesized that, in presenting a cartography of the regime of justification in social and environmental controversies, it is not a sense of justice, but is rather the use of territory by the actor that defines the justification system. It is argued that the six worlds defined by Boltanski and Thévenot are not enough – for the case presented here – to arrange the cartography of the regime of justification that recognizes the multiple territoriality of human action. No one denies the importance of the authors in defining the object of research, but it is understood that its full use would result in the

consolidation of the idea of a controversy based on a perceived risk, where the justification of the actors would be terminated by the housing and environment as a legitimate greatness. To understand the actual risk, one would arise from existence of a priori controversy defined by the legal form of the norm, but defined, even by intrinsic interest – both material and immaterial – in territory use by the actors. Thus it is understood, therefore, recognizes the premise given by Venturini (2009) in the need to extend the arguments, actions and relationships to the meaning that the actors ascribe to them as a way to complexity the approach.

It starts with the power territorialization that, guided by socially constructed relations built on in existential or productive bases, performing in such a way to appropriate the space in order to create new dynamics (Raffestin, 1993). The way this process is triggered, i.e., its territoriality, is the result of an action conducted by an individual or group of individuals who held a program – considered here as an actor – for which appropriates a concrete or abstract space through discursive, symbolic or coercive relationships (*Ibidem*). Thus, the territory is not only characterized by a geographic area circumscribed by the instruments of power. The construction of the territory becomes also a strategy for the actors to profess the ideals – and therefore their ideologies – which traditionally holds the group together (Claval, 1999). The readability of the territories is given then by the recognition of territoriality as centers of translation (Law, 1992), because it is territoriality, in that case, that builds the possibility of equivalence between networked actors – in this sense we can conclude that the territoriality of the actors is measured by their ability to activate their networks of interest in accordance with its objectives, as Callon (1987, p.93) would say: "An actor network is simultaneously an actor whose activity is networking heterogeneous elements and the network that is able to redefine and transform what it is made of."

As we have already seen, networks that sustain the regime of justification – since they can be enabled or disabled depending on the interest in the exercise of power – can give to the territory a fluid nature in the moment when the existence of the territory is not absolute anymore (Sack, 1986). This mobility supports a discontinuous and overlapping territorial configuration, which, by establishing a territorial condition to enable and disable network in accordance with the interests, establishes a multiterritory in human existence (Haesbaert, 2004). It is argued, on the other hand, that the multi-territoriality does not condition the actor to only one regime of justification. The same actor is justified in multiple territorialities through multiple speeches – each supported by a specific regime of justification – that makes him turn on as many networks of interest possible in order to facilitate the implementation of its program over the territory by increasing the density of territoriality of the actor about a certain program. When the multiple territories converge to legitimize the discourse of a dominant actor, the program that provides a specific territorial space reproduces a certain hegemony established by actors who have their own systems of legitimate justification for their own formed territorial. Thus, the recognition of a discursive multiterritoriality – characterized by the actor's multiple speech – is necessary as a method for drawing up a mapping of the controversy that has its founding moment, the definition of risk perception beyond the perceived risk.

In developing public policy aimed at settling controversy, the consultation spaces become important issues for analysis. Assuming that at the time of drafting of public policy there is an attempt to resolve the dispute over different regimes of justification – Project New Guarituba is, in principle, a

way to "reconcile" two quantities of different values, housing and environment – one would think that the establishment of agreements (Boltanski and Thévenot, 1999) defines itself, what are the schemes and legitimate justification which discursive territorialities will be hegemony over space. Thus, the Project New Guarituba becomes an agreement on the arrangements concerning the justification of the occupation of the springs Guarituba. However, since these agreements we rely on the equivalence between the magnitudes legitimate – that housing and environment supposedly have the same political significance, for example – it is easy to denounce the vulnerabilities argumentative, making necessary to implement the agreement in objects and institutions (*Ibidem*).

The concertation spaces are those objects and institutions which have appropriated by the discursive multiterritorialities to legitimize their regime of justification – since their presence, or better, their discursive territoriality, is validated in these spaces, the use of the territory that matters the actor in particular, is then legitimized. Thus, the concertation spaces of the New Guarituba Project – site of political struggle between the actors and thus of convergence of discursive multiterritoriality – are the places where disputes arise, as it's when it is possible to observe the actor network that were activated. Finally, to analyze the multiple discursive territorialities and how they operate in the New Guarituba Project's concertation spaces is to identify the actual controversy in the exercise of power over use of springs land. Within the regime of justification, four main discursive territorialities in Guarituba are identified – mercantile, preservationist, pragmatic and structuralism – which will be detailed below. The concertation spaces will also be analyzed in order to understand how they ensure the legitimacy of the agreements.

4.1 The mercantile discursive territoriality

This first territorial demarcation is formed by the discourse that has a mercantile ownership of the space, i.e., it has the springs as capital of their economic reproduction. Three actors are identified: Sanitation Company of Paraná (Sanepar), the real estate sector and the productive sector (in one of its specificities).

Sanepar's main objective is "the access universalization to environmental sanitation services," distributing "clean water and collection services, treatment and disposal of sewage and solid waste throughout the Paraná." (Sanepar, 2010) The springs have strategic importance for the company for its nature, as it assures raw materials. The existence of good quality water and close to the final receiver facilitates the treatment and reduces the infrastructure costs. Resuming, the preservation of these areas guarantee a financial return to the company. The Municipality of Piraquara is the main collection area base through Piraquara and Iraí systems. Close to Guarituba, the company already has the Piraquara I water tank and is already building a second reservoir (Piraquara II). As a compensatory measure, during the environmental licensing, a series of programs were introduced, such as environmental education, environmental restoration, Municipal Master Plan of Piraquara, among others.

The real estate market has a relationship with Guarituba that dates back to the 1950s, when the first lots were licensed in the region. However, its occupation only began in 1970, with a rapid rise in the 1990s, with the intense promotion of the metropolitan real estate market and the financial loss of value due to environmental legislation that focuses on the springs since 1996. This legislation

ultimately creates the existence of an informal market, linked to the proximity to Curitiba and the average smaller price of lots than the formal market, makes Guarituba as one of the areas with highest growth rate in the Metropolitan Region of Curitiba during the 1990s. The New Guarituba Project is provided with the area banning measure – banning the construction of new works – after its implementation, which should be an obstacle to the appropriation of new areas, but without interfering with the already installed market. It would be also possible to include the Social Housing Company of Paraná (Cohapar) as real state market. The New Guarituba project has new public housing construction (where part of the company's revenue comes from), but as the budget of the New Guarituba Project is divided by other state bodies, it is understood that the Cohapar alone did not initiate the project aiming at getting some income from it, keeping its speech very well linked to other territorialities described below.

The productive sector installed in the region – the township trade is not being considered here, i.e., the local residential sector's small direct supply business – takes the environmental preservation discourse and the nature relationship to justify the use of springs as an economic reproduction. Regarding some types of industries (called "clean" because of their lack of waste), not all of them have the legal support to operate in spring areas – as is the case of the tire recycling industry, closed in 2007 by order of the Public Ministry. The projects related to ecotourism use the natural landscape – proximity to the Serra do Mar – as a form of attraction.

4.2 The preservationist discursive territoriality

The preservationist territoriality is built by the discourse that the springs are areas where the environmental preservation is the guiding principle of its social reproduction. There is a direct relationship with the mercantilist discourse of Sanepar and the ecotourism ventures – the last one connected to the work of the environmental NGOs, like the case of the Ecological Movement of Piraquara (MPE). Two other players – with different approaches, but who also insist on the preservation issue – can be identified: Operational Support Coordination for the Environment, Public Ministry of Paraná (CAOP-MP) and the Environmental Institute of Paraná (IAP).

Although the ecotourism ventures discourse is easy to understand – the area conservation ensures the maintenance of its main attraction – the preservationist discourse of Sanepar must be better understood. The argument used is the same of its mercantile territoriality; however, the starting point is the opposite – the preservation rather than profit. Sanepar has a Springs Conservation Program, resulting from a set of 26 research projects on environmental quality of water sources, and has developed Springs Management Plans specific to each of the fountains it operates. As previously mentioned, maintaining the springs environmental quality is what guarantees a smaller investment in collecting and treating water. However, in the Metropolitan Region of Maringá, Sanepar was accused by CAOP-MP of polluting important supply sources with polluted load sewage and of operating without environmental license (Pacheco, 2009) – which calls into question the company's own discourse regarding to the environmental conservation.

The CAOP-MP has a militant profile in the State of Paraná. It is divided into two sections, one for the whole state, and another specifically for the Metropolitan Region of Curitiba, and aims at guaranteeing the compliance with the art. 225 of the Federal Constitution, the right to environment.

The entity is responsible for the judicial interpolation against polluters (see the interpolation against Sanepar). The entity has specific action in the spring's areas against illegal and disorderly occupation, but is not yet active in high standard houses irregular occupation in spring areas (Sanepar, 2007). The Public Ministry was also an arena of decision on the New Guarituba Project to ensure that the project would not interfere with the springs area preservation conditions (Cohapar, 2007b).

The IAP is the state body responsible for the environmental issues, the environmental licensing, control and surveillance, development of standards and projects, among other issues, being one of the operating bodies of the State Secretariat of Environment. Its interest in the conservation can be considered formal, since their participation in discussion and preparation of the New Guarituba Project has happened through a bureaucratic process of licensing. They became more active in the project implementation, when they obtained the funds release from the State Environmental Fund to purchase the implantation area of the residential units.

4.3 The pragmatic discursive territoriality

The pragmatic territoriality is defined by a cultural appropriation of the space, where the emphasis is in the maintenance of already territorialized social relationships. Thus, the actors who have territorialized themselves have a defense position towards the local population and, it is possible to observe the defense of the population rights in their speeches. This relationship causes many of the actors to have a political-electoral concern and they can identify a potential electorate in the local population. This makes the relationship between these actors and the territory to be paternalistic, in an attempt to build a leadership of/in the territory, attempt hidden in the discourse that they are acting in the territory to solve a problem.

The Dwellers Association is the first level of establishing the culturalist actors, because their performance is bound to the relationship, especially with the public power – mainly the city hall – aiming at making direct pressure in order to achieve improvements in the quality of life. The associations are seen as local leaders and therefore they end up having a special place in the debate on the New Guarituba Project, whereas the other scales of power formally recognize these leaders as first spokesmen in the community.

The Social Housing Company of Paraná (Cohapar), is a culturalist player per excellence. Since there is no defined housing policy for the state, Cohapar operates in areas of political interest – being the housing issue of great appeal, it is no surprise that many of its presidents have run for a seat in the State Legislative Assembly. Thus, the performance of Cohapar in the Guarituba region is guided by a position in order to guarantee the right to housing and territorial bounds with the preservation of the environment (Cohapar, 2009b), reason why the relocation of families that will be taken from areas of environmental risk will occur inside the Guarituba.

The city hall has its main municipal project of social structure in Guarituba. Its current mayor, who has Guarituba in his political base, has been elected city councilman and twice mayor aiming at changing the living conditions of the Guarituba inhabitants. The position of the city hall – independent

from the mayor – (i) to always criticize the amount transferred through the Ecological ICMS[44], justifying that the value is derisive compared to the challenge of conserving the metropolitan springs, and (ii) to allow, during the 1970s and 1990s, the area occupation in exchange of political waiver, demonstrating the pragmatic relationship that the Guarituba has – more than a legal issue, it is seen as a form of subordination of the city for the regional interests (Sampaio, 2009).

The Federal Government has one of its greatest social housing and sanitation projects in Guarituba, included in the Growth Acceleration Program. For President Lula, the work is "emblematic" (Cohapar, 2009c), and its success is an example of intervention in spring areas. The participation of the Federal Government does not denote any moral debate about the housing versus the environment controversy – or even each other's integration – but a pragmatic focus on the local population (solving the housing conditions problems) with good response to the general public (environmental preservation).

4.4 The struturalistic discursive territoriality

The structuralist territoriality consists of actors who take ownership over springs through a scientific positioning, depoliticizing the debate and aiming at giving science – mainly through the technical planning – the only possible form of intervention. The individuals in this area have a lot of turnover among the institutions that compose them – while they are university professors, they take leadership positions in the planning bodies (Comec), or else they perform scientific research for specific actors (Sanepar). The objective of these actors is to understand the dynamics of the territory through the isolated analysis of the structures that comprise it. Since the interaction between these structures is considered (or not) possible, it becomes possible for other actors (or not) to scientifically justify its position – giving it more credit. Three great actors can be identified: Coordination of the Metropolitan Region of Curitiba (Comec); Institutional Research; and Academy.

Comec is the state body responsible for the metropolitan planning who, however without great intervention power, has seen its regulatory role clean out the last two decades. Proof of this is the Integrated Development Plan of 1972 (already mentioned), which, while indicated the incompatibility of the occupation of the eastern region due to the water sources and the need to induce the occupation of other areas, the opposite has happened. Comec starts developing restructuring plans for the Guarituba area, from the delimitation of the region as a Territorial Unit Planning Zone (UTP), without, however, ever promoting a major intervention, remaining only at the legislative level. In the New Guarituba Project, Comec has played a role in the approval of urban projects, keeping positioned for a technical planning view by imposing certain criteria that show a distorted picture of reality, which has been a standard position by the metropolitan planning in the region (Pellizzari, 2006).

What we call here of Institutional Research, is the one conducted by government bodies – either direct or indirectly – aiming at supporting government action. Although the Paraná Institute of Economic and Social Development (Ipardes) is the official State Government Research body, it will not be reported here, for its research on metropolitan dynamic deal with the region as a whole,

[44] The Ecological ICMS is a piece of IVA that is transferred to the Municipalities that preserve spring areas through a State Law. Piraquara receives approximately R$ 9 million (€$ 3.75 million) per year.

having no direct involvement in the case of Guarituba. Moreover, the research developed by Sanepar incisively guides the position of the concessionaire in relation to spring areas. The entity possesses three major research projects: Iraí Project (on water eutrophication in the basin of the Highest Iguaçu River); Springs Conservation Research (composed of 26 research projects based on four thematic areas: water quality, environmental, socioeconomic and experimental) and the Comprehensive Spring Management Plan. The other projects structuralize Sanepar's speeches by giving them a scientific basis for its position with respect to controversial issues – as the use of spring areas for occupation – making then technical rather than political, having the efficiency and productivity of the Concessionaire as background (*cf.* Andreoli *et al*, 1999). It's important to observe that many of their researches are conducted together with other actors, especially with the Academy.

At last, but not least, the Academy has an important role in this debate because it gives it a scientific component, while depoliticizes it. Its discourse is mainly connected to the research programs of universities based in Curitiba that work on themes like the environment and development, geography, urban management and water resources – its goal is to give science the only possible answer: since science believes in the integration of springs and society, then it becomes possible to develop projects for this purpose. Characterized by positivist studies, that territoriality gives the planning the only way to save the springs, and more, legitimizing the urbanization of the region, as long as it is provided with increased sanitation – which makes clear that is not the nature of urbanization that worries the Academy, but its compatibility with the investment policy of Sanepar – as we can see at Busch (2008), Andreoli *et al* (2000), Pellizzaro *et al* (2008), Francisco (2003), Lima and Mendonça (2001) and Lima (2004).

4.5 The concertation spaces

To analyze the concertation spaces is necessary to examine the spaces where the actors' discourses are legitimated, because those are the spaces where there is convergence between the recently described territoriality. It is in the process of convergences that hatch conflicts among the actors, and so, it's in the concertation spaces that these conflicts are remedied. Where one might expect a high degree of participation as a way of deciding on social controversies and on the project techniques, the purely formal community participation is performed when the decisions have been made, only for countersignature them, as observed in the public hearings and in meetings that precede the implantation steps, as a way of transmitting information only. Thus, there are three main areas identified for the deliberation on the New Guarituba Project and its controversies: the Spring Management Council (CGM, a collegial body that deals with policies to protect the spring and its land use), prosecutors (through the Operational Support Coordinator of Environment, CAOP-MP) and various government bodies (especially those directly related to the design, environmental licensing and approval of projects).

The CGM is a collegial body composed of several representatives: Comec (besides the Council Presidency), Environmental Institute of Paraná, the Superintendence of Water Resources Development and Environmental Sanitation (Suderhsa), Sanepar, four municipalities located in springs areas (current municipal governments of Piraquara, Fazenda Rio Grande, Campo Magro and Quatro Barras), the real estate and construction (current Construction Industry Syndicate –

Sinduscon), non-governmental environment protection entities (current Paraná's Environmental Spring Preservation Association of Rio Iguaçu and Serra do Mar – Appam) and Universities, educational and research institutions (current Tuiuti University). In March 2006, during the 33rd Meeting of the Council, the New Guarituba Project was presented. During exposure, the council members are reminded that the project already has the approval from the State Governor and the Environment Prosecutor (CAOP-MP), and that the discussions are related to the inspection actions to avoid new occupation (CGM, 2006). The project is approved by all members, without restrictions, being referred to the State Government to provide a new decree to modify the UTP of Guarituba zoning to fit the project design. The CGM is considered to be a body that represents the interests of the economic sectors related to the real estate – as its role in approving plotting subdivisions in spring area – and, with its agenda set by the Government, the participation of social sectors (ong's and universities) is considered a "*forged* participation, manipulated to reach a final product, a result."(Italics by the author, Schöne, 2004:129).

The prosecutor's approval is not required for the implementation of the New Guarituba Project, however, its prior consent seems to declare the actors' concern about posterior actions by the Public Ministry, taking into account the incisive performance in the environmental area in the state. Besides the first agreement – reported at the CGM meeting – all the project changes were presented to prosecutors. In one of those presentations – which counted on the presence of all the state bodies involved in the project – the prosecutor Saint-Claire Honorato Santos has made the prosecutors position very clear: "We need to keep the project guidelines and follow the main objective, which is to keep Guarituba as a spring area (Cohapar, 2007b). A review of the Public Ministry's role of in the Federal Constitution of 1988 gave credibility to the body, and transformed it into the arena of debate on different issues in the construction of the public good.

The importance of the public bodies in the debate on the New Guarituba Project denotes that the state is still the great concertation space, as if it simply represented the "will of the people." The relationship between the bodies' technical teams – both in the project's design and approval – demonstrates the ability of the technicians to make politics. More important than any social base, is that the project is in accordance with the criteria of approval of bodies as the City Hall, Comec, IAP, CGM, Federal Savings Bank (financial agent of the project) etc. The ability to approve (or not) the project or to request changes to the existing posture towards the norm, is the moment of technical and political bargaining, or "office politics" (Geraldi, 2008), where public debate is conducted by the technicians' understanding and the deliberative process becomes bureaucratic and obscure, as seen in Cristo (2010th, 2010b).

5 In conclusion

The New Guarituba Project is, as mentioned earlier, an "emblematic" work, and when it's done, will certainly serve as a model for other brazilian interventions that are based on the interpolation between housing and the environment. This due to the speech built on a specific form of intervention in the territory that supposedly includes the springs salvation and social recovery. As we have suggested earlier in the essay, our goal was to demonstrate the complexity of this relationship, in order to clarify that it is not the controversy between housing and the environment that is under

discussion here, but the land use by different actors – who take advantage of the fake housing versus environment dichotomy to justify without having to position themselves, and leave out actors that are noxious to this appropriation through the depoliticization of the deliberative process. Thus, all the controversy is constructed in order to give the planning the only legitimate voice to decide, and to the state, the only legitimate way of acting. Now, if the spring's legislation itself does not prohibit the plotting and the consequent use for housing, how can housing in these locations be controversial? We will present we will present next three points that based the central argument.

Multijustification as negotiating skills. The ease with which certain actors make justifications through different discourses must be recognized as great negotiating skills. In the case of Sanepar, for example, its political and territorial connection is not built by the controversy itself – does not absolutely position itself in one of the areas – there's a greater maneuver space. Despite the great apparent interest in the environment preservation (apparent, as in other regions of the State of Paraná, the company is presented as a potential polluter), what really matters to Sanepar is the water availability – the bigger the controversy between housing and environment, the less the need to politically position themselves for or against the others actors, thus, its speech is repeatedly justified and, especially, legitimated for and by the other actors, as it never is in direct conflict with any of them.

The renegade politic: the participation as a referendum. Despite the existence of participation in certain phases of the project, they always happen when major decisions have been taken, so the population is called upon to participate to countersignature the process, featuring a mere transmission of information by the authorities. Thus, the society's potential to make a politicized discuss on the production of urban space is denied, submitting it to a subordinate position – position legitimized by the establishment of a decision process that is based on the construction of false dichotomies to depoliticize the debate on social and environmental controversies.

What is the role of the media? ... And the "great audience" keeps waiting for more news. As the decision making process is unclear, information becomes a privileged matter. Thus, the media becomes the great decisions diffuser and, even, in the establishment of the project's controversy – as being the main form of inclusion of the society in the debate, and also defining it. In the way it is presented – as a spring's salvation and social redemption project, there is no definition of a critical view to the way in which decisions are made. In the analyzed documentaries, one can observe that the voices against the way the project has been implemented (especially local people), are shown through uninformed people that have no environmental awareness (after all, they are against the water preservation) or even compared to Don Quixote – as insane people raging against the machines used in the works.

Finally, we conclude that government planning – particularly its technicistic perspective – still seems to be the main tool for public deliberation, as if the state was a representation of the social virtue. We wonder thus, how can the planning – and the state itself – open up to the socioenvironmental controversies discussion and how can the participation give the appropriate weight for each actor in particular – especially for those left out of deliberative process. We are not concerned with the formal participation, because this would transform any participation in good participation, but it is the quality of the deliberative process that must be preserved. The construction

of public affairs through committed *demos* with an active citizenship would make the actual controversy appear rather than direct the discussion to a crossroad where the only possible solution would be that technically defined by the state.

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Planning policies and infrastructure development: the case of Vila Real Municipality

Sadia Afrin, Cristina Matos, Luís Ramos, Isabel Bentes, Júlia Lourenço

Department of Civil Engineering

University of Minho, sadia@civil.uminho.pt

Phone/fax numbers: 00 351 932814257

Department of Engineering

University of Trás-os-Montes and Alto Douro

This paper identifies the land-use changes in Vila Real Municipality, the major urban pole in North-eastern Portugal, for the period of 1990-2006. In addition, it explores the relationship between land-use change and wastewater infrastructure development in this municipality. The study uses CORINE land cover map and a Geographical Information System (GIS) to identify the pattern of urban development and identifies that about 822 ha of land have been urbanized in this municipality over those 16 years. The trend of land-use transformation and urbanization in Vila Real Municipality exerts pressure on the surrounding forest and rural areas by converting them into urban areas. The study finds that the main driving force behind this urban expansion is the improved road infrastructure rather than the application of urban and other land development policies. Thus, unplanned and sporadic urbanization has induced urban sprawl in this municipality and created pressure on its existing wastewater infrastructure system. The municipal cost of developing wastewater infrastructure has been increased to serve its dispersed urban clusters, aggravated by the complex natural topography and morphology of the terrain.

Keywords: Land-use; Urban sprawl; Wastewater; Infrastructure cost

1 Introduction

Vila Real Municipality, one of the medium sized municipalities in Portugal, has been facing rapid urbanization due to different policies and program undertaken by the Portuguese Governments since the last decade of the 20th century. Previously the municipality was underdeveloped like the other municipalities in Douro Region and it had lack of adequate infrastructures and proper connectivity with other major cities of the country. In fact, for decades, infrastructure development had been lagging behind in the axis Vila Real/Régua/Lamego because of the escalated construction costs involved in the complex topography of the region and the pricey land planted with vineyards. The urban areas of Vila Real Municipality started to expand when the government set out the Regional Plan for Douro Valley Land (PROZED) in 1991. Consequently, the government undertook other programs like PROSIURB and POLIS to foster urban growth in Vila Real Municipality. As a result, the population of Vila Real Municipality has continued to rise and it has increased about 10% over the period of 1991-2006 (Table 1).

Table 1. Population of Vila Real Municipality

Year	Population	Dynamic (%)
1981	47020	-1.6%
1991	46300	-1.5%
2001	49957	7.9%
2006	50423	0.7%

Source: INE, 2006

The increasing number of population creates pressure on the existing land uses of the city, as more people need more residential areas and more infrastructure facilities (Osman et al, 2008; Speir and Stephenson, 2002). Like the other rapidly growing cities, Vila Real has been experiencing land use transformation and a great deal of farm land and forest areas has already disappeared in order to accommodate the increasing number of population. However, due to the topographical and morphological complexity of the municipality, here the urban areas started to grow sporadically and it turned into urban sprawl. Thus, the physical dimension of urban sprawl exerted an enormous pressure on the existing infrastructures of the municipality, which fell behind to increase and/or maintain the quality of service provision in newly urbanized areas.

This study was carried out to explore the pattern of land use changes in the Vila Real Municipality over a period of 16 years started from 1990 to 2006 and its impacts on the existing infrastructure facilities of the municipality especially on its wastewater infrastructures. The paper has four major sections. The first section gives an overview of urban sprawl and its impact on the infrastructures of today's cities. The second section briefly discusses the different policy interventions undertaken to generate urban growth in Vila Real Municipality. The third section shows the result of these policy interventions, which generated land use transformation and urban sprawl in the municipal territory. The fourth section investigates the impacts of urban sprawl on wastewater infrastructure system of Vila Real Municipality.

2 Study Area

The Vila Real Municipality is located in the interior northern sub-region of Portugal named Douro and it is the capital of the district Vila Real. The municipality has 50,423 inhabitants to cover a total area of 378.8 km². Now Vila Real Municipality is one of the most densely populated municipalities in the Northeastern sub-region of Portugal, with a population density of 133.3 inhabitants /Km^2 which is well above the national average of 115 inhabitants/Km^2 and far exceeding the regional average of 52 inhabitants/Km^2 (INE, 2006). Although the municipality is composed of 30 parishes (freguesias), its main city covers only three parishes (Fig 1) and covers about half of the total population of the municipality (Wikipedia, 2010).

The municipality is located on a plateau surrounded by two mountains, Marão and Alvão, and has an average elevation of 460 m. The municipality exhibits a heterogeneous topography and a large diversity of morphological, ecological and climate conditions.

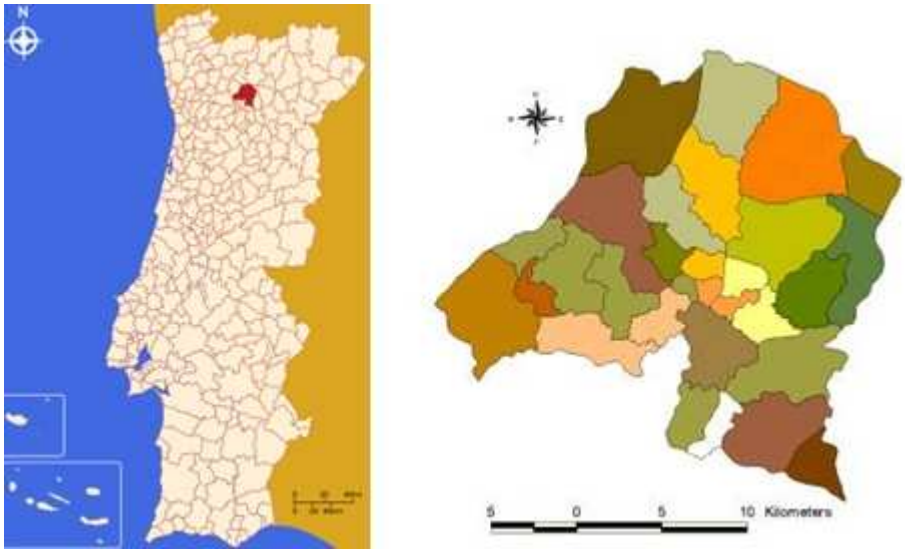


Figure 1. Location of the study area. Source: Wikipedia, 2010 and Vila Real Municipality, 2010.

The Vila Real Municipality is well connected with the other major cities of Portugal by two major highways. The IP4 highway connects the municipality in East-west direction with Porto and Bragança; and the A24 (toll-free motorway) connects it in North-south direction with Chaves and Viseu (Fig 2).



Figure 2. Road network in the study area.

Previously the municipality did not have adequate water and wastewater infrastructure but the situation was improved after the World Bank investment in 1980s. Additional funding was provided upon Portugal's admission into the European Economic Community (EEC) in 1986. These incentives and continued concern with expanding, upgrading and renovating of the existing networks have resulted in significant improvement to the infrastructure. By 2006, about 99% of the total population of the municipality was served by the water system. However, a disappointing situation

was found in case of waste water service as Vila Real Municipality's coverage was 71% which was below Douro region's average of 81% and the national average of 76% (INE, 2008). The municipality still needs improvement in the waste water infrastructure system to attain the national target of 90% coverage in 2013. It is relevant to mention that 100% of wastewater collected in the municipal sewer line is treated by the existing three wastewater treatment plants.

3 Methodology

A literature review was conducted In the study to get a general idea of the impacts of urban development on the wasterwater infrastructure. Information was also taken from the secondary sources to get the knowledge of the study area under review and find out the dynamic of urban development that has been observed there over time. The study used CORINE Land Cover (CLC) for two discrete moments in 1990 and 2006 respectively. In CORINE Land Cover (CLC), land uses are divided into three levels of classification: i) the first level includes five main classes of land use, ii) the second level consists of 15 classes of land use, and iii) the third level comprises 42 classes. In this study, two thematic land cover maps for Vila Real Municipality were produced based on the first level of CORINE Land Cover classification. Therefore, the land uses of Vila Real Municipality divided into the following five classes: i) Urban, ii) Rural, iii) Forest, iv) Wetland, and v) Water bodies.

ARC GIS 9.2 and Microsoft excel software were used in the study. At first, the CORINE Land Cover (CLC) of 1990 was opened in the ARC GIS software and its the third level of land use were reclassified into the first level of land uses. Afterwards, the administrative map of Vila Real Municipality was imported and the CORINE land cover was cut according to this administrative map to produce a thematic map of Vila Real Municipality in 1990. Later on, the area under each classification of land uses was calculated and the information was exported to an excel file. The same process was done for CORINE Land Cover (CLC) of 2006. Lastly two pie charts were prepared to compare of the land uses in Vila Real Municipality between 1990 and 2006. In addition, two thematic land use maps of 1990 and 2006 were used to show the pattern of land use change in the municipality.

The Municipal Master Plan (PDM) was scanned and some extracts were taken out at 1: 10,000 scale and overlaid with the digital orthophoto map from 1994 and 2004. Subsequently, an attempt was made to identify the existing pattern of new contruction in municipality based on the urban area delimitation provided in the PDM. Lastly, the statistical data were collected from INE (2008) to show the impacts of urban sprawl on existing wastewater infrastructure system of Vila Real Municipality in 2006.

4 Urbanization, urban sprawl and infrastructure development in cities

Urbanization is a process where cities grow as people move from the countryside in search of better jobs, better quality of life and better future of their children. It is a common phenomenon in today's cities and the cities grow spatially to accommodate an expanding population. Consequently, the infrastructure of the cities requires both development and rehabilitation to keep pace with this process of urban development (Sahely et al., 2005). However, too much spatial and uneven growth of a city

may create urban sprawl that requires roads and sewer systems to be extended over long distances to reach relatively fewer people.

Although urban sprawl has several definitions, the core concept of most definitions is low density, pattern of land use conversion which exceeds the population growth rate over a specified time period and the changes of the rural areas and/or farmlands into man-made environments (Beck and Kolankiewicz, 2001; Burchell, 1998, Galster et al, 2000 and Osman et al, 2008). Ewing (1997) has characterized urban sprawl as low density, strip, scattered and leapfrog development. Again, in Chesapeake Bay and Mid-Atlantic (2001) have been identified the three basic spatial characteristics of sprawl development: low-density sprawl, ribbon and leapfrog development. Low-density sprawl is the consumptive use of land for urban purposes along the margins of existing metropolitan areas that are supported by piecemeal extensions of sewer line. Ribbon development means a line of buildings, served by individual accesses, extending along a road, without accompanying development of the land to the rear. The areas along the road are served by wastewater infrastructure that was extended perpendicularly from the major roads and line. Leapfrog development is the most expensive in term of providing water and wastewater services in the cities. It is a discontinuous pattern of urbanization with patches of developed lands that are widely separated from each other (Burchell et al, 2005).

The infrastructure services play vital roles for ensuring urban sustainability (Osman et al, 2008). Infrastructure cost estimation is a fundamental step in the process of planning and selecting investments, and also for supporting medium and long-term strategic decisions (Earle and Farrel, 1997). In a context of urban sprawl, the need for accurate infrastructure cost estimation becomes more important since disperse urban types imply increased design, implementation, managing and operation and maintenance costs as opposed to more compact urban clusters, where these costs are kept lower (Neumann, 2003). One of the main criticisms of urban sprawl is that it undermines the cost-effectiveness provision of public services (Kaiser et al., 1995). In particular, it is argued that, for many services, the cost per unit of development rises as density decreases (Nelson et al, 1995, Carruthers, 2002). Therefore, urban sprawl leads to greater costs because of the large investments required to extend roads and other types of infrastructure like waster and sewage to reach relatively fewer numbers of people.

A number of studies have found that the costs of providing infrastructure-intensive services, such as water and sewers are much more sensitive to spatial pattern (Duncan et al, 1989). Water and sewer services are of particular interest to local governments, since these governments bear the vast majority of these costs. Overall, water and wastewater systems correspond to 20% (6% and 14%, respectively) of the total infrastructure cost of an urban system, which also includes transportation, energy and communication systems (Mascaró and Yoshinga, 2005). Duncan and Associates (1989) and Frank (1989) found that water and sewer costs for compact, contiguous housing patterns are 40% and 44% less respectively than those for spread-out patterns. Abiko et al (2003) list a number of factors that influence the cost of sanitation infrastructure: (1) network type and configuration; (2) size of serviced area; (3) shape of serviced area; (4) density of serviced area, and (4) slope in serviced area. Depending on the system, these factors become more or less important.

However, the cost of wastewater system depends more on network type and configuration of the network than on the size and shape of the area to be serviced. In long run, the large-scale

centralized wastewater treatment facilities are less expensive than the small-scale decentralized wastewater treatment facilities, although the first option is difficult to implement in case of urban sprawl in the city (Danko et al, 2009).

5 Urban policies and program for Vila Real Municipality

Previously the trend of urbanization here was mainly concentrated towards Lisbon, its national capital city and Porto, its commercial capital city. Later on, in 19th century the trend of urbanization also shifted towards its coastal regions located along the axis connecting the metropolitan areas of Lisbon and Porto, following a 400-year old migration trend of population from the rural interior of the country (Danko and Lourenço, 2008). The cities located in the coastal areas offer more job opportunities and better quality of life than those located in the interior region. Therefore, there is uneven urban development and growth between two regions. To tackle this problem of uneven development, the Government undertook a strategic approach to make urbanization more harmonize through out the territory of the country.

In 1993 Vila Real Municipality had its own Municipal Master Plan (PDM) covering it all municipal territory, in which urban areas including equipments, green parks and industries were projected to use 8.77% of all municipal land. Previously, in 1991 government approved a Regional Plan for Douro Valley Land (PROZED) where Vila Real town was first-time considered as a major node in the interior of northern Portugal (DGOTDU, 2002). Moreover, it took an effort to create links among Vila Real and other gateway cities through this regional plan (Fig3). Later on, to reduce development inequalities in the Portuguese urban network, Portuguese government created an urban policy tool PROSIURB Program which was put in practice between 1994 and 1999. The programme invested strongly in the strategic role of medium-sized cities in polarizing development and in organizing sub-regional spaces. In addition, the programme paid particular attention to the development of cooperation synergies between urban centres (Lobo, 1997). As a result of this program, the population of Vila Real Municipality started to increase rapidly. Finally, in 2000, Vila Real Municipality was incorporated as one of 28 medium sized cities of Portugal where the POLIS program was initiated to improve their quality of life and to increase their attractiveness and competitiveness in the urban constellation of the national network system as key urban nodes (MAOT, 2000).

As an impact of the above mentioned planning policies and programs, the existing urban area of Vila Real Municipality has started to expand outward. Moreover, new urban areas have been created in this municipality. However, the municipality was unsuccessful to maintain sustainable development as in most cases the newly developed area has low density which has introduced urban sprawl in the municipality. Not only a scattered development was found besides the city proper area but also a leapfrog development was introduced along the A24 motorway.

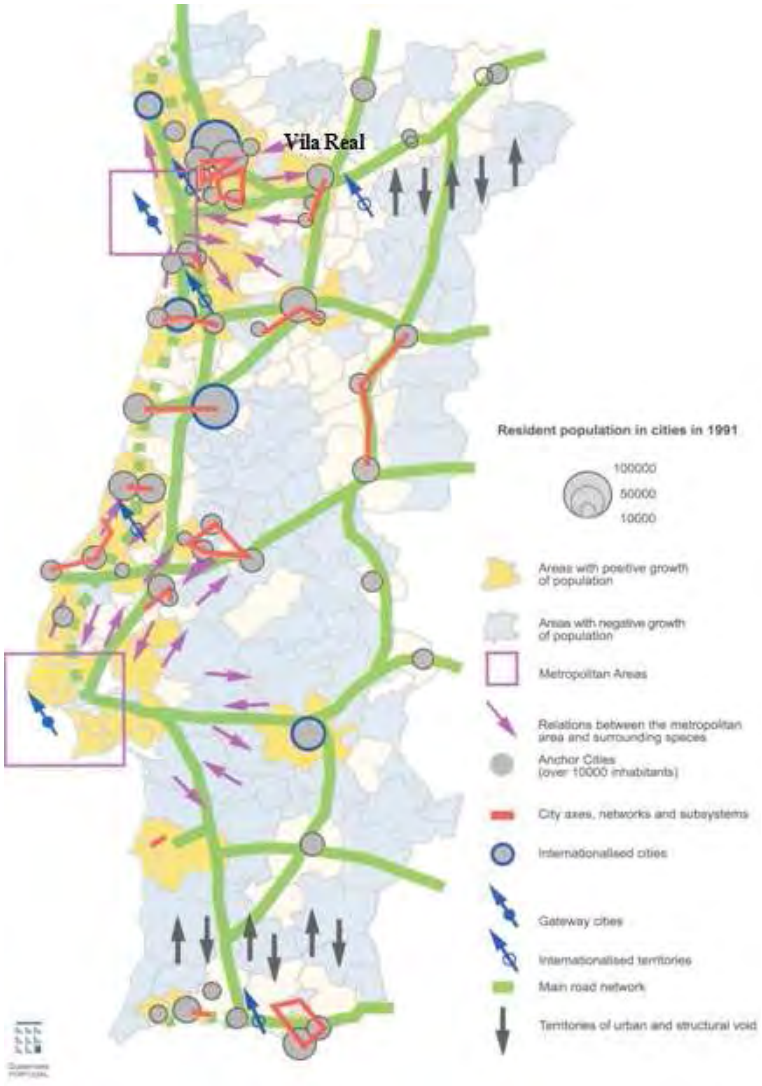


Figure 3. The Portuguese Urban System – a strategic approach in 1991. Source: DGOTDU, 2002.

6 Urbanization and land use transformation in Vila Real

The two thematic land use map of the Vila Real Municipality of 1990 and 2006 illustrate the pattern of land use changes in the municipality over 16 years period (Fig 4 and Fig 5) and the proliferation of urban sprawl in the municipal territory. For easy understanding, quantification of land use changes are shown in percentage by the pie charts in Fig 6.

Though Vila Real Municipality is one of the fastest growing municipalities in Northeastern Portugal, two types of land use are dominant here. Forestry and rural uses of the municipality prevail over urban uses, wetland and water bodies and this scenario is unchanged over the periods as shown in Fig 4 and 5. Vila Real Municipality maintains strong rural characteristics, having 34.67% of land occupied by rural uses (Fig 6). Despites urban sprawl in the municipal territory, only 0.28% areas were shifted from rural uses to other uses over the period. The municipality's dependency on agriculture was the main reason to maintain rural landscape in its territory. Primary activities of the

municipality contribute to the national agricultural sector regarding the production of high quality products such as wine, olive oil, dried fruits and fresh fruits.



Figure 4. Land uses of Vila Real Municipality in 1990.

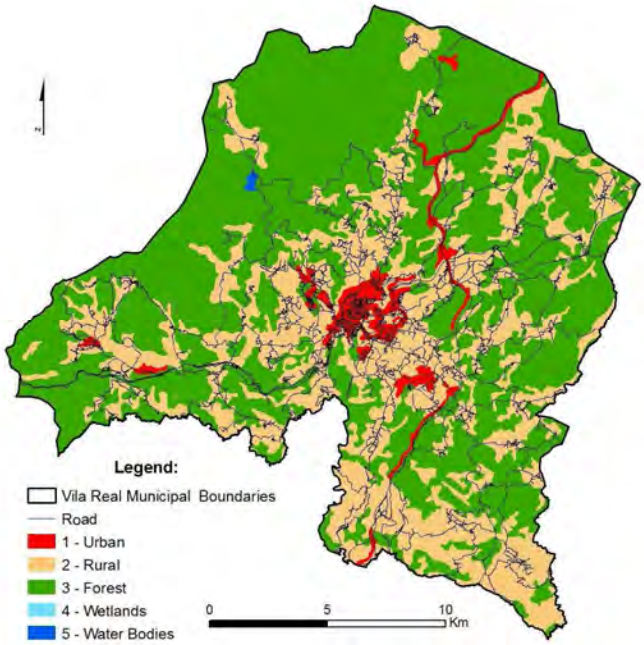


Figure 5. Land uses of Vila Real Municipality in 2006.

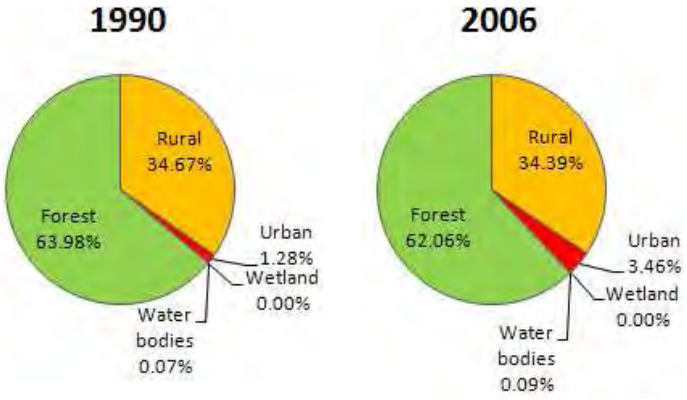


Figure 6. Land use change in Vila Real Municipality over the period of 1990 to 2006.

Forest uses are the most dominant landscape in Vila Real Municipality, covering almost three-fifth areas of the total municipal territory. A tendency of deforestation prevails in the municipality to accommodate the urban sprawl which is continually increasing. So far, the urban areas of the municipality were increased by 2.17% (Fig 6) during the 16 years period due to the application of the different planning policies and improvement of road infrastructure. The leapfrog urban area developments in central and northern part of the municipality, and the ribbon development along the A24 toll-free motor were the main driving forces behind this land use conversion. In addition, low density sprawls escalated on the outskirts of the already existing urban areas in the municipality.

The calculation of urban areas in two distinct times shows that about 822 ha (82200 Km^2) more lands are occupied by urban uses in 2006 than that in 1990. The urban areas of the municipality are likely to increase further as projected in PDM in 1993. Again, the municipality consistently displays higher population growth rate than other municipalities in the Douro region due to several factors such as demographic change, growing affluence and transportation infrastructure development. It seems that improvement in the main road infrastructures were the main driving force of urban sprawl in Vila Real Municipality rather than application of the different planning policies.

7 Effects of urban Sprawl on the wastewater infrastructure

Vila Real Municipality is not successful to maintain a controlled and sustainable urbanization in its territory. Therefore, urban sprawl is spreading in the municipality which is difficult to serve by its centralized network based wastewater infrastructure system. The present system of Vila Real Municipality serves 71% of its total population. Hence, 29% of people remain outside of the conventional wastewater treatment service. Every day the existing system can treat 100% of $1516X10^3$ m^3 wastewater that are drained to the three wastewater treatment plants, although the total volume of wastewater produced in the municipality is $2146X10^3$ m^3 (INE,2008). However, Vila Real Municipality needs to boost up the service coverage of the wastewater infrastructure upto 90 % of its population by 2013 to fulfill the national target of wastewater coverage stipulated in the Strategic Plan for Water Supply and Wastewater Collection and Treatment (PEASAAR) 2007-2013. Therefore, the challenge remains for the municipality to include 20% additional people under its current wastewater infrastructure system that will greatly increase municipal wastewater service cost per

inhabitant to serve relatively small number of people. Moreover, the service coverage of the present wastewater infrastructure also needs to be increased to serve a greater number of inhabitants in future to cope up with the increasing trend of the municipal population in Vila Real Municipality.

Harsh natural factors combined with observed population dynamics place major hindrances to implementation of improved level of service in Vila Real Municipality. The cost of equipping dispersed urban clusters is compounded by the complex natural topography and morphology of the terrain. For instance, broader wastewater collection systems (they are gravity based) are not only bound to the number and size of urban clusters but also to the limitations of the terrain. Again, the several extracts of the Municipal Master Plan (PDM) show that a large number of new buildings are following the road network of the municipality and located themselves outside of the already enlarged urban areas boundaries delimited in 1993 (Fig 7). Therefore, it will not be feasible to install network based sewer line in all the newly developed urban areas and hence, to cover them under the current wastewater treatment system.

Developed in 1980s, the present network based of the sewer system was right choice for the municipality until the municipality faced the problem of urban sprawl. It mainly serves the densely populated central urban areas of the municipality which contains the majority of the people. However, Fig 5 and Fig 6 clearly illustrate the expansion of urban areas in Vila Real municipality which shows the requirement of either the renewal of existing system or the installation of alternative systems such as small scale decentralized treatment plants to maintain a given level of public service for all its residents. It is to mention here that rendering wastewater services to the households developed on the scatter urban areas will cost more than to the households developed in the low density urban areas development along the A24 motorway. At present the municipality spends 17601 euro per 1000 inhabitant on wastewater management. The urban sprawl will increase per capita wastewater management cost of the municipality to cover the extra people, living in the low density areas.

According to the data from INE (2008), expenditure of Vila Real Municipality on wastewater management was 883 thousand euros whereas its collected revenue from this service is 822 thousand euros. Therefore, the municipality has already a 61 thousand euros deficit in managing its current wastewater service. Urban sprawl of the municipality will exert pressure to increase its expenditure on operation, maintenance and management for providing wastewater services. Again, as discussed in the earlier section, the current trend of urban sprawl will push new development away from areas with existing high density urban development and pull new development towards areas with yet undeveloped land. Therefore, the municipality will need additional financial resources for the construction of new wastewater infrastructures or the expansion of the existing system to serve the people living in the sprawl areas. It will further reduce the cost-effectiveness of the wastewater service in Vila Real Municipality.

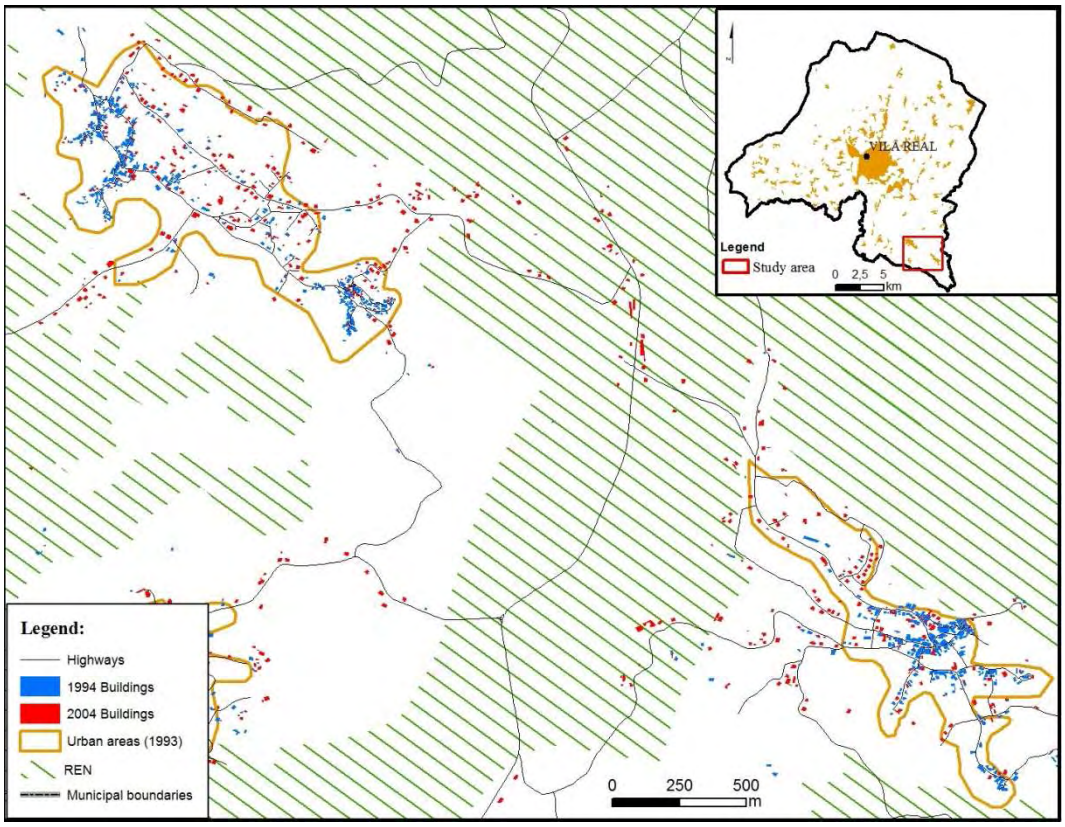


Figure 7. Current habitation pattern of Vila Real Municipality.

8 Conclusions

Similar to the other municipalities in the Northeastern region of Portugal, the land uses of Vila Real Municipality are largely dominated by the vineyard and forestry uses. However, the municipality is facing rapid urbanization with its increasing population trend which is resulting in urban sprawl. Apparently different planning policies undertaken by government has been successful to generate population growth in this municipality but the uncontrolled proliferation of small, scattered and low-density areas are being replaced the forest and agricultural use and also get exerted pressure on the existing wastewater infrastructure service of the municipality. As a consequence, the municipality is falling apart from its target of achieving 90% coverage of wastewater service by 2013. Again, technological difficulties to find a suitable and cost-effective alternative solution for the complex morphology of the municipality and increased municipal expenditure of wastewater infrastructure put pressure on the municipal government to serve a large number of people living in scattered areas. Therefore, a combination of small scaled decentralized waste water treatment plants together with the existing conventional wastewater treatment service of the municipality could be a possible solution. However, a comprehensive research is required to bring sustainable wastewater management for the municipality. Moreover, measures are necessary to retard the urban sprawl and ensure a systemic and controlled urban growth in Vila Real Municipality so that all inhabitants of the municipality get a standard quality of wastewater infrastructure services. The municipal government

should adopt some land use control as low-density zoning and building permit caps to discourage urban sprawl. Again, it can also identify areas where high densities are appropriate such as the already built-up central urban areas and provide incentives for high-density residential development to occur there.

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Urban form versus economic interests: an unstable balance

Emília Rebelo

CITTA – Research Centre for Territory, Transports and Environment

Faculty of Engineering, University of Oporto, emalcata@fe.up.pt

Phone/fax numbers: 00 351 225081482 - 00 351 225081486

The main purpose of this article consists in making a reflection on the relations between the planning decisions on urban form and the interests of the different agents involved in development processes (where the economic interests stand out) and respective impact on urban land rent and, therefore, on proper real estate values. The increasing economic pressures on urban morphologies and building typologies simultaneously influence and are influenced by planning processes and practices. Contrary to what currently occurs in planning frameworks, economic issues are rarely dealt with in Portuguese plans. Thus the author contends that plans should cease to be strictly-focused on physical concerns, and enlarge their scope for intervention. She argues that physical and economic issues shouldn't proceed different ways in planning, and proposes that plans should include measures to assess the economic impact they exert on urban realities and vice versa. Some proposals are made for these measures, based on econometric procedures, in order to generate alternative analysis and feasible surplus values taxation devices, complying with morphological and typological patterns of land use, but strengthening synergistic development processes.

Keywords: urban land rent; land and real estate agents; surplus values; economic impacts of planning; econometrics

1 Introduction

Social life of individuals proceeds through a set of inter-relations with spatial expression (Santo, 2006). Territory is a first-order good and, within this scope, local territorialities assume increasing relevance.

Municipal decision-makers have been intervening in property markets in order to foster private free initiative, through concession of permits and provision of favourable development conditions. But territorial users are becoming more and more dependent on state and municipal institutions, and on concessionary firms that explore infrastructures and services networks (Pardal, 2004) that, in practical matters, charge monopoly prices and rents (Pardal, 2006b). Despite property markets are strongly shaped by territorial plans, and by the intervention of those organisms, the urbanism shouldn't be mastered by a strictly market rationale, as it is a public service under the auspices of the state and of the municipalities (Pardal, 2003). Besides, whenever municipal powers take planning decisions, whether at the level of plans or planning processes – concerning land use changes, urban perimeters, land property division; increases in the number of autonomous plots, expansion of building capacity, and public works - they potentially trigger effects on land uses and respective values.

Within this context, the public administration holds the responsibility to provide land for the different kinds of uses (Pardal, 2006a), making sure that their decisions don't benefit certain groups at the expense of the general social interest. A strategic territorial management is required, that includes a whole inter-related assessment of engineering, economics, and law perspectives (Santo, 2006), as a guarantee of justice, trust and technical and scientific accuracy. Thus changes in land

uses and respective intensities should be monitored and rendered operational, in order to articulate sustainable economic and social policies. These interventions involve the development of a set of tools to monitor and control property price levels (and respective evolution) by municipal powers, based on the comprehension of its structure, operation and local characteristics.

2 Bibliographic framework

2.1 The interests of the different agents in property markets

The production and allocation of urban space result from the inter-relations of complex decisions taken by different economic agents. The search for land – and its price – depends on anticipated space needs for family lodging, and for industrial, trade, and services activities. So the analysis of the roles played by the different property agents[1] becomes increasingly important**.**

In order to increase land values, landowners often resort to hoarding and land differentiation strategies. Development agents, promoters and builders operate at the production and trade stages, in order to reach as much profit as they manage to. Real estate agents, valuers, consultants and other professionals foster trade volume and efficiency through the articulation between buyers and sellers, as they render easier the circulation of information concerning real estate availability, characteristics and location. Final consumers (whether owners or leaseholders) worry about real estate quality and prices. Credit institutions, by their turn, perform a cash-flow regulation role within property markets. Finally, regional and local authorities are responsible for the application of laws and regulations; for tax collection, for control over land use changes and respective intensities, and for decisions on investments in infrastructures, equipments and public spaces.

Municipal interventions foster urban development processes, and render flexible their administrative control. However, they are also pressured by prevailing political and economic forces (Feagin, 1982, 1983; Form, 1954; Rydin, 1984; Short et al., 1986; Tang et al., 2000). Sometimes agents try to escape from the strict application of planning and fiscal regulations, and enter into negotiations with the authorities in order to change zoning borders and land use parameters, to transfer development rights, or to slack tax collection (Wakeford, 1990). The proper characteristics of the property markets – namely the limited number of trade participants, the lack of transparency and a certain monopoly degree detained by some market agents - cherish these behaviours. All these reasons together nourish speculative processes, and lead the majority of surplus-values generated by planning administrative decisions to escape authorities, not being allocated for the general social interest.

2.2 The absence of economic concerns in Portuguese territorial plans

Portuguese territorial plans have systematically ignored the operation of property markets[2] (Pardal, 2006a), and the effects they exert on these markets, namely in what concerns: (i) demand and supply segmentation, (ii) the formation of land and real estate prices; and (iii) how land should perform its social function, respecting property rights (Pardal, 2006b). There exists a high search for new territorial forms; rules concerning the creation, computation and distribution of surplus values aren't accurately settled; and the planning system doesn't clearly delimitate central and local remits (both of

them depend on discontextualised and arbitrary technical views). Thus the assignment of uses, the formation of values, and the appropriation of land become obscure, and many interests operate on the margin of law, what entangles in market uncertainty and distrust. On the one hand landowners search for the maximum profit when they sell land to developers, what increases the latter's risk. On the other hand, promoters also try to appropriate as much surplus-values as possible, what is supported on proper legislation. The state and municipalities – through taxation – and banks – through credit systems – also look forward to appropriate surplus values on their behalf (Pardal et al., 1996).

2.3 How planning can retrieve surplus values

Planning interventions on property markets (Dunse and Jones, 2002) are performed through planning, regulations, administrative proceedings, or fiscal mechanisms. These interventions are implemented through (Ihlanfeldt and Raper, 1990; Rebelo, 2009, 2010): zoning ordinances; legal incentives or restrictions; property taxation; control over land use changes; urbanization costs; and decisions on investments on infrastructures, equipments and public spaces. As these interventions rule development processes (Ihlanfeldt and Raper, 1990), they impact on the physical form, the urban morphologies and the building typologies, as well as on the economic-territorial distribution.

Zoning policies (Ihlanfeldt and Raper, 1990) shape real estate supply, namely through either the prohibition or promotion of respective concentration, or through raised urbanization costs – that may result either from the shortage of proper land, or from the lack of infra-structured land. The United States of America, Canada and several Latino-American countries manage to indirectly control real estate price and rent levels (Rebelo, 2009) through the application of different surplus values taxation mechanisms, and different urban policy regulation tools. Incentive or restriction policies, control over land use changes, urbanization costs or investment decisions – implemented, namely, through fiscal incentives, zoning or building regulations, and subsidy awarding to encourage real estate investment in certain spaces -, besides regulating the capital flow between the economic cycles, guide private investments to certain locations and respective neighbourhoods, thus conditioning respective profitability (Hanink and Cromley, 1998; Feagin, 1983).

The value of a certain land plot is shaped both by plans and by the economic dynamics. Thus it comprises a territorial-based component (that depends on its juridical status, location, dimension, and use authorized by territorial plans), and another component that results from the investments of its owner (Lee, 2003; Arnott and Petrova, 2006; Pardal, 2004, 2006a). The territorial-based value depends on the land use policy that rules the juridical, economic, administrative and functional land appropriation, and settles the reasonable price that should be supported by its use (Lee, 2003; Pardal, 2004, 2006a).

The pure surplus values correspond to the accrued value of a plot that results from the administrative remit to decide on urbanization programmes (that correspond to the qualification of territorial systems), but part of them may translate profits or property valuations that result from owner's investments (Pardal et al., 1996). It consists in ascribing it an index expressed as a building area, or as the number of autonomous parcels for housing, offices or trade purposes, and it can only

be assessed for specific plots, within a determinate market context. Public works may also potentially engender increases in real estate values[3].

When public entities buy land that, afterwards, develop and send at public auctions, they manage to keep beforehand[4] the surplus values generated by their own decisions on behalf of the general social interest. This procedure disciplines urban growth, balances land markets, and doesn't trigger conflicting situations (Pardal et al, 1996). However, if the production of development land ceases to be the sole responsibility of public administration, then it faces greater difficulties to rule land markets and urban growth, and consequently looses its ability to keep the resulting surplus values. In the current system, where the majority of development initiatives are lead by private agents, surplus values merge with costs of infrastructures and with additional profits, thus its effective retention for the general social benefit isn't possible any more (Pardal, 2004, 2006a), what is often worsen by difficulties to distinguish rent from profit (Pardal et al., 1996).

In many European countries, speculative prices are kept under control through land exchange: municipalities provide land plots when alternative market plots reach excessive high prices (Correia, 1993).

In property markets, surplus values may be retrieved through taxation (Smolka and Amborski, 2003). As this process is prone to engender unbalanced situations as compared with the taxation of other property assets, its justification funds, on the one hand, on the guarantee of possession rights given by the public administration to landowners and, on the other hand, on the services rendered by infrastructures´ maintenance, and on the support to the settlement structure that justifies land use and economic value. From this perspective, property taxes rely on the benefits attached to each kind of property, and depend on its territorial-based value. In the United States of America, Canada and Latino-American countries different surplus values appropriation tools, as well as urban planning regulation tools, are used by public administration. They span from traditional taxes to urbanization fees, in varying percentages, according to countries (Smolka and Amborski, 2003).

In order to make sure of the neutrality of owners´ interests in relation to uses or intensity of uses proposed in plans, the surplus-values tax should solely have an effect on the territorial-base value (that is independent from investments and improvements that result from the owner's initiatives). So a balanced land use policy should proceed that allows the settlement of parameters, the monitoring and control of surplus values´ creation and distribution, avoiding and fighting against speculative behaviours (Pardal, 2004, 2006a, 2006b). The amounts that add or decrease to the plot value as a consequence of use classifications, of building coefficients, or of other ruling factors that accrue from plans or decisions that impact property values should be clearly defined (Pardal et al., 1996; Pardal, 2006a, 2006b). Also real estate prices should be kept under control, thus avoiding the opportunistic appropriation of speculative profits by promoters (Arnott and Petrova, 2006; Lee, 2003; Pardal, 2006a, 2006b). If these transparent procedures aren't issued, the political, technical and administrative agents that intervene in land use regulation and licensing will strive against one another for changes in land use and respective intensities (Pardal, 2006a).

3 A methodological proposal to compute surplus values

In order to ensure the availability of land for the different functional uses at reasonable prices, avoiding the generation of excessive profits in property markets, and guaranteeing the neutrality of landowners´ interests, planning should intervene on property laws, and develop property assessment tools for any places, uses and intensities of use, at any time.

Herein is exposed a methodology that enables the assessment and quantification of surplus values, in order to support more efficient urban planning interventions in monitoring, evaluation, control, taxation, and distribution of surplus-values engendered by territorial plans and regulations. This methodology consists, on the one hand, of the development and implementation of a management information system, and on the other, of the development of an original way to compute surplus values and additional profits in land aimed at different functional uses, based on a hedonic model for real estate and on average development costs (Figure 1):

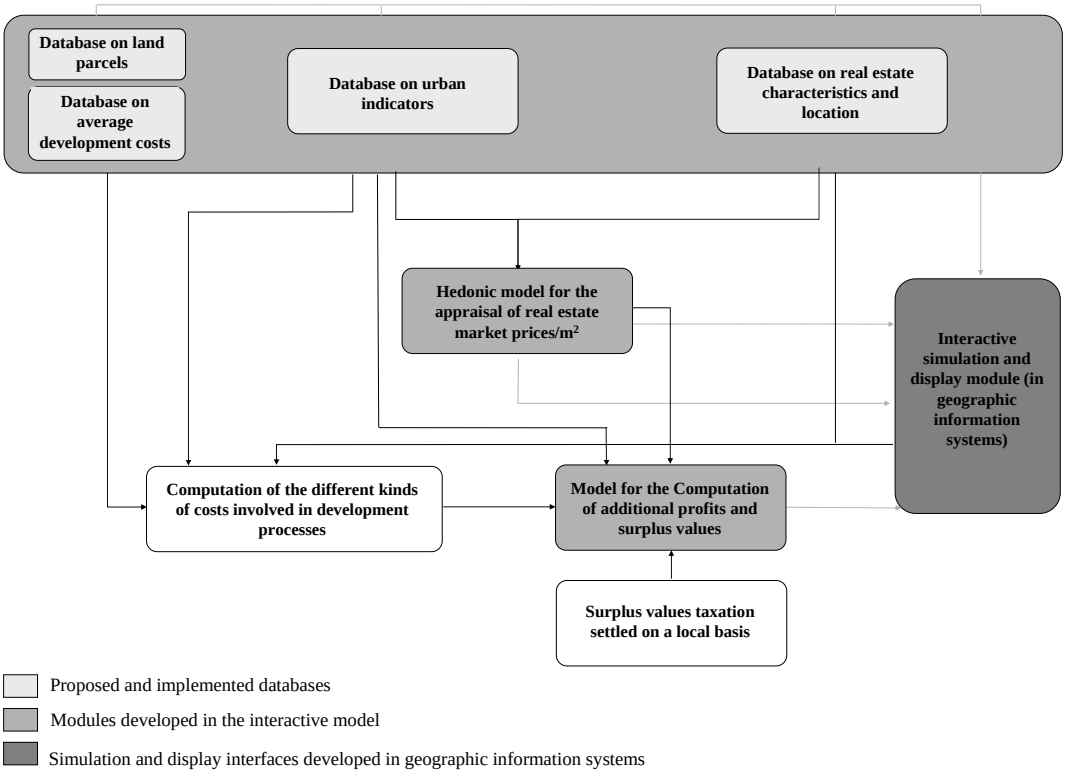


Figure 1. Model to compute the extra-profit and surplus values that accrue from planning decisions.

The management information system developed and implemented in the research reported in this article is made up by the following four databases:

1. Database on land parcels, that enables the monitoring of the majority of variables concerning land characteristics and uses allowed by territorial plans and other land use policy tools. It includes the following indicators: dimension of the plots; geomorphologic characteristics; absolute and relative location in relation to the main centres and sub-centres; licensed land use; (current or anticipated) property division; (real or anticipated)

taxes; and indirect surplus-values that accrue from infrastructures, equipments, public services and other undertakings.

2. Database on urban indicators, that include indicators that shape real estate supply, demand and prices (some accrue from market operation and others are under municipal authorities´ control): geo-referenced location of real estate units; applicable planning rules (concerning, namely, zoning ordinances and land use coefficients); location indexes of different kinds of functions (that show their relative spatial concentration as compared with the whole territory); weighted distance to the main urban centres; tendency that activities exhibit to remain in the same location, or to change to a new location; public investments in communications and transports; culture, sports and leisure time; public health utilities; environment; education; housing; economic development and tourism; civil protection; social action; and urbanistic qualification; number and density of inhabitants in each block; and date.

3. Database on average development costs, that includes land acquisition and related costs; urbanization costs; building costs; management, administrative and marketing costs; financial costs; and property taxes:

- Building land costs/m^2 are computed taking as a base the selling prices of plots for housing traded at public auction – which approach land prices for social uses. These prices are, then, weighted according to the average percentage that land for different functional uses (for industrial, trade or services purposes) exceed land for housing purposes. Land acquisition costs include other parcels, expressed as percentages of building land costs/m^2: municipal transfer tax (10%); stamp duty (0.4%); property registration costs (0.5%); notarized costs (0.5%); and lawyer honoraries (0.5%).
- Development costs/m^2, that represents the costs of land infrastructures and participation in public investments, are computed according to the municipal tax on urban infrastructures.
- Building costs/m^2 include not only proper construction costs (that approach selling prices/m^2 of common housing, annually published as a decree in the government diary), but also costs of equipments (heating systems, lifts and special foundations); building honoraries; different contingent costs (that generally go up to 5% of the total costs); and building inflation.
- Management, administrative and marketing costs/m^2 were assumed to amount to 0.8% of total construction costs/m^2. It was additionally considered a 20% added value rate upon those costs.
- As far as financial costs/m^2 are concerned, it was considered a 6.2% rate of annual capital cost, and 50% of borrowed capital for land acquisition purposes, and 50% of borrowed capital for commercialization purposes (commercialization costs were assumed to amount to 0.5% of total building costs).
- The municipal tax on property depends on the kind of use[5].

4. Database on real estate characteristics and location, that gathers systematized information on the characteristics, location, morphology, typology, and kinds of uses of real estate units and respective buildings.

The planning regulations and restrictions allow the construction of a certain area or volume in each land plot. The total expected income may be computed by the product between the total allowed building area and the selling price of the real estate product/m^2. According to the functional use, characteristics and location, the selling price/m^2 may be anticipated by a hedonic model that expresses it as a function of the indicators systematised in the urban management information system (Rebelo, 2009; 2010). This model easily fits new and upgraded information, thus it may be reformulated and used as a continuous monitoring system.

The difference between the land market value and the land cost based on public auction sales of land plots with similar characteristics and locations includes two distinct components: the additional profit (difference between the land patrimonial value[6] and the land cost based on public auction sales), and the surplus value (difference between the land market value and respective patrimonial value). The land market value is given by the difference between the total expected income and the set of anticipated urbanization, construction, management, administrative marketing, and financial costs, taxes and a normal profit margin, and expressed as a multiple of those total costs[7]) (Rebelo, 2003, 2009). The patrimonial value of building land is computed according to the municipal tax on property[8] (Rebelo, 2009): it is given by the sum of the value of the buildings´ implantation land with the value of building-adjacent land. The value of buildings´ implantation surface, by its turn, spans between 15% and 45% of building costs (this percentage already includes the location characteristics).

4 Case study: the office market in Oporto city

The developed hedonic model expresses offices selling price/m^2 as a function of the following urbanistic variables (see Rebelo, 2009, 2010): spatial location of offices; zoning and land use coefficients; location indexes of office activities; weighted distance to the most recent business district (located on Rotunda of Boavista); temporal inertia of the activities (tendency they have to stay in the same location); public investments; number of people working in the upper tertiary sector; and date.

In Table 1 is presented an excerpt of the database of the different costs involved in offices urbanization and building processes in Oporto city:

Table 1. Different kinds of costs/m^2 involved in land acquisition and building of offices, according to their location in Oporto city (excerpt of the database)

	Land acquisition costs/m^2								Building costs/m^2				Financial costs/m^2				
Address	**Building land costs/m^2 for offices**	**Municipal transfer tax /m^2**	**Stamp duty/m^2**	**Property registration costs/m^2**	**Notarized costs/m^2**	**Lawyer honoraries/m^2**	**VAT on lawyer honoraries/m^2**	**Urbanization costs/m^2**	**Total land costs/m^2**	**Average office building costs (andspecialized works)/m^2**	**Average costs of building garages /m^2 of office buildings**	**Office buildings´ total cosrs/m^2**	**Management, administrative and marketing costs/m^2**	**Financial costs of land acquisition/m^2**	**Financial costs of trade/m^2**	**Total financial costs/m^2**	**Municipal tax on property/m^2**	**Total costs/m^2**
95 RUA JOAO BAPTISTA LAVANHA R	11,5	4,2	0	2	2	2	2	1,5	2,0	5,0	4,8	8,8	,7	,4	1	,4	0,8	,6
ALAMEDA ECA QUEIROS AL	1,5	1,2	8	1	1	1	2	1,5	8,4	5,0	4,8	8,8	,7	,3	1	,4	0,770	,0
ARGO ADRO LG	11,5	3,2	1	4	4	4	2	1,5	6,8	5,0	4,8	8,8	,7	0,7	1	4,8	0,770	,8
7762 ESTRADA CUNVALACAO EST	6,0	2,6	9	1	1	1	2	1,5	4,6	5,0	4,8	8,8	,7	,8	1	,9	770	5,7
7742 ESTRADA CUNVALACAO EST	6,0	2,6	9	1	1	1	2	1,5	4,6	5,0	4,8	8,8	,7	,8	1	,9	770	5,7
RUA TENENTE VALADIM R	00,0	0,0	2	5	5	5	2	1,5	6,3	5,0	4,8	8,8	,7	1,0	1	,1	770	0,6
RUA INFANTE SANTO R	11,5	4,2	0	2	2	2	2	1,5	2,0	5,0	4,8	8,8	,7	,4	1	,4	770	4,6
646 RUA PROF RREIA ARAUJO R	1,5	1,2	8	1	1	1	2	1,5	8,4	5,0	4,8	8,8	,7	,3	1	,4	770	0,0
RUA ALEGRIA R	6,0	2,6	9	1	1	1	2	1,5	4,6	5,0	4,8	8,8	,7	,8	1	,9	770	5,7
PRACA FLORES PC	11,5	3,2	1	4	4	4	2	1,5	6,8	5,0	4,8	8,8	,7	0,7	1	4,8	4,8	0,8
48 LARGO FONTINHA LG	11,5	3,2	1	4	4	4	2	1,5	6,8	5,0	4,8	8,8	,7	0,7	1	4,8	770	0,8
46 CAMPO RTIRES PATRIA CPO	11,5	3,2	1	4	4	4	2	1,5	6,8	5,0	4,8	8,8	,7	0,7	1	4,8	770	0,8
RUA ALEGRIA R	6,0	2,6	9	1	1	1	2	1,5	4,6	5,0	4,8	8,8	,7	,8	1	,9	770	5,7
RUA EUGENIO CASTRO R	00,0	0,0	2	5	5	5	2	1,5	6,3	5,0	4,8	8,8	,7	1,0	1	,1	770	0,6
PRACA PEDRA VERDE PC	05,0	0,5	8	0	0	0	2	1,5	1,1	5,0	4,8	8,8	,7	,1	1	,2	770	2,5
RUA EUGENIO CASTRO R	00,0	0,0	2	5	5	5	2	1,5	6,3	5,0	4,8	8,8	,7	1,0	1	,1	770	0,6
6 LARGO PROF L SALAZAR LG	11,5	3,2	1	4	4	4	2	1,5	6,8	5,0	4,8	8,8	,7	0,7	1	4,8	770	0,8
ALAMEDA ECA QUEIROS AL	1,5	1,2	8	1	1	1	2	1,5	8,4	5,0	4,8	8,8	,7	,3	1	,4	770	0,0
50 RUA SOEIRO MENDES R	05,0	0,5	8	0	0	0	2	1,5	1,1	5,0	4,8	8,8	,7	,1	1	,2	770	2,5
PRACA PEDRA VERDE PC	05,0	0,5	8	0	0	0	2	1,5	1,1	5,0	4,8	8,8	,7	,1	1	,2	770	2,5
ALAMEDA ECA QUEIROS AL	1,5	1,2	8	1	1	1	2	1,5	8,4	5,0	4,8	8,8	,7	,3	1	,4	770	0,0
PRACA PEDRA VERDE PC	05,0	0,5	8	0	0	0	2	1,5	1,1	5,0	4,8	8,8	,7	,1	1	,2	770	2,5
174 CAMPO RTIRES PATRIA CPO	11,5	3,2	1	4	4	4	2	1,5	6,8	5,0	4,8	8,8	,7	0,7	1	4,8	770	0,8
ALAMEDA ECA QUEIROS AL	1,5	1,2	8	1	1	1	2	1,5	8,4	5,0	4,8	8,8	,7	,3	1	,4	770	0,0
116 PRACA QUES POMBAL PC	6,0	2,6	9	1	1	1	2	1,5	4,6	5,0	4,8	8,8	,7	,8	1	,9	770	5,7
11 LARGO JOSE OREIRA SILVA LG	6,0	2,6	9	1	1	1	2	1,5	4,6	5,0	4,8	8,8	,7	,8	1	,9	770	5,7

Unit: euros

In Table 2 is presented the computation of the additional profits and surplus values for some selected offices in Oporto city, according to their location:

Table 2. Computation of the additional profits and surplus values in some selected offices in Oporto city (excerpt from the database)

Address	Land use coefficient	Number of floors	Anticipated selling prices/m^2 (euros)	60% of total income/m^2	Land market value/m^2 (according to the hedonic model) [1]	Land costs/m^2 (based on sales at public auction) [2]	Land patrimonial value/m^2 [3]	Additional profit = Land patrimonial value/m^2 – Land costs/m^2 [3]-[2]	Surplus-values = Land market value/m^2 – Land patrimonial value/m^2 [1]-[3]
8 RUA BRAS CUBAS R	5	1,85	1052,4	1169,3	855,5	211,5	705,1	493,6	150,4
57 RUA FLORES R	5	1,85	858,0	953,3	691,4	281,5	653,1	371,6	38,3
55 RUA DR RICARDO JORGE R	5	1,85	1377,0	1530,0	1268,1	281,5	659,2	377,7	608,9
49 RUA FORMOSA R	5	1,85	1429,5	1588,3	1285,4	226,0	659,5	433,5	625,9
455 COMBATENTES GRANDE GUERRA AVE	5	1,85	1160,3	1289,2	975,5	211,5	705,8	494,3	269,7
433 RUA NOSSA SENHORA FATIMA R	5	1,85	1436,0	1595,6	1340,0	290,0	637,4	347,4	702,6
411 RUA CASTELOS R	5	1,85	1362,1	1513,5	1290,5	290,0	753,8	463,8	536,7
393 RUA ALEGRIA R	5	1,85	1472,4	1636,0	1332,9	226,0	696,5	470,5	636,4
35 RUA LIMA JUNIOR R	5	1,85	1284,0	1426,7	1074,0	159,0	756,2	597,2	317,8
2533 FERNAO MAGALHAES AVE	5	1,85	935,3	1039,2	686,5	159,0	758,4	599,4	-71,9
242 RUA S BRAS R	5	1,85	1504,2	1671,3	1409,5	281,5	649	367,5	760,5
227 RUA PINTO BESSA R	5	1,85	1260,8	1400,9	1059,0	173,5	745	571,5	314,0
203 RUA GUEDES AZEVEDO R	5	1,85	1554,3	1726,9	1465,1	281,5	645,2	363,7	819,9
1395 RUA CONSTITUICAO R	5	1,85	1304,9	1449,9	1146,9	226,0	694,3	468,3	452,6

Unit: euros

5 Conclusions

In this article were carried on some reflections of the consequences that urban planning decisions on urban morphologies and building typologies exert on land and real estate economic values, considering planning regulations and tools, as well as the behaviours of property agents.

It was additionally proposed the setting of an urban management information system, and a methodology was developed for the computation of surplus-values that accrue from planning decisions. It is expected this research contributes to the incorporation of economic issues in territorial plans, simultaneously promoting the private initiative but making sure planning is able to keep the social value of land.

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Endnotes

[1] These include landowners, development agents, promoters and builders, real estate mediators, final owners or leaseholders, credit institutions and public authorities.

[2] Namely in what concerns the great variability of land and real estate prices.

[3] The surplus values generated by public works are called non-pure.

[4] Before land enters the competitive market.

[5] The alternative uses may be housing, trade, industry and equipments.

[6] The land patrimonial value represents its territorial-base value.

[7] However, as it was admitted that 60% of a certain area was assigned to the studied use, and only 40% to the remaining uses (including public spaces), only 60% of the total income was considered.

[8] The municipal tax on property is regulated by the decree law nº 287/2003 (the official valuation code) that settles the parameters for the computation of reasonable real estate prices/m^2, based on the application of socially-oriented land policy principles (Pardal, 2006b).

Part 3. Urban Planning and Housing

The Europeanization of territorial policies and inter-municipal cooperation: some evidence from Portugal and Italy

Carlos Oliveira, Isabel Breda-Vázquez

CITTA - Research Centre for Territory, Transportation and Environment

Faculty of Engineering – University of Porto, *carlosol@fe.up.pt and ivazquez@fe.up.pt*

Phone/fax numbers: 00 351 225 081 903 - 00 351 225 081 486

Over the last couple of decades, a "new" model of urban policy has been spreading across Europe. Some of its main features are territorial integration, local actors involvement and a creative approach of multi-level governance. These features are particularly important in dispersed urbanization contexts, where inter-municipal cooperation is a crucial aspect of territorial development. The European Union played a key role in the spreading of this 'model', particularly in less developed regions, where EU-funded programmes were often responsible for the introduction of important institutional innovations. This "Europeanization" process did not produce homogeneous results, however, as the same instruments often generated varying outcomes between and within member-states. The paper compares the implementation of a Community Initiative – Territorial Employment Pacts - in Portugal and Italy, focusing in particular the institutionally innovative aspects of this experience related with inter-municipal cooperation in two urban dispersed contexts, the Sousa Valley (Portugal) and Agro Nocerino Sarnese (Italy). Territorial Employment Pacts differed from other EU-funded programmes for the type of targeted areas (usually wider than a municipality, but smaller than a region), their integrative approach and their emphasis on strategy and local-level, broad-based partnerships. This cross-national comparison is focused on the factors that may be responsible for divergent results, such as specific local aspects, political cultures or diverse ways of responding to common structural challenges. We aim to learn more about the role of Europeanization on the introduction of creative approaches of territorial policy tackling inter-municipal, dispersed urban contexts.

Keywords: Europeanization; Territorial Policy; Portugal; Italy

1 Introduction

Territories under strong pressure for change are often targeted for the introduction of much-needed innovative practices in territorial policies. In such territories, social, economic and environmental challenges problems often imply the commitment of several neighbouring municipalities. Yet spatial planning often fails to meet the complex problems emergent in these fragmented landscapes. It is often criticized for trying to organize dynamics that are intrinsically unorganized. Its allegedly cumbersome procedures are perceived as unable to cope with increasing demands for creativity and innovation. Its regulations are blamed for being too bureaucratic and its concepts are considered a poor reflection of the richness and diversity of urban dynamics. Many planning instruments are charged for relying on a narrow definition of territory as something continuous, objective and coherent, where social and economic systems may be integrated and a pre-conceived, desirable, "order" may be established (2007). In spite of these criticisms, or may be because of them, planning - and territorial policies in general - have been experiencing some sharp changes in the last few decades (Tewdwr-Jones and Allmendinger, 2006), that go beyond the traditional plan-led procedures to embrace process-led features such as actors involvement in area-based strategy definition and implementation.

This is especially true in Western Europe, where the European Union played an important role in the (re)emergence of place-focused policies, at least in the more peripheral parts of the

continent, where EU-funded programmes have been spreading over the last two decades. EU regional policy tried to promote place-specific strategies designed to attend several criteria, such as vertical and horizontal coordination among actors and policies, the involvement of local stakeholders and a proactive valorisation of territorial assets (Herrschel and Newman, 2002). However, despite common EU-level rules, the outcomes of these programmes are remarkably different.

The paper is focused in a European Commission initiative implemented about ten years ago in all the then 15 member-states, the Territorial Employment Pacts (TEP). It is centred, in particular, in the outcomes of two of these experiences, one in Portugal and the other in Italy, facing similar challenges such as competitiveness problems, institutional fragmentation, urban sprawl and social exclusion, which typically need to be faced at inter-municipal level.

The paper aims to address what are the main factors of convergence (or divergence) between these two experiences, attending not only to structural changes, such as the “Europeanization” of territorial policies, but also to national political cultures and local actors rational choices. It is structured in the following way: section 2 focuses in the theoretical aspects used in research, notably the concepts of a “relational” approach to planning (Healey, 2007) and of institutional *millieux* (DiGaetano and Strom, 2003) as tool a to integrate structuralist, culturalist and collective action-focused views in cross-national comparative studies; section 3 and 4 focus Territorial Employment Pacts as an example of an experience of the Europeanization of territorial policies and the two analysed cases of the Sousa Valley (Portugal) and Agro Nocerino Sarnese (Italy); section 5 presents the main conclusions. The communication is part of a research programme that is underway in the University of Porto, which includes the elaboration of a Ph.D thesis focused on the role of territorial policies in the structuring of Oporto Metropolitan Region.

2. Territorial policies in a comparative perspective

As Mandanipour *et al* (Ed., 2001) argue, if the territorial dimension is to be considered a valuable asset in governance activities in the next decades, there is a need to link governance with new ways of thinking about territory. Interpretations of territory often differ considerably, according with contexts and disciplines. Traditionalist (or "Euclidean") views of territory tend to emphasize its “objective” dimension. According with this view, territory is a contiguous space where physical proximity plays a central role in spatial interactions. Places are integrated units endowed with a physical, social and economic coherence, which interact between each other through a hierarchical system of spatial relations. Since patterns of location reflect abstract principles and laws, they can be “discovered” through analysis. As a consequence, planning should be understood as a linear process that evolves from intention to action and outcome.

Nevertheless, research shows that territories are too complex to be understood in such a simplified way (Healey, 2004). They are at the crossroads of multiple dimensions and evolve along unpredictable, contingent, trajectories that cannot be pre-conceived. Fragmentation, one of the main features of today territories, is hardly compatible with the integrated, coherent views of Euclidean geography. A new "relational" geography is presented in some literature as an alternative perspective, better fitted to present day volatile times. According with Healey (2007), relational

geography does not necessary inspire better interventions, though it seems more persuasive in a "post-modern" world characterized by diversity and multiplicity.

"Euclidean" and "relational" approaches of territory may diverge according with several dimensions. The first dimension is focused on the prevailing concept of territory. Euclidean geography conceives territory as a political jurisdiction (Raco, 2006), in contrast with the interactive relational approach, which emphasizes a “variable geometry” of nodes and networks rather than formal status (Gualini, 2004).

A second dimension is centred on territorial positioning in relation to other spaces. “Euclidean” geography sees territory as part of a hierarchy of administrative levels and privileges proximity and physical interaction, while relational geography enhances the complex web of “horizontal” relationships among people and activities. These are often of long-distance, informal and immaterial. Current debate about the “Europeanization” of state policies (Börzel and Risse, 2000; Radaelli, 2000) and the emergence of new kinds of multi-level governance is intertwined with this search for a geography that may fit better with the complex and intricate dynamics that intersect territories (Tewdwr-Jones and Allmendinger, ed, 2006).

The third dimension is related with time. Euclidean geography perceives time as linear, which means that the future may be envisioned in a plan. Relational geography, on the contrary, conceives time as multi-dimensional. Strategy may articulate very different temporalities (daily, weekly, annual, inter-generational), each of them associated with a specific actor, subject or activity (Thrift, 1996).

The fourth dimension has to do with the processes of strategy definition and implementation. In a Euclidean approach the plan, once defined, is supposed to remain the main driver of change, while a relational strategy is defined and implemented through interactive practices among a wide range of local actors. As Healey (2004) put it, governance transformations are very often the outcome of struggles between new coalitions and institutionalized practices. Institutional innovations, such as new discourses, new regulations or new networks, must face resistances not only from actors that oppose them, but also from already routinized practices.

Strategy content reflects the outcome of these struggles in different ways. All strategies have their “front regions”, or the most visible focus of attention, and “back regions”, the issues, objects or actors that remain in the shadow. These are the expression of complex space-time relations between multiple social groups within the territory, a process that tends to privilege some of them (those which interests are at the “front regions”), at the expense of others.

These considerations are particularly acute in territories that are bigger than municipalities but smaller than nations or large regions. As several actors argue (Salet *et al*, 2003), this kind of territories rarely fit with a specific jurisdiction, and consequently they usually lack formal arenas. For this reason, a thriving literature advocates the need for specific governance mobilization at this level, since it seems to be large enough to include the complex dynamics that characterize urban areas and adequately small to manage the different networks that sustain those dynamics (Herreschell and Newman, 2002).

Different government practices are however embedded in their correspondent planning cultures, which remain diversified, in spite of all efforts to “Europeanize” state practices, notably those

related with territorial policies (Benz and Erblein, 1999; Gualini, 2004). This fact turns critical the search for a methodology of cross-national comparisons of territorial governance.

According with DiGaetano and Strom (2003), international comparative studies about political science use to adopt at least one of three kinds of approaches, notably those focused on structural factors, those which emphasize cultural aspects and those concerned with the rationality of local actors. These methods are not mutually exclusive, as each of them is not exempted from drawbacks. Structuralist views centred on global processes such as rescaling, for instance, neglect important divergent outcomes among countries and cities, which persist in spite of global transformations. Culturalist views based on values, symbols and beliefs, enhance the role of ideological constructions and their "embeddedness" in its values system, along with the discourses and narratives compete among each other. The predominance of some of these discourses in a given territory may help to clarify resistance to structural change, yet they are less efficient in explaining factors that contribute to rupture. They also fail to explain divergent institutional trajectories of territories that share the same “core” group of cultural values. A third type of approaches, centred on the role of local actors, is perhaps a better methodological option in such situations. These Models are based on the role of local actors in mobilizing "territorial coalitions" that may produce widely different outcomes across national contexts. While providing important explanatory potential for divergent results in territories that share common structuralist and culturalist contexts, they do not seem particularly suited to contexts where national actors, most notably the government, have a strong intervenient role.

In sum, any of the three methodologies may contribute to the aims of cross-national comparative studies, since they are highly complementary. DiGaetano and Strom (2003) use the concept of institutional milieu as a tool to explore these complementarities. By institutional *milieu* the authors define the set of formal and informal arrangements among local actors that contribute to mediate all the interactions between their collective actions, the political culture that is embedded in their territory as structural change. Using the concept of institutional *millieu*, the present paper will analyse the role of two EU-funded programmes, Territorial Employment Pacts (TEP) in the introduction of institutional innovations related with a move from Euclidean to relational interpretations of territory. The Portuguese Sousa Valley TEP and the Italian Agro Nocerino Sarnese TEP will then be analysed according with the role of structural, cultural and rational actor factors in producing new trends at this level.

3 The Europeanization of territorial policies: the case of TEPs

There is a general consensus on literature about the significant impacts of Europeanization on member-states and their differential intensity across Europe (Börzel and Risse, 2000; Radaelli, 2000). Most studies on Europeanization focus on domestic institutions and how they adapt to top-down processes of change, of increased penetration of the European-level system of governance in national or sub-national institutions, policies and identities. These approaches are based on the recognition of ‘inconvenience’. There is a ‘misfit’ between European and domestic policies and institutional contexts, which is the driving force behind Europeanization. There would be no need for Europeanization if all national systems were harmonious and compatible. A lower compatibility (fit)

between EU-level requirements and existing domestic structures will probably produce a higher adaptation pressure and a more difficult process of adjustment (Radaelli, 2000). Although Brussels attempt to produce converging institutional models through emulation and contagion processes (Le Galès, 2002), this may not result in converging trends, at least not entirely. Participation in EU programmes and networks may produce changes at national and sub-national levels, yet these changes may assume different forms in different places (Olsen, 2002). Response to institutional innovations is mainly explored among the routines incorporated in existing institutional settings. Consequently, impact of the EU on domestic settings may vary extensively in territories endowed with different rules, norms and practices (Bache and Marshall, 2004). While in certain places convergence trends are noticeable, other locations may remain attached to their specific institutional systems of relations and cultural values. Some may converge in relation to certain aspects of the EU-purposed policy, while continuing to diverge in relation to other features (Börzel and Risse, 2000). The outcome of this diversity is a wide range of national and sub-national responses to Europeanization processes, usually classified in four categories (Radaelli, 2000):

- Inertia denotes lack of change and occurs when domestic authorities perceive EU policy choices as too disparate from their own and resist any incorporation of institutional innovations. It may be unsustainable for a long period of time, and often precedes abrupt changes.
- Absorption corresponds to a situation where the degree of domestic change is low and member sates incorporate European policies without really revising existing routines, processes and institutions. Changes may be considered ‘cosmetic’ and institutions often go back to their previous positions after a moment of (apparent) rupture.
- Transformation represents a stronger degree of change, since new policies and processes replaced existing ones, producing fundamental shifts. This process corresponds to a real incorporation of institutional innovations that often evolves to a new paradigm.
- Retrenchment denotes the opposite situation, when domestic arrangements turned paradoxically more distant in relation to EU institutional setting than before the Europeanization process. This happens when adaptation pressure motivates strong and successful resistant movements at domestic level, producing what Radaelli (2000:15) calls ‘negative integration’.

This repertoire of domestic outcomes may also be found at the level of urban policies, which do not constitute a specific competence of the European Union. Beyond the fact that most EU policies have strong direct impact on urban areas, cities need to deal increasingly with EU-framed rules and norms. European programmes spread new ideas across European cities, promoted cross-border cooperation and European-wide networking among cities (Goldsmith, 2005). Both the European and the urban level often seem to find useful to ‘bypass’ refractory national governments and interact directly. For all these reasons, authors such as Le Galès (2002: 96) argue that the ‘European City makes greater political sense’. In our view, this is even truer in complex, dispersed and fragmented urban spaces that cross multiple jurisdictions increasingly tight by ever-stronger functional relations.

Local level responses to EU initiatives are surely diversified, as the last two decades of EU initiatives may testify. 1988 reform of EU structural funding, which introduced a more decentralized approach of regional policy, paved the way to the implementation of institutional innovative

partnerships at local level. A 'new' model of urban policy emerged in different countries since then, based on integration at local level of different objectives and sectoral policies, territorialized, 'area-based' strategies and innovative forms of negotiation between different actors and levels of government (Andersen and Van Kempen, 2003). This model also seems to fit better with new concepts of territory. Recent research has been stressing that territories are too complex to be understood in a simplified way (Healey, 2006).

European Urban pilot projects and Community Initiatives are privileged tools for diffusing this model across Europe. As John (2000) put it, Community Initiatives and Pilot Projects encourage partnership principles and create conditions for a more entrepreneurial behaviour of cities and sub-regional authorities. In this sense, they represent a privileged instrument for the introduction of institutional innovations. Territorial Employment Pacts (TEP), an EU initiative delivered about a decade ago, is an accurate example of this kind of programme.

In the middle 90s, when Europe was facing a particularly acute unemployment problem, the "Confidence Pact for Employment", launched by the European Commission, represented an attempt to reverse the acute unemployment of the European Union at that time. The European Council of Dublin, in December 1996, reaffirmed these guidelines and called for the rapid implementation of Territorial Employment Pacts (TEPs), presented as the main tool to this locally focused approach (EI 2000, 2001a).

TEPs were based in four principles:

- To be territory-centred,
- To hold an integrative, strategic approach
- To mobilize broad-based partnerships.
- To introduce innovative experiences and foster good-practice diffusion across Europe.

TEP integrative approach means that a wide range of actions was eligible, ranging from education and training to SME support and entrepreneurial promotion or measures targeting specific groups (table 3). Nevertheless, they all have a focus on employment, on how to address the offer and supply of jobs. TEPs were introduced in the second half of the 1994-99 structural funding programming period, at a time when most financial resources were compromised with other actions. The available resources destined to each TEP were scarce (€ 200.000, and additional € 100.000 to the considered well-succeeded experiences) and destined exclusively to technical assistance. Since institutional innovation was the main objective of the TEPs, they were expected to promote a "leverage" effect in relation to other funding sources, both national and European. Rather than directly supporting local actors, TEPs should contribute to gain influence over mixing supplementary resources. This was fulfilled in a large extend, although the leverage effect was deeply unequal across the member-states (EI2000, 2001a; Ecotec, 2002).

The territorial eligible areas were diversified, ranging from small municipalities of 16.000 inhabitants to large regions of more than 3.000.000. In spite of a formal adoption of uniform methodologies, partnership structures were also diversified, having the number of involved partners in each TEP ranged between 5 and 105, including local, regional and national authorities, public institutions, private companies and the Third Sector (Gambaro *et al*, 2004). TEP most outstanding achievements, such as innovative ways to create and nurture partnerships, improved trust and

development of a sense of common purpose among participants, were not sufficiently disseminated, either for the reason that they often relied on context-specific factors, or because of a lack of understanding about the importance of dissemination.

Nonetheless, despite being almost ignored in literature about Europeanization at urban level (in sharp contrast with other Community Initiatives), and notwithstanding its lack of continuity at EU-level, TEP model looks an interest object of study, as it looks close to a relational approach of territory. As it does not aim to be fully integrative, it proposes the division complex problems in manageable and "loosely coupled" thematic arenas, such as those related with employment, training or competitiveness (Benz and Erblein, 1999). This gives more space for acting in wider spaces than neighbourhood, such as complex inter-municipal territories, such as Sousa Valley (Portugal) and Agro Nocerino Sarnese (Italy), the two selected territories for this comparative study.

4 TEPs in Sousa Valley (Portugal) and Agro Nocerino Sarnese (Italy)

This section aims to describe the implementation of TEPs in two territories of comparable size in Portugal and Italy, facing the same social, environmental and economic problems that can be found in many other Southern European dispersed urban regions. Methodology used in the paper includes a literature review related with both the theoretical aspects and the empirical case studies, including the evaluation reports about TEP experiences, as well as semi-structured interviews with the main local actors of the two analysed territories.

4.1 The Sousa Valley TEP

Located in Northern Portugal, close to Oporto Metropolitan Area, the Sousa Valley includes the six local authorities of Castelo de Paiva, Felgueiras, Lousada, Paços de Ferreira, Paredes and Penafiel. It has 767 Sq. Kms and a population of about 328.000 inhabitants. Its relatively high population density, of 428 inhabits/Sq. Km is not due to a strong network of medium sized cities. Quite on the contrary, the main urban centres hardly exceed 10.000 inhabitants. The majority of the population leaves "between cities" in spaces usually called of "dispersed urbanization" that sprawl along a dense network of secondary roads.

Dispersed urbanization goes on a pair with dispersed industrialization. The Sousa Valley is a predominantly industrial region, where a dense fabric of small and medium-sized companies in the furniture, clothing and footwear sectors coexists with other uses, such as housing, retailing and logistics. This situation generated strong and persistent economic, social and environmental problems, as well as important damages to landscape.

Sousa Valley competitiveness has for many decades relied on low labour costs, thanks to the continuity of urban and pre-industrial practices promoted by the dispersed model that helped to supply the local industry with unqualified and inexpensive labour (DHV MC, 2004; Quaternaire, 2003; Valsousa, 2001).

The Portuguese context was defined in the TEP Evaluation report for the 89 European pacts (Ecotec, 2002:44) as of "narrow spectrum", meaning that local-level actors involvement in employment projects was limited at that time. Most interventions were public or quasi-public and implemented by the national government, or one of its local and regional agencies. This is partly due

to the country still over centralized administrative structure, in comparison with observed in other European nations (John, 2001). Ecotec concludes that this is an “available” context for initiatives such as TEP, since there is relatively “free space” for innovative governance operations, in contrast with the “crowded” institutional settings of more mature governance landscapes.

Sousa Valley TEP was proposed by the national government during negotiations with the local Association of Municipalities (Valsousa) for the implementation of a mainstream EU-funded, territorial-based programme, known as PROSOUSA. TEP should target the more immaterial actions related with the employment, education and training, in order to complement with more physical-oriented PROSOUSA. The meetings involving local actors took place between February and September 1997. The first, more generalist meetings, were followed by a second phase of more specialized discussions. Three working groups were then formed, each of them related with one of the main thematic areas: social networking, education and training and competitiveness and entrepreneurial culture (Valsousa, 2001). Several international seminars and study visits promoted interaction between the Sousa Valley TEP and other TEP’s in Portugal and abroad.

According with the evaluation reports (Valsousa, 2001; Ecotec, 2002) and statements issued from the interviews, TEP introduced new governance procedures in a territory where they were uncommon, at that time (Ecotec, 2002). Its approach introduced new ways of action, notably more frequent interactions between Valsousa and the central administration agencies involved in the process. Along with the formal meetings related with TEP process, more informal contacts were promoted between agents that were not used to interact among each other. Some actors, such as the volunteer institutions, began to promote common events. Local authorities, once hardly involved in common projects, also began to move to a more cooperative attitude. Among the most relevant actions concerted under TEP process is the “Educative Charter”, a strategic document that defined the diagnosis and proposals for action in this field, on an inter-municipal scale. This was a pioneering experience in Portugal, not only because of its inter-municipal scale but also for its inter-sectoral approach of educational problems (DREN, 2000; Valsousa, 2001).

Some of the Sousa Valley TEP learning experiences reverted to higher-scale strategic documents, such as the Northern Region chapter of the National Programme for Economic and Social Development, PNDES (MEPAT, 1999), which defined the guidelines for the 2000-2006 EU funding programming period, and the National Plan for Employment (MTS, 1999).

Nevertheless, the main difficulties did not emerge in the strategy-defining phase but in its implementation. Local and regional actors, including decentred bodies from the national government, showed a highly co-operative attitude in both phases. However, in a highly centralized country such as Portugal, compromise from the national level is crucial and TEP was not considered a top priority by the Portuguese government. National government indecision throughout the process played an important role for less desirable results during the implementation phase. Although the Ministry of Planning set up TEP national structure, it shared its tutelage with the Ministry of Labour affairs (EI2000, 2001b) without any clear definition of the roles of each of the two sectors.

The projects implementation proved to be far more problematic than its conception, also because of inadequate timing. TEP was implemented in a final stage of the second EU-funding programming period (1994-99), when resources were scarce. The lack of a specific financial line for

TEP hampered its implementation because most national and EU resources were at that time compromised to other actions. This proved to be a strongly discouraging factor.

4.2 The Agro Nocerino Sarnese TEP

As Sousa Valley, Agro Nocerino Sarnese area is located halfway between Naples and Salerno, in the less developed part of Italy often called *Mezzogiorno*. Its 14 municipalities comprise 175 Sq. kms and a population of around 282.000 inhabitants. As in the Sousa Valley, dispersed patterns of urbanization and industrialization produced damaging environmental and socio-cultural problems (PdA, 2007). *Città dell'Agro*, as the whole area is often called, uses to face flood problems related with the lack adequate planning and basic infrastructure. The food industry, mainly related with tomato production, is the main activity in the area, which however faces high levels of unemployment (more than 15 %), in spite of high levels of entrepreneurialism. Until the 80's, Agro Nocerino was also facing institutional difficulties related with low levels of inter-municipal coordination, political instability, clientelist practices and organized crime.

TEP, which is partly inspired in an Italian experience called *Patti Territoriali*, emerged when Italy experienced several deep changes in the design and deliver of its local and regional development policies. Part of these shifts was related with, structural funding reform at European level, which introduced institutional innovations that often represented a rupture (Gualini, 2004). At the begining of the 90's, the end of *Intervento Straordinario,* the main top-down instrument for the *Mezzogiorno* based on the direct delivery of subsidies and the provision of infrastructure, paved the way for a more decentralized approach, focused on endogenous development. Included in a wider range of instruments called *programmazione negoziata*, TEPs were introduced by the Italian national government as one of the many “area based” instruments delivered in the 90’s, along with the exclusively national-funded *Patti Territoriali* (Gambaro *et al*, 2004). However, the European version of the pacts produced more efficient results, thanks to its homogeneous and stable legal framework (DPS, 2003).

The Agro Nocerino Sarnese TEP history has many protagonists (Cersorsimo and Wolleb, 2006). It can be divided in three phases. The first one, between 1995 and 1997, was led by the mayor of Nocera Inferiore, the main city in the area, who played a key role in mobilizing the neighbouring municipalities for common action. In the second phase, between 1997 and 1998, a highly influent national government subsecretary for Treasury was a key actor in defining the programme guidelines as well as in "transforming" it in a EU-funded tool. In the third phase (1998-2000), the Salerno Province was charged for institutional coordination, while a new local development agency called Patto dell'Agro S.p.A was responsible for implementation.

The 1998-2000 Action Plan included six domains of action (active employment policy, historic centres, environmental and cultural assets, production areas, research and agriculture) and more than € 40 millions of investment. The agency pursued its activities well beyond the completion of TEP activities and it is still active today. The TEP strategy-defining process produced several protocols signed by the local and provincial authorities, associations, financial institutions, unions and non-profit bodies. Many of these institutions were created since 1998 by Patto dell’Agro S.p.A (PdA, 2005). The network of inter-related institutions or initiatives, including a mixed society of urban

transformation, an inter-municipal plan for the programming and delivery of social services, a mutuality consortium, an agency with functions of mediation between labour offer and supply and a consortium aiming to promote local agro-industrial products (PdA, 2005).

The Agro Nocerino Sarnese TEP introduced important institutional innovations (Gualini, 2004) and contributed to the fading of initial distrust among local actors and the promotion of a shared culture (Gambaro *et al*, 2004). The once fiercely independent local authorities began to cooperate in a wide range of projects, contributing to a "renewed sense of community that was somewhat fading since the 90's" (Cersorsimo and Wolleb, 2006:185).

TEP filled provided a new culture of cooperation, intensified after a decade of intense interactions between local political and associative leaders, public servants and academics. Agro Nocerino Sarnese historical identity was not translated in a static model of territorial bordering, associated with precise administrative jurisdictions. Quite on the contrary, TEP borders evolved through time. Since no superior administrative level imposed territorial limits, continuous expansion became an outcome of the bottom-up process.

In spite of its flexible, innovative purposes, TEPs were obviously not isolated from the more traditional, hierarchical administrative structures of the different European countries where they were implemented. In the case of Agro Nocerino Sarnese, three administrative levels above the municipality played an important role in the process. These were the Province of Salerno the National Government, and the European Union. Since the beginning, Salerno Province was a key player in the negotiation process among local authorities, although some mayors perceived their presence as "strange to the territory political culture" (Landi, ed., 2003:30). The Province pivotal role would increase further, anyway, when the negotiation process became more specific. The Province became the institutional leader of the process when a political crisis forced the mayor of the main city to *resign*. It had to outstrip resistance from mistrusted municipalities, particularly those led by mayors of a different political orientation.

Agro Nocerino Sarnese TEP also benefited from "protection" from Rome. The then subsecretary of state for treasury used its deep knowledge of local territory to "transform" the territorial pact in a EU-funded programme, fostering its credibility at the eyes of local actors. The highest administrative level involved in the process is the European one. EU influence contributed to the introduction of new attitudes in different ways, such as time and evaluation procedures. Rigid chronograms imposed by the European Commission were not part of the territory administrative traditions. Local actors consider this aspect of strong importance, since it helped to consolidate a new culture of evaluation based on results, more than on financial inputs.

As a highly interactive governance process, Agro Nocerino Sarnese PTE strategy suffered considerable changes through time. While being initially conceived by local actors as a territorial agreement focused in the competitiveness of the food industry, it moved from a competitiveness-led programme to a cohesion-led, thanks to pressures from Rome and Brussels. This implied a strong shift of protagonists through time. Employers and their associations were less involved in a territorial pact that they perceived as "too political", while third sector actors, particularly the Catholic Church, by far the most powerful among them, emerged as new protagonists.

5. Discussion: TEPs and the dimensions of territorial governance

Since Sousa Valley TEP was designated by the national government as the “immaterial supplement” of another programme known as PROSOUSA, boundary limits were defined in a hierarchical, top-down traditional way. The same block of six municipalities that form the local association of municipalities participated equally in all dimensions of the project as a continuous, “objective” and “integrated” territory, in a great extend defined according with “Euclidean geography” principles, contrasting with the programme methodology imposed by the European Commission, which clearly emphasized a relational view of territory focused on local actors mobilization. This contradiction has its origins in a structural factor, the clash between different levels of governance in the sequence of the Europeanization of territorial policies.

Empirical evidence from the Sousa Valley shows that the same happened in relation to other dimensions of governance, such as the territory interactions with other spaces. TEP meant an opportunity for "good practice" exchanges across Europe, as referred by most interviewees and reports. This fact represented an opportunity to introduce different kinds of institutional innovations. However, these practices did not pursue after TEP conclusion and contacts with experiences in other countries became more and more rare.

A cleavage between European-level purposes and national-level imposed contingencies can also be found in the way how Sousa Valley TEP dealt with time. Since TEP strategy was only partially implemented, in a large extend because the implementation phase occurred at a final stage of an EU-funding programming period, many long-term projects were not accomplished. This produced discouraging effects among local actors, and reduced TEP impact in the long term (Table 1).

Although TEP relational experience in the strategy-defining phase, due to strong involvement of local actors in the process, produced innovative measures and contributed to increased cooperation at inter-municipal scale, the impact of Sousa Valley TEP in Portugal is considered “very slight” (EI2000 2001c:23) given the high level of administrative centralization of the country and the lack of stability of the political context at that time, on a national level.

The more recent developments show that TEP innovations influence in the territory landscape is apparently hard to find in today Sousa Valley, since most routines look relatively unchanged. Although some of the Sousa Valley TEP proposals related with “employability” can be found in certain 2000-2006 EU-funding period instruments (EI2000, 2001a), such is not the case in other fields, like education, where a reversing trend from previous achievements is noticeable. The second generation of the “Education Charter” is a sum of municipal documents rather than an integrated, inter-municipal strategy.

Exchanges of experiences with other national and international TEPs, which according to interviewed actors produced fruitful results at strategy-defining phase, had no continuity after implementation. The lack of technical and financial resources of some institutions that could play a key role in forging more consistent inter-municipal government processes also seems to be an important obstacle for further progress in inter-municipal cooperation.

Unlike in the Portuguese experience, the concept of territory prevailing in Patto dell’Agro is closer to a relational view of geography rather than a static, hierarchical one. The interactive

approach promoted a radical shift in the traditional ways of action of Public Administration, from unilateral to cooperative practices and from a managerial system to a more pluralist one, since it was based on agreements (Gambaro *et al*, 2004). The "constellation" form of institutional architecture emanated from Patto dell'Agro, S.p.A., on the other hand, tends to privilege a flexible, "geography of fluxes" model of planning. Each problem has its own specificities, involved actors and territorial limits.

Table 1. Dimensions of territorial governance in Sousa Valley TEP

Dimension	**Main trends**
Concept of territory	• Relational model of territory imposed by the European Union. • Top-down definition of boundary limits imposed by national government.
Territory positioning	• "Good practice" exchanges and other kinds of long-range networking did not pursue after TEP experience.
Time	• Excessive dependence on EU-financing programming cycles compromised outcomes. • Lack of a coherent institutional architecture compromised long-term goals.
Strategy definition and implementation	• Strong relational approach during strategy-defining phase. • Excessive dependence on national government action and political instability compromised TEP sustainability.

Source: Own authors

Agro Nocerino Sarnese TEP benefited from the coincidence in time of events with structural, cultural and local causes. The most prominent structural factor was the Europeanization of territorial policies. EU regional policy reform fostered new, more local-oriented and integrative approaches of territorial policies such as those evidenced in TEP. Changes in the Italian political culture, such as increased decentralization of the Italian state was also allowed institutional innovations such as more interactive TEP approaches and the coordinative role of an emergent actor, the Province.

Agro Nocerino Sarnese TEP also introduced considerable shifts in time dimension, not only because EU rigid chronograms were responsible for considerable shifts at this level, but also because Patto dell'Agro and its associated entities represent a consistent system of management tools that confer sustainability to strategy implementation and enhance prospects for consistent long-term results. In Agro Nocerino Sarnese, there was a common feeling of frustration towards national government policies among local actors, which fostered mobilization at this level. Networking among local actors and with national government members remains then a specific aspect of Agro Nocerino process that is not replicable to other TEPs across the country. Once again, local action rational choices favoured a relational approach of planning, although the national decentralizing process and European guidelines reflected in TEP regulation gave a framework to their action (Table 2).

Table 2. Dimensions of territorial governance in Agro Nocerino Sarnese TEP

Dimension	Main trends
Concept of territory	• Relational model of territory imposed by the European Union. • Dynamic boundary definition reflected in successive increases of the involved municipalities. • As a privileged arena, TEP fostered cooperative practices.
Territory positioning	• Institutional architecture promoted "variable geometry". • Interactive approach made possible by state decentralization.
Time	• Coincidence in time of EU-funding development, decentralization and local actors will fostered change. • Patto de'll Agro and other agencies activities conferred sustainability to the process and the accomplishment of long-term goals.
Strategy definition and implementation	• Inclusive processes both in strategy management and implementation.

Source: Own authors

In sum, as Europeanization processes, the experiences of Sousa Valley and Agro Nocerino Sarnese may be categorized as 'absorption' and 'transformation', respectively (see section 3). In the Portuguese experience, changes produced at the level of strategy defining did not produce long-term revising of existing routines, processes and institutions. As a consequence, after a brief enthusiastic period of strong inter-action among local actors, institutions went back to previous positions. The apparent moment of rupture vanished at the very early period of strategy management.

In Agro Nocerino Sarnese change seem to have achieve a more steady degree of maturation. The plethora of new institutions emergent in the last decade and the continuous involvement of a wide range of local actors in common objectives, seem evidence a high degree of incorporation of institutional innovations and the growing of a more relational approach of territorial policies, visible in the replacement of old routines by new ones.

6. Conclusions

Territorial Employment Pacts constituted an European Commission attempt to introduce innovative approaches of territorial policies in a context of increased criticism towards more traditional spatial planning instruments. They represented one of the several examples of a 'new' model of territorial policies emergent in the 90s, a period characterized by intensive fertilization of ideas and initiatives at European level. Following principles of partnership, integration, innovation and territorial-focused strategy common to other Community Initiatives and Urban Pilot Projects, it remained a quite discreet programme, however. This was partly due to the precise moment it was implemented, at a final stage of a EU-funding programming period, when resources were scarce.

Nevertheless, TEP profile provides good reasons to reflect about the role of structural, cultural and local actors collective action in producing institutional innovations on territorial policies, according with the institutional milieu model developed by DiGaetano and Strom (2003). Since both experiences followed the same European Commission defined rules, TEP results cannot be explained by structuralist explanations such as Europeanization. Cross-national comparison between

TEP implementation in Portugal and Italy suggests that Europeanization processes and trajectories may diverge significantly, even when they show apparently similar outcomes. Portuguese and Italian TEP experiences may be considered relatively successful, as both countries have a considerable proportion of TEPs that were prized in all evaluation reports for their high degree of local level participation and good management. Yet the two specific experiences analysed in this paper portray somewhat different outcomes. Agro Nocerino Sarnese remained much closer to a relational conception of territorial policies rather than the Sousa Valley experience. Its conception of territory privileged local collective interests and a more interactive and flexible approach of strategy implementation than its Portuguese counterpart. Being more inclusive, especially in the management phase, the Italian experience also produced more consistent results in the medium and long term, thanks to an institutional architecture that confer sustainability to the whole process.

Cultural factors could provide a more convincing explanation power. In spite of all attempts to produce a more homogeneous European-wide landscape of urban and territorial policies, national political cultures remain varied across the country. Portugal and Italy share a common heritage of administrative and juridical traditions, which roots go back to the Roman law and the Napoleonic code (John, 2001). Yet over the last decades their planning systems and state organizations evolved along remarkably divergent trajectories. Portugal remains a highly centralized country and, as Healey (2006:539) put it "territorially-integrated imagination seems to develop most effectively in governance contexts where financial and regulatory resources are already strongly concentrated at local and sub-regional level. But it can be difficult where traditionally investment resources and regulatory powers are concentrated at the national level". Italy, on the contrary, faced a gradual but systematic process of decentralisation, which made possible the quiet emergence of new players in the local development game, such as Provinces endowed with enlarged coordination powers. The more decentralized Italian governance landscape also led to a greater autonomy of local actors, which contributed to an institutional "densification" represented by the local development agency Patto dell' Agro and its associated entities.

However, Patto dell'Agro success is far from being the rule in the Italian context. Many other Territorial Pact experiences, both EU and nationally funded, did not produce comparable results in terms of inter-municipal cooperation, local actors empowerment and long-term accomplishment of strategic goals (Gambaro *et al*, 2004). In other Italian territorial pacts, including some of the EU-funded TEP, volunteer, or non-for-profit sector representatives, were often minor partners. The number of civil society organizations involved in the TEP process, particularly the non-for-profit organizations, is remarkably high in comparison with other Italian TEPs, a fact that Gambaro *et al* (2004) attribute to the pro-active attitude of local political leaderships. On the other hand, according with TEP evaluation report (ECOTEC, 2002) another Portuguese experience, Northern Alentejo TEP, produced more sustainable outcomes than Sousa Valley TEP in terms of the transition from an Euclidean to a relational approach of territorial policies, thanks to the pivotal role of the Alentejo Regional Development Commission (CCDRA), a decentred body of the national government, which dismisses the Portuguese centralizing culture as the main culprit for Sousa Valley drawbacks.

Two other factors seemed to have played a more relevant role. The first one is related with the stability and clearness of rules. TEP success in Italy is partly due to this factor, in a striking contrast

with nationally funded *Patti Territoriali*. In Portugal, national government instability and lack of a clear definition of responsibilities among two of its ministries prevented a larger extension of TEP experience. The second reason is related with leadership at local level. Transition from strategy defining to management phases is the most delicate moment of any programme of this kind. In Portugal as in Italy, the mediating role of leaders proved to be crucial to ensure the continuity of high levels of enthusiasm and commitment. This fact leads to debates on the mediating role of institutions in urban governance processes. The pivotal function of leadership in successive arenas such as those related with strategy making and management, may make the difference between successful and less successful experiences.

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Evaluating the impact of territory plans on urban compactness: the case of Northern Douro Valley

Nuno Pereira [1], Ricardo Bento [1], Isabel Bentes [1], Luís Ramos [1], Júlia Lourenço [2]

1 Department of Engineering, University of Trás-os-Montes and Alto Douro

2 Department of Civil Engineering, University of Minho, jloure@civil.uminho.pt

Phone number: 00 351 253 510243

This paper identifies the urban areas dynamics between 1994 and 2004 in the seven Municipalities that belong to the Northern Douro Valley. The research consisted of using a Geographical Information System (GIS) to identify the trends of urban expansion in the decade under study and the pattern of compactness of the urban clusters. Furthermore, the development of urban areas is compared with urban expansion areas as mapped in municipal plans as to analyze its compliance with the legal Municipal Plans of the nineties (PDM, a similar plan to Unitary Development Plans in England). Albeit urban sprawl can be found in all Municipalities, the intensity of this phenomenon varies and more than one set of outcomes was obtained depending on the specific Municipality. In some Municipalities, the existence of the Plan seems to have made some inflexion upon urban sprawl trends while in other Municipalities, past urban sprawl trends were kept independent of the existing plan proposals. This leads to the need to identify another range of existing or non-existing policies, namely housing policies in order to fully explain the different obtained results. Cultural context has also to be brought in the framework of analysis, namely the economic value of the vineyard lands. Therefore, the assessment of the impact of the territory plans in fostering more compact urban areas needs further analysis and unsustainable trends have to singled out and researched as there might be local causes as this paper points out. Nevertheless, lack of strategic regional implementation policies as well as lack of housing policies towards urban regeneration seems to be a major cause for the persistence of unsustainable trends of urban sprawl in Northern Douro Valley

Keywords: Land-use; Urban sprawl; Municipal Plans; Evaluation

1 Introduction

Portugal suffered, in recent decades, a series of political, economic and social settings that marked the national urban system. The growth of urban agglomerations associated with the increase in population and/or purchasing power led to a relevant consumption of the territory not always following planned urban growth criteria, i.e. this urban expansion associated with lack of planning, has created a phenomenon which we call urban sprawl. This assumes greater importance at a time when there is a focus in European territorial cohesion. Today, unlike what happened a few decades ago when the urban and the rural territories were set in a separate order, the landscape is transformed into a "hybrid form", susceptible to encroachment by urban areas. This invasion of urban areas occurs not only in large urban areas but also in smaller areas, those defined as regions of medium and low densities, such as the municipalities of the northern Douro Valley.

A regional planning agency in Seattle, PSRC, presented in 2005, a definition of urban sprawl that can also be applied to the territory under study, stating that "Sprawl can be broadly described as development that has occurred in a haphazard, undirected manner, often at a pace faster than that of population growth. Sprawl also can and has occurred in regions that are losing population. It is often associated with low density development, separated land uses, road infrastructure that favors the automobile over pedestrians or bicyclists, and weak or nonexistent centers of activity."

2 Urban boundaries and sprawl

The first generation of Municipal Master Plans, implemented over the decade of the nineties and subsequent new millennium, focused in the delimitation of urban boundaries to achieve a central goal of compactness. The reasons for this major goal derived from territory and natural resources degradation due to the disordered occupation in the peripheries of the urban areas as well as in the rural areas. The delimitation of urban districts, through the definition of preferred areas for construction, aimed at a significant control of this problem of urban sprawl because there are not other policies to regulate it.

As the 1st generation of PDM started to be reviewed, LBOT (the Portuguese Act on Land Use Policy and Planning) was passed on and, for the first time in the Portuguese legal framework, general principles and objectives to guide land-use policies were established, stating that one should "... ensure the rational utilization of natural resources, preservation of environmental balance, the humanization of cities and functionality of built spaces". Indeed, the rational use and occupation of territory are still quite evident in these two points in the same law, which states among several objectives, the following:

- "The profitability of the infrastructure, avoiding the unnecessary extension of networks and urban districts and streamlining the use of urban slums;
- "The preservation and protection of soils with a natural aptitude or used for agricultural activities, farming or forestry, restricting their transfer to other uses in cases where this proves necessary."

The incongruity between the date of preparation of the first generation of PDM and the emergence of the Act on Land-Use Policy and Planning shows that there are shortcomings in terms of legal instruments for land management, particularly in the first-generation of the municipal master plans.

3 Objectives and Methodology

The study area is located in the territory of Trás-os-Montes, specifically in seven municipalities located north of the Douro River comprising the Northern Douro Valley (see Figure 1).

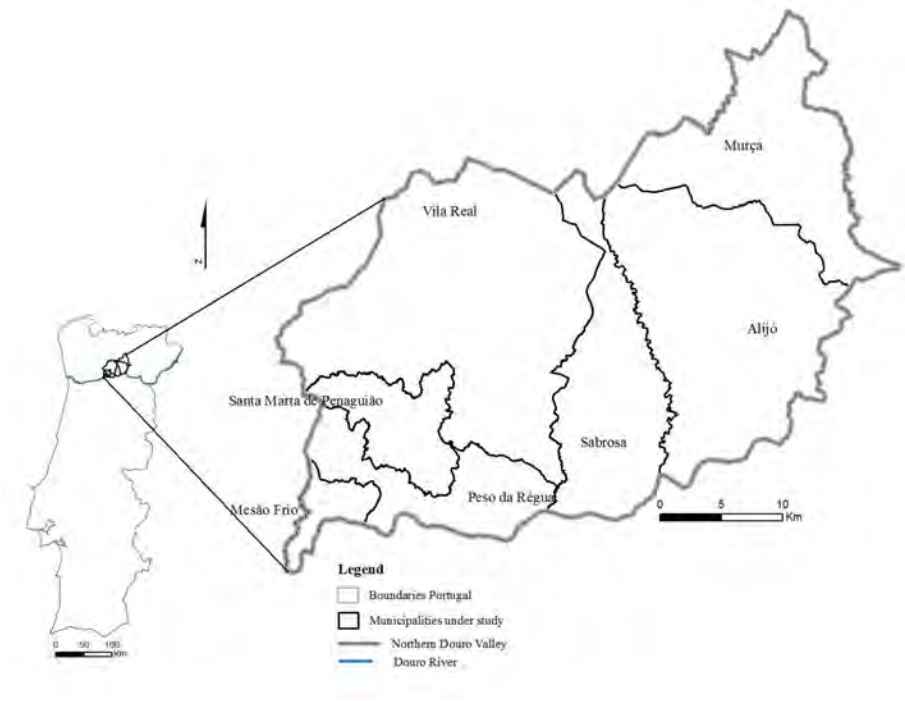


Figure 1. Location map of the municipalities in Northern Douro Valley.

The analysis followed in this research aimed at identifying possible shortcomings that the PDM in this sub-region had from its beginning until a decade had passed on, being this the legal period in which they normally remain legally binding. The approach to the problem is done through a quantification of the areas of deployment defined in urban districts over 10 years, from 1994 until 2004, a period that coincides with the entry into force of the first Municipal Master Plans and goes until the beginning of the second review. Outlines of the major points for consideration are:

1. To identify urban boundaries delimited in the first generation of PDM (1994) and quantify the existing built area (1994), in and out of its boundaries.
2. To analyze the dynamics of the area built during the period 1994-2004 in order to verify the effectiveness of PDM in terms of control of the areas of deployment.
3. To overlay the built-up areas with the urban areas boundaries as mapped in PDM in both zoning and constraints maps to ascertain which land uses are most affected.
4. To assess the impacts of the built-up areas dynamics in the northern Douro Valley.

In order to reach these objectives, as a first step, a spatial analysis in GIS environment was carried out in order to collect the necessary data. Then, as a second part of the review process, the values extracted by the tool Arcgis 9.3 were treated in Excel spreadsheets for statistical analysis. For the data were used shapefiles of buildings 1994 and 2004. Since there were inconsistencies in the mapping of the two years due to the process of obtaining the same layer in the two periods, relevant shapefiles were worked out to generate a uniform mapping.

Initially, considering the mapping of the buildings in 2004 and, through the tool of ArcGIS 9.3, it was possible to select the center of mass of these buildings that contained its centroid on the shapefile of buildings in 1994. Those containing their common centroid in the shapefile of buildings in 1994 were identified, and a new field of attributes in shapefile 2004 was designated as "built in 1994". In turn, all those that did not contain its centroid in the shapefile of buildings in 1994 were characterized as recent and designated as "built in 2004." In the second phase, and once all the buildings had been classified according to typology, it was decided to remove all constructions with less than 30 m^2 as well as annexes, according to specifications in Urban Building Regulations. Thus, it was possible to obtain a valid cartography for the two years, which allowed a dynamic analysis consistent over time since there is no discrepancy between the base data.

In addition to generating a shapefile with the built-up areas in 1994 and in 2004, the remaining inputs were the zoning and the constraints maps of each municipality´s PDM which were generated through editing, vector and base information on the respective maps and urban perimeters of the first generation PDM. Again, it was needed to standardise zoning classes in the several plans under study as they do not use the same typologies of land uses. These were grouped in three classes pertaining to land uses, designated as urban, agricultural and forestry, natural and cultural areas, therefore allowing a cross-comparative global analysis.

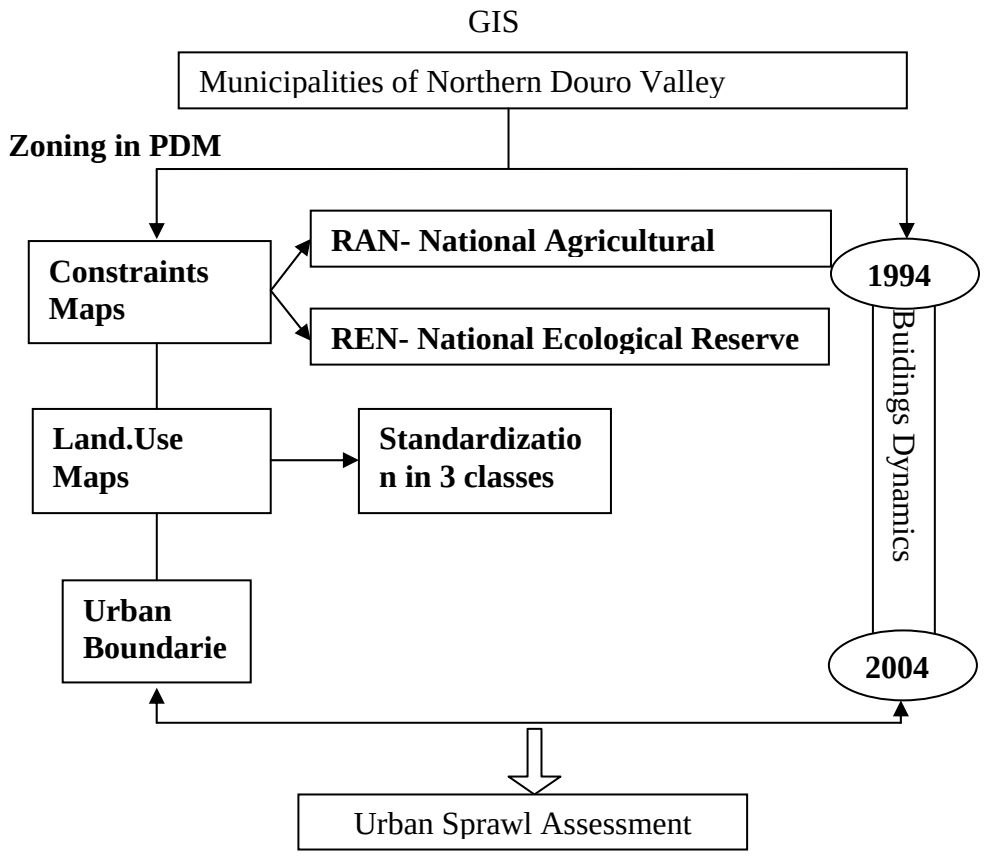


Figure 2. Flowchart of analysis.

4 The areas of deployment of the buildings in the Northern Douro Valley

The seven municipalities under study comprise a total area of 1213.5 km^2, which in 1994 contained a built up area of deployment of 6785.06 (x 10^3m^2). This value increased about 45% in 2004 when for the same municipal boundaries, there is now a total of 9824.03 (x 10^3m^2). Alongside these data, if INE estimates of resident population are analyzed for the same period, it shows a decrease in almost all municipalities, except Vila Real with an increase of 6.8%. Nevertheless, despite the general loss of population between 1994 and 2004, the municipalities of the northern Douro Valley had, year after year, a very significant increase in buildings.

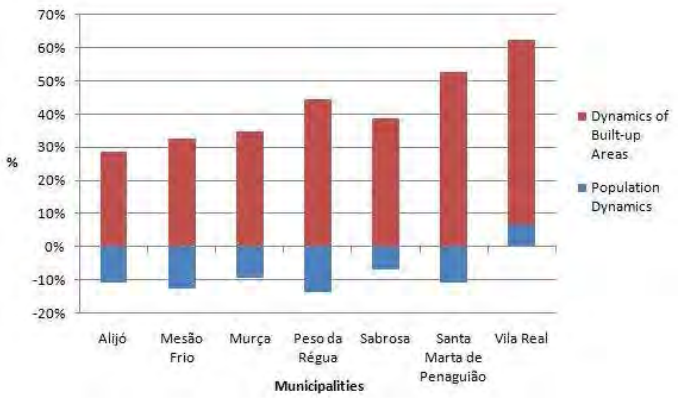


Figure 3. Change in areas of deployment and in the resident population between 1994 and 2004.

As can be seen in Figure 3, the municipalities that had a more significant increase immediately after Vila Real, in terms of deployment of the built up areas were Santa Marta de Penaguião and Peso da Régua, with population losses in the same period, exceeding 10%. In other cities, the trend is the same, with Sabrosa, Murça, Mesão Frio and Alijó appearing immediately below, also showing significant loss of population.

Given these increases in areas of deployment in all municipalities, these outcomes were compared against the urban areas defined in the Municipal Master Plans in order to assess if the buildings after 1994 were built inside or outside these limits. The results (see Figure 4) show that all municipalities have a fairly high percentage of areas of deployment outside the urban perimeters. The municipality of Mesão Frio shows the highest value, reaching a higher percentage of new buildings outside the urban boundaries than within them. That is, the total new construction that took place in the municipality of Mesão Frio, which shows a 32% increase of the pre-existing stock, 51.9% correspond to areas of deployment outside of urban districts, while 48.1% corresponds to areas of the buildings within the perimeters. Immediately ranked municipalities of Sabrosa, Peso da Régua, Murça and Alijó show a relative increase of buildings outside urban areas in the range between 39.9% and 36.1%.

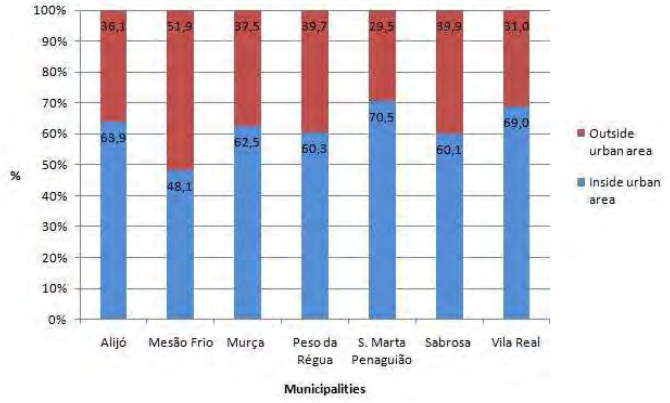


Figure 4. Areas of deployment within and outside the urban areas between 1994 and 2004.

The remaining two municipalities, Santa Marta de Penaguião and Vila Real, display lower percentages of construction outside urban districts with 29.5% and 31%, respectively. For Santa Marta de Penaguião, knowledge of the city allows us to state that this smaller albeit still considerable figure is explained by factors of physical origin, namely topographic factors. The fact that the city is in a prominent risk area favors less and smaller areas for new buildings, so there is less risk of those taking place outside the urban boundaries perimeter. In the municipality of Vila Real, the fact that it is the district capital and increasingly asserting itself as a city of regional balance caused either a stricter management of the Municipal Plans guidelines and / or a pull factor towards the city with greater magnitude than the one in the surrounding areas.

Table 1. Change in areas of deployment in Constraints (REN and RAN) maps

	1994 (x $10^3 m^2$)		**2004** (x $10^3 m^2$)		**Dynamics 1994-2004**	
Municipalities	*REN*	*RAN*	*REN*	*RAN*	*REN*	*RAN*
Vila Real	51,07	43,87	108,79	67,79	113%	55%
Alijó	75,72	8,50	117,51	15,84	55%	86%
Murça	36,32	7,97	56,27	12,84	55%	61%
Sabrosa	39,58	9,22	53,35	17,52	35%	90%
Peso da Régua	73,64	5,60	114,75	7,69	56%	37%
S. Marta Penaguião	32,01	1,20	69,58	1,56	117%	30%
Mesão Frio	26,01	0,11	38,46	0,37	48%	230%

Illustrating this analysis of the buildings inside and outbound of urban areas, we decided to include an analysis of the areas of deployment framed with the mapped constraints of the municipalities under study, since they identify the public utility easements which were pre-conditions for a stricter refusal of buildings located upon them. Site case-studies were selected from various areas of the reserves designated as REN (National Ecological Reserve) and RAN (National Agricultural Reserve), the more relevant given the increased rigidity of legislation for the inclusion of new constructions.

As we can see from table 1 all municipalities, as of 1994, showed considerable occupation increases in terms of areas of REN. However, three stood out as the most populous and largest areas of deployment in all seven municipalities, Alijó, Peso da Régua and Vila Real. The most relevant outcome is that, ten years past, the areas of deployment in REN significantly increased in all municipalities, the three aforementioned municipalities keeping with the highest values. But other municipalities such as Santa Marta de Penaguião also score high in this topic, as built-up areas on REN doubled and there is also an increase of around 50% in other municipalities.

Contrarily to what happened with REN, RAN areas had much lower values of built-up areas in 1994, however, Vila Real town continued to stand out as the city with the highest gross value in this class. The cities of Santa Marta de Penaguião and Mesão Frio emerged with values less representative with 1.20 ($x10^3$) m2 and 0.11 ($x10^3$) m2, respectively, ranking after the municipalities of Sabrosa, Vila Real, Murça and Peso da Régua with intermediate values ranging between 5 and 10 ($x10^3$) m2. In 2004, the positioning of the municipalities was exactly the same but with substantially higher values.

An analysis of change between 1994 and 2004 shows that Mesão Frio submitted a higher percentage, however, this municipality had a lower gross rate of buildings increase in RAN. Therefore, much importance has to be given to the gross increases, because in 1994 this Municipality had a gross value of 0.11 while in 2004 it was 0.37. In this context, it should be stressed a lot more, the built-up areas on RAN in the municipalities of Sabrosa and Vila Real in which the amount of buildings in these locations nearly doubled over a period of 10 years.

At the level of the Municipal Plans, the classes of land-use areas are established in accordance with Art. 28 of Decree-Law No. 69/90 of 22 March The subdivision of these classes varies according to the specificity of each area and this led to a standardization of the same typologies in the different municipalities in order to perform an analysis consistent either in the cities or in the region of the Northern Douro Valley. Following this, it was essential to standardize all classes in three classes (Urban Areas, Landscape Agriculture and Forestry Areas, and Natural and Cultural Areas) in a sustained empirical analysis of the respective maps.

Regarding the built-up areas in the three standardized classes, the trend is similar to the ones obtained in the previous analysis, as there is a prevailing tendency that municipalities with more population have classes shifts with the highest absolute value. Vila Real and Peso da Régua present themselves with the highest values. It must be noted however, that variation in terms of a class is distinguishable from the other, albeit the spaces of Agriculture and Forestry, in all municipalities, showed an increase in areas of deployment, in this class, above 50%. In the most heavily populated cities like Vila Real and Peso da Régua, they had variations as high as 101%, 73% and 51%.

Table 2. Change in areas of deployment in accordance with standardized classes of plans

Municipalities / Classes	Built-up Areas (x $10^3 m^2$)		Dynamics 1994-2004
	1994	2004	
Vila Real			
Urban Areas	2265,43	3314,08	46%
Agricultural and Forestry Areas	438,92	883,56	101%
Natural and Cultural Areas	27,78	53,55	93%
Alijó			
Urban Areas	960,28	1177,09	23%
Agricultural and Forestry Areas	252,44	380,54	51%
Natural and Cultural Areas	1,77	2,75	55%
Murça			
Urban Areas	496,39	657,01	32%
Agricultural and Forestry Areas	91,90	150,13	63%
Natural and Cultural Areas	0,30	0,38	25%
Sabrosa			
Urban Areas	510,78	677,62	33%
Agricultural and Forestry Areas	133,89	217,81	63%
Natural and Cultural Areas	8,70	11,01	27%
Peso da Régua			
Urban Areas	661,12	895,60	35%
Agricultural and Forestry Areas	209,07	361,89	73%
Natural and Cultural Areas	3,93	5,44	38%
S. Marta Penaguião			
Urban Areas	369,50	536,58	45%
Agricultural and Forestry Areas	77,72	146,39	88%
Natural and Cultural Areas	0,00	0,00	0%
Mesão Frio			
Urban Areas	151,85	193,75	28%
Agricultural and Forestry Areas	95,99	134,60	40%
Natural and Cultural Areas	5,32	7,41	39%

In turn, the class that stands out as having the smaller absolute values, is the Natural and Cultural areas. Also because it takes up the smallest geographic area, but it still Increased by 93% in Vila Real, between 1994 and 2004. After this municipality, the municipalities of Sabrosa and Mesão Frio display the largest shifts in the areas of occupation in this class, presenting the first 27% of increase, while the latter rose by 39% in the decade under analysis. The remaining municipalities have relatively lower absolute values and display variations between 25% and 55%, with the exception of Santa Marta de Penaguião which has no representation in this class.

5 Conclusion

As it is well known, the PDM "first generation" decisively marked the establishment of a new awareness of the problems of land-use planning and structuring that the Portuguese territory displayed. The making-up and approval of these Plans allowed a fruitful period of discussions and development of concepts that, until then, had never been treated with due importance. However, shortcomings and failures of the plans and of the process of making them and especially their implementation are now evident and can be traced. Factors such as those municipal master plans being drawn up for the first time, and the shortcomings of the available data cannot provide an excuse for lack of efficient policies in shaping land-use change.

We evaluated the impact of urban boundaries of the PDM municipal plans in the new buildings location, incorporating demographic information over the past decade. This analysis provided two outcomes regarding the deployment of new buildings. The first is that while the northern region of the Douro Valley has lost population, areas of deployment increased in all municipalities. The second is that the increase of built-up areas, independent of their intensity, has not complied with the regulations stipulated in the Municipal Master Plans in all studied municipalities. In the mid 90s, it was found that the number of events outside the urban perimeters was already high. A decade later, the trend continues as urban areas are emerging outside the perimeters in REN and RAN as well as in Agriculture and Forestry Areas. But more serious still, is the fact that there are land-use plans that supposedly should have regulated and guided the deployment of new areas in a sustainable manner and they have not performed accordingly, resulting in often irreversible structural problems.

The 1st generation of Municipal Master Plans (PDM), implemented in Portugal in mid-1990, had as one of its main aims to counteract this process by defining urban areas preferred for the location of buildings, seeking to control the problem above mentioned. With this purpose as a starting point, the objective of this study was to analyze the efficiency that the PDM had over compactness of urban areas and hence helping to fight urban sprawl. Thus, through a set of spatial analysis developed in GIS environment, we evaluated the actual impact it has had in the building dynamics between 1994 and 2004 and compared its spatial location, either with the proposals of urban boundaries defined in PDM, as well as with the constraints and zoning maps of the northern Douro Valley municipalities.

The overall conclusion is that PDM did little in comparison with the past existing trends to sustain urban sprawl in this area. The main causes associated with this inefficiency can be related to the permissiveness, as checks between REN and RAN show but a complex relationship between land use and agricultural land with Port wine vineyards needs to be introduced in the discussion. Lastly, this relationship between land-use changes and zoning and plan regulations has to be strengthened with better diagnosis including an updated knowledge of the territory, urban land rents that drive land-use conversion and of policies for dealing with new buildings in a context of population decrease and abandoned old housing stock in central urban areas. As urban sprawl does not appear to be a sustainable option and the urban encroachment on rural lands has kept its pre-PDM rate of increase even in areas as Northern Douro Valley typified as medium and low density where there has not been, up to the moment, a real perception and national awareness that the building dynamics has been leading to urban sprawl.

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Porto Morphological Territories

Teresa Calix

Centro de Estudos de Arquitectura e Urbanismo, Faculdade de Arquitectura da Universidade do Porto,

teresa.calix@arq.up.pt

Phone / fax numbers: 00 351 226 057 100 / 00 351 226 057 199

Nowadays the widespread idea about the real city form results in a feeling of loss of an image that no longer corresponds to the contrasting physical reality of the urban. Regardless the evidence of regional urban sprawl, the common sense idea still associates city with an ordered sum of morphological clusters, sometimes referring to ancient tissues and other times associated with contemporary architectural objects with recognized authorship and accepted as 'extraordinary'.However, the reality shows that the distinction between the 'ideal city' and the 'other city' in its surroundings is not as real as the one that once distinguished the ancient walled city from the countryside. In fact, the common analyses regarding the crisis of city form, structure and boundaries normally derive from conceptual frameworks too influenced by the old concepts. The alleged 'urban', produced by the metamorphosis of the city, is less consistent with a framework that does not correspond to present reality and does not discard the concept of the city as a 'confined thing'. The boundless 'urban' is not a result of the post-modern expansion by contiguity of the modern city. The extensive land development, as we know, is a 'mosaic of fragments' produced by several processes, sometimes resulting from the expansion over 'free' land, and above all, resulting from the urbanization *in situ*, 'colonizing' infrastructure including old rural landscapes. The starting point for the analysis and planning of the present day territories therefore requires the integration of new concepts to understand the authentic physical and social condition of the contemporary city and accept the lack of a single and simple identity. Focusing on "morphological territories" instead of "urban fabrics", as proposed by Font (2004) in *L'Explosió de la Ciutat*, this article intends to present for the debate, the concrete example of morphologies in Porto Urban Region.

Keywords: City form, Urban sprawl, Morphological territories

1 Purpose

The awareness of the complexity that characterizes current forms of settlement emphasizes one's idea about the difficulties regarding their interpretation, understanding and systematization

This perspective about the territorialisation of the urban, led to an investigation, still in progress, whose main purpose is an attempt of typifying urban forms and spatial structures, through a systematization that will enable the understanding of the reality of the contemporary city landscapes.

This goal, adopted as the most important, arises not only from the interest in exploring and describing the construction of the territory, showing the 'materials' that compose it, which, in our view, could prove to be extremely useful, but also and more significantly, from the intention to prepare, based on the classification achieved, a possible reading frame for the urban.

Indeed, to characterize the "morphological territories" of the expanded city, as proposed in *Explosió de la Ciutat* by Font et al (2004), requires accepting that an urban area is a single object in its vastness. This entity integrates both the new morphologies coming from the emerging urbanization and those resulting from construction, regeneration or conversion processes of the so-called compact city.

This attempt of taxonomic classification aims to contribute to the systematization of an interpretive framework that enables the apprehension of the complexity of the current city through its simplification, assuming as correct that the rejection phenomenon that overhangs over it derives, above all, from ignorance.

2 Alleged city crisis

In the past, city used to be a confined place usually surrounded by real or imaginary walls. Urban things were inside and non-urban things, the countryside and all the small villages, were outside. Therefore, the distinction between urban places and rural spaces was quite simple and intelligible for everyone.

After a very short period of remarkable transformation, cities have become extremely complex. In fact, as part of a sequence of transformations forced by the Industrial Revolution, they grew so exceedingly large in the last century that they have lost its original reference parameters.

The *marks of "urbanness"*, as Webber (1963) calls the *old symbols of order*, became indistinguishable at the same time as the physical boundaries disappeared and the networks of interdependence became functionally intricate and spatially widespread.

Nowadays reality shows one can no longer find the distinction between city, like it was known in the previous eras, and its surroundings. Nonetheless the ‘city of the past’ is still commonly seen as the 'ideal city' while the ‘city of the present’ – the ‘other city' – is attached to a feeling of loss of an image that no longer corresponds to the current physical reality and derives from conceptual frameworks too influenced by the old concepts.

The territory produced in the metamorphosis of the city to the urban, is less consistent with a mental frame that is not based on existing reality nor abandons the concept of city as a confined object.

The difficulty in understanding this new territory prevents it from being recognized and accepted when the theories, practices and instruments acquired, tested and consensual for analysis and intervention in the traditional and limited city are no longer the most appropriate for the new and endless city.

More than overcoming the nostalgia of the loss of the 'simple' idea of opposition between city and countryside, what we really intend, is to demonstrate that what exists today is a generalized urbanization unfolded in distinctive scales, morphologies and functional diversity and that it incorporates features of different realities.

Thus, the starting point for analysis necessarily requires, integrating new concepts, to understand the actual physical and social condition of the contemporary city and to accept the lack of a single homogeneous and recognizable identity.

Being synthetically exposed the main issues and difficulties inherent to the contemporary urban thought, we attempt, in the scope of this communication, to clarify the assumptions inherent to the problems that new forms of urban settlement gather and legitimate and which are not dependent on a single geographical context.

3 Working assumptions

Originated by a *triple decentralisation of the urban sphere in formal, conceptual and regulatory terms* (Domingues, 2009) the physical reality of the current urban territory is fragmented, each sector corresponding to a variety of morphological materials and different functional objectives.

In fact, at the *formal level*, the extensive land development, as we know, is a ‘mosaic of fragments’ produced by several processes, sometimes resulting from the expansion over ‘free’ land, and other times, resulting from the urbanization *in situ*, ‘colonizing’ infrastructure.

The territorial distribution of infrastructures covers increasingly large regions making land development possible in very different and detached geographic areas. This new reticular order, associated with the exponential increase of mobility, makes relations easier in every context and enables relational closeness without physical closeness.

By combining the effects of physical and relational closeness in land development processes the use of space as radically changed. Every material place is also an immaterial ‘site’, a possible node in a system of relations or links which illustrates the "network society" (Castells, 1996). The complexity of the developments and their lack of integration with their surroundings, the relocation of urban uses and innovative functional combinations are associated with the visual language of corporate or commercial architectures.

These urban clusters, both from the morphological point of view, either from the aesthetic standpoint, experience a process of self-organization further ruled by the laws of the market than by the mechanisms of urban planning. Architectural objects are not indifferent in themselves, but rather indifferent to each other, contributing to a perception of the periphery as disorder. This idea of disorder is also justified by approaches to aesthetic nature.

The discontinuity prevailing on built forms and open spaces highlights the persistent presence of the urban void as a condition of the peripheral areas (Solà-Morales, 1997). Neither contiguity nor continuity is requirement of the city of global urbanization. Both the influence of a unique historical and geographical place and the importance of distance to it are in sharp decline.

While people and activities keep moving to suburban locations, the traditional or historical centre (clearly recognized by its specificity due to a long accumulation of fixed collective capital) denies legitimacy to the rest of the city in its surroundings. The very idea of the centre, earlier extremely consensual, is undergoing a profound change and is the subject of controversial claims.

Some believe that the essence of the present city is seen by many as a kind of place-absence. The no-placeness reflects the dissolved condition of nothingness.
The current vision of the present territories as spaces without identity derives from the lack of a history inscribed on the civilization issues typically related with urban space. This absence reduces to zero the configuration of the *locus* in its classical sense (Solà-Morales, 1997).

Urban nothingness can be seen as one of the possible metaphors of our contemporary condition and reminds us of the no-place dimension, conceived by Augé. The no-place is assigned only to the individual; it lacks relationships, identity and history.

On the other hand, the uncritical acceptance of the periphery, the defence of the disorder, the praise of the aesthetic chaos associated with the new figurative paradigm are not easy to sustain beyond the initial intuition (Solà-Morales, 1997).

Faced with this reality, Koolhaas (1995) emphasizes an inevitable break with the former concept of order. Invention and innovation have, in his ideology, a predominant effect which triggers a process of critical interpretation that leads to the development of a work free of typological constraints.

The extensive manifestation of commonness induced similarity between spaces and these, having no former history, seem to have no identity. Cities became, in fact, the personification of the generic. Generic city (Koolhaas, 1995) is only possible without a centralizing identity produced by significance or personality. The so-called ‘urban’ is the place for dreams and ideals. Here one can find the apotheosis of multiple choices.

His work takes a provocative attitude, which does not hesitate to question the normal order of things and is founded in the idea that generic city is a new city liberated from the captivity of history and identity.

The flattering justification about territorial disorder and peripheral empiricism introduces attention and admiration for void and decomposing spaces that flow into the splendid releases and post-modern suburbs - images of an area of road infrastructure and uncritical consumerism.

This urban attitude and way of thinking bring consequences that will involve the creation of unexpected freedoms founded in an urban design based on contrasts and rupture.

Urban voids should be understood as the most important condition for the project, considering, also, the distance, as a compositional argument of the peripheral urban form (Solà-Morales, 1997). Similarly, the architectural vision, paradoxically complementary to typological thinking, will always be more innovative in the field of figurative urban forms, far away from the shackles of compulsory morphological order dominant in the consolidated city.

It is important to recognize the actual space conditions as specific of the peripheries. Those who tend to conventionally be understood as spontaneous actually are not. The apparent randomness of the constructed objects obeys, in fact, to rational location criteria.

One must understand the void spaces and the interesting distances. The distance between built structures must be seen as a compositional argument of the present urban form. One must reflect on the whole interest of those distances.

As Webber (1963), *we have compared these symbols with our ideological precepts of order and found that they do not conform; and so we have mistaken for "urban chaos" what is more likely to be a newly emerging order whose signal qualities are complexity and diversity*.

Approaches to this reality by cinema and photography were not accompanied by the required taxonomic endowment so that one can define the peripheries without appealing to the use of metaphors and analogies or to the idea of degradation or the central city (Solà-Morales, 1997). To exceed this constraint is essential to understand the concrete peripheral space.

Indeed it is this scarcity of concepts that goes beyond the traditional city framework and assumptions that has not allowed the creation of tools and instruments that permit the comprehension of the contemporary city, or even worse, that encode it as unreadable in its complexity. It requires the taxonomic resources available for the consolidated city.

The success of some intellectual attempts to systematize or classify the urban was not followed, at least not in an extensive and culturally recognized way, by virtuous practice. Positive approaches, opposing to the negative and opaque stigma associated with these territories, allow optimistic visions of sprawl and outweigh the compact urban model.

However, one systematically appeals to the use of metaphor and analogy, and not to the exercise of description. Therefore, one tends to replace descriptive by figurative analysis (Solà-Morales, 1997) preventing, by doing so, solid advances in the intellectual field of urban studies.

A conclusion can be drawn from all the new theories: strict determinism and seemingly accidental development are not mutually exclusive. On the contrary, their coexistence is by and large the rule of nature.

4 Two levels of approach

At a time when the understanding about the identity of the city and the concepts underlying the urbanization (as an act of creating city) face with each other, we intend to reconcile two levels of approach - the processes and the products (or forms) - considering a range of analysis that makes possible to understand the distinguished characteristics of the main spatial circumstances and of the 'fragments' that shape them.

The territory is not a given, says Corboz (1983), but a result of various processes that transform it according to its own logic. It is the object of a construction and therefore a social product. Within this communication we will underline the products as urban forms produced by society dynamics. Thus, to show such reciprocity between society and the city we will turn to the analysis of urban morphology and simultaneously show that, even in forms and processes apparently spontaneous, there are a number of implicit rationalities (Vecslir, 2007) in the construction of a territory without one single order.

4.1 Processes

The analysis of the contemporary city morphology has revealed that its enormous heterogeneity, visible in more flexible and fragmented morphologies, is due to a change in the city's recent production and simultaneously establishes a new historical relationship between society and its territory.

On the one hand, there is a predisposition towards homogenization associated with the globalization process, which affected production systems, behaviours, and thus the artefacts (Corboz, 1983). On the other hand, the affirmation of difference and specificity towards a more equal world apparently works as reaction mechanism to draw resources.

Through processes of concentration and decentralization the reality moved from the cluster to the network. The new territorial order is reticulated. Being true that the mobility network has always played an important role in structuring urbanization, by establishing guidelines for growth forms, today these infrastructures are shaping up as clearly urban pieces, combining morphologies and activities.

In this new order, urban occupation, understood as a system of poles that simultaneously oppose and complement each other, attaches particular importance to locative values and is strategically fixed in terms of certain points or lines with positional advantages in the infrastructure network.

Indeed, polarization takes place through the use of a variety of morphologies and urban materials. The directional functions with high potential of attractiveness are no longer concentrated in a unique

area and as such, the leverage of traditional centres dispersed across the territory and turned it into a network of points with different levels of attractiveness.

Major highway pieces, particularly nodes, mark the reading of the landscape and, by defining new accesses, enhance the parameters of mobility and intervene on how the territory is occupied. The effects of disruption on the one hand, and the promotion of new areas of expansion, on the other, are two of the most direct impacts of implementing these projects.

Wise interpretation, the one that is not common sense, uses the network as a metaphor of the relational space between points, in which the last match activities concentrations. To them the mega-structures, usually with commercial origin are often associated. These organize the relational dynamics that structure the extensive urbanization and that are very different from the surrounding context, proximity and contiguity that characterized the small scale of the old city.

Therefore, the city with which each individual is identified has developed new morphologies, not always resulting from an autonomous and differentiated culture.

Furthermore, although not always evident the resilience of places in presence of the dissemination of ideas and models from the global sphere, this reality has confirmed and reinforced the opposite trend, strongly supported by the market. Focusing on cultural patrimony and the specific historical context places resort to large urban events as a pretext for launching strategies of marketing, combined with flagship projects that capture a segment of urban and transform it into the symbol of a revitalized urban space.

In fact, the assertion of differences and situational specificities of each site leads to operations of urban qualification and, similarly, although at other scale and in other way, reflect the importance of urban spaces visibility and representation.

There are, thus, two major sets of growth typologies: linear growth, establishing a differential relation between the new interventions and the mobility network; and the nodal intensification, which, like the previous one, arises from compliance with the network, creates polarities *ex-nuovo* in crossing points or acts by contiguity and densification of existing nuclei also integrated into the system.

The contemporary city is materialized without those growing features that occur exclusively by continuity of the compact city. This city is mainly composed by a sum of isolated parts increasingly self-organizing and independent. As a result, the new urban geographies are increasingly independent of a specific urban nucleus.

These two major trends underlying the processes of growth in recent decades can thus be summarized in the four themes below, presented in chronological order, taking into consideration their succession bearing in mind the moment of their greater participation in the development of urban agglomerations:

- expansion by spatial contiguity and continuity of the historic cores through the extension and densification of existing fabric and paradoxically characterized by uses promiscuity or by the suburban almost exclusive housing or industrial use;
- changes for replacement or reuse of existing obsolete or empty spaces in internal areas to urban agglomerations;
- dispersed growth, usually housing;

- establishment of new places of activities (business, commerce, leisure) and innovation corresponding, generally, to enclaves of high accessibility and visual display along the major elements of mobility infrastructures.

Although coexisting in different intensities at present time, it is evident that the recent forms of growth have been reinforcing the polynuclear and discontinuous urban structure associated with the reticular system. This reality is being accomplished by combining activities and morphologies that tend to set up new urban fragments which give ‘thickness’ (in the sense explained by Secchi) to the main routes and polarize the network.

This complex construction of urban form leads to an increment of morphological heterogeneity by gathering in the various 'parts' that constitute it, contributing to an already fragmentary and discontinuous scenario.

4.2 Products

Processes are understood as dynamics or trends of growth and transformation while products are their forms of physical materialization.

Although processes are responsible for producing undeniable consequences in territory spatial configuration, one can not confuse the actions related to the succession of moments in which events unfold with the qualities or properties of what is material.

As such, the partition of the diverse components of the urban we intend to make intelligible by reducing their level of complexity arising from a multiplicity of elements that come together, overlap and establish intricate relationships between them.

This decomposition doesn’t intend to detach the urban occupation until its minimum constituent elements but rather a coherent thematic dissection. This analytical procedure establishes, initially, two different categories which will allow a better legibility and interpretation of the various components of the complexity. In later stages these will be subdivided into other classes in order to set out the level of systematization that allows their understanding.

So, the two major tendencies that underpin the processes of urban growth, and which act systematically by overlapping (which hinders their effective distinction in various contexts), increase the establishment of territorial extensions which are intended to systematize.

In an attempt to typify the metropolitan territories, Font (1997) suggests the existence of three large sets of morphological elements, which are subdivided into smaller groups:

a) Ambientes urbanos: los aglomerados, las extensiones, y los hilos o filamentos.

b) Paisajes de la baja densidad y de los límites: los desagregados, los asentamientos dispersos.

c) Escenarios en red: los elementos arteriales, los enclaves o nodos.

Instead, our proposal, following all the research that has been developed in this area by the Research Group *Morfologias e Dinâmicas do Território*, coordinated by Prof. Manuel Fernandes de Sá, in Centro de Estudos de Arquitectura e Urbanismo da Faculdade de Arquitectura da Universidade do Porto (CEAU-FAUP), aims to describe the forms arising from physical embodiment of the current processes considering, as a starting point, the division of morphological materials in only two categories designated as Structures and Textures.

The morphological material is here understood, as explains Viganò (1999), as a summation of inseparable elements of an operation and of a composition. The material therefore corresponds to an assembly or a mixing of existing components that create an image. The recognition of the distinctive characteristics of each material can decompose the territory into identifiable categories, facilitating the apprehension of reality.

Thus, the proposed classification integrates the different urban materials of the three categories proposed by Antonio Font, rearranging them, however, divergently. This way, in a first level of dissection, their affinity or disparity in regard to each group is based on the intensity of occupation.

4.2.1 Structures

Structures correspond to the morphologies of intensive character, corresponding to systems of axes and nodes, infra-structural channels and points of functional agglomeration.

Indeed, Structures describe the traditional city centres and its extensions, and also the nodes or polarities, which correspond to the points of greatest accessibility at network intersections and to the areas of activities that are adjacent to them. Apart from these, this group incorporates linear systems of urban occupation that present characteristics of intensity, concentration or compactness.

They include therefore the various forms of urbanization associated with logics of intensity and intensification, produced by the long and the short time of urban phenomena.

These places of convergence, but also of radiation, systematically gather two distinctive characteristics of the surrounding context by combining not only the particularity of a medium to high density of occupation, but also a significant intensity and functional diversity. Consequently, they correspond to the differentiating elements of the urban and, as such, are seen as fundamental references for its legibility and intelligibility.

Undoubtedly crucial to characterize the specificity of each territorial context, they also allow predicting the direction of urban development and its expression, due to the accumulation of knowledge regarding the known effects of certain important actions. Therefore they correspond to the areas of intensive urban agglomeration, whether traditional or historical centres, new peripheral centres or emerging and complex artefacts that aggregate these various identities.

However, places of functional concentration do not always correspond to the sum of the two indicators mentioned above. Indeed, one can find within the built environment morphological materials where there is a prevalence of one of these characteristics over the other. We refer to the poles of functional concentration in which is associated with low building density a strong concentration of activities, usually poorly diversified and respecting to the productive sector or the logistics branch, as it is the case with some logistics platforms and business or industrial areas. However, because of its potential attractiveness, due to the number and diversity of jobs assembled, and of the requirements usually associated, as the performance of the infrastructures of mobility, they represent a particularly important role in organization, identification and recognition of recent territories.

Unlike the former explanation for the points of condensation (or planning) of activities, we believe that the strong concentrations exclusively residential, characterized by high building density but without an acceptable offer of other type, although they might detach from the viewpoint of their territorial expression (volumetry, form, image), are not Structures.

As can be inferred from the above description, when we increase the scale of analysis, Structures are subdivided into more subgroups of morphological territories: the traditional and compact city, the innovative transformations in city inner spaces, the new urban settlements, the emerging spaces of concentration of activities in the intersections of the reticular system and the linear polarization, corresponding to the intensive urban occupation along some sections of the principal arteries of the road network

Each one of these groups integrates the set principles inherent to functional relationships and reflects potential market and its geographical areas of influence. The localization bearing in mind the population on which it intends to exercise more attractiveness (physical distance and, above all, the travel time) and hence the innovative character and synergies between activities, are assumptions inherent in these provisions.

From the morphological point of view, the intensive urban corresponds to areas with higher building density and land cover, to urban fabrics further consolidated and to volumetrical compositions that seek to achieve an expressive image. Trying to capture attention (in every sense of the word) at the expense of other network points is a phenomenon inherent to polarity system.

4.2.2 Textures

Textures correspond to the extensive nature of urbanization. They stand for continuous surfaces classified as homogeneous when analyzed according to some simple indicators (demography or land use, for example).

Textures represent the landscapes of low density, as named by Font (1997), and the diffuse urbanization. This morphological group includes dispersed interventions, with some marks of contiguity and usually mono-functional in the immediate expansion of existing settlements, in "between-cities" (Sieverts, 1997) and along the national road network.

In this kind of urban occupation, clearly diluted in nature, it is difficult to find a hierarchy giving the almost absence of different levels of importance.

These extensions of dispersion and diffusion result from forms of urbanization that gather a low building density and a low rate of occupation of land. They refer to the urban patterns consisting of repeated and undifferentiated morphological elements that make up the grain or the texture of the city, noticed in large and consistent areas.

Therefore, textures correspond to urban occupation weakly consolidated and dependent on local roads, to areas of exclusive housing developments resulting from actions of parcelling or urbanizing and to individualized logic of isolated occupation of rustic land. They also integrate the forms of diffuse industrialization and the small industry or commerce connected to housing.

They reflect the morphological features produced by the dynamics of extensive character, such as decentralization, dispersion, diffusion and rurbanisation, which become visible in areas without hierarchy and in the mix between the built environment and agricultural or forestry uses.

As can be deduced from the description, when we change the scale of analysis by reducing the visual field, Textures are subdivided into more subgroups of morphological territories. The unplanned, individual and punctual occupation usually meant for housing or industrial typologies; the filament, corresponding to a linear organization in changed rural environments, the extensive or diffused urbanization and the planned housing developments.

From the morphological point of view, the extensive urban corresponds to areas with low building density and land cover, between centralities or polarities of medium or large dimension. The urban occupation is poorly consolidated and highly dependent on the road network and is associated to an absence of formal references and to a nonexistence of continuous qualified collective space as in the consolidated city, even in the presence of planned urbanizations.

The diffuse city doesn't have a particular type of architecture. In reality it is actually based on the import of models and typologies from the traditional city. The differences found in the urban spaces of these emerging derive more of the relationship that the architectural forms set out with empty space, prevailing the latter over the built objects. Here, instead of the traditional city, public space is not the "negative" of built space.

5 Porto Urban Region morphological territories

Following the already mentioned investigation developing in CEAU-FAUP and the study conducted under the studies for the Northern of Portugal Regional Plan and, more specifically, the several approaches that have been developed for the Porto Metropolitan Area, we intend to contribute to the systematization of Porto's contemporary urban morphology.

The analysis of Porto Urban Region morphologies and their inherent dynamics is the basis for attempting to typify the spatial patterns.

5.1 Porto Urban Region Structures

The acceleration of growth and the dispersion of the urban landscape of the Porto Urban Region are associated with a remarkable ability that certain axes have to pull on the urban functions.

Major highway pieces and particularly the highway nodes, mark intensely the landscape and, in defining new accesses enhance the parameters of mobility and intervene on how the territory is occupied. The effects of disruption, on the one hand, and the promotion of new areas of expansion, on the other, are two of the most direct and visible impacts of implementing these projects.

The main materials for structuring the urban settlement in the Porto Urban Region are networks and infrastructures of arterial mobility arterial, major concentrations of industrial and logistics activities, and major urban centres.

The logic of installation of industries and logistic enterprises, in large monofunctional areas, the Industrial Zones, and more recently, the Business Areas, has been followed and complemented by Logistic Platforms.

Large shopping complexes begin with the hypermarkets, in the late 80s, and will be diversified and complicated until present morphologies. Nowadays, they include business, leisure and housing and implant themselves in the vicinity of urban areas, understood as potential markets, and adjacent to large mobility infrastructures.

The integration of more recent and entrepreneurial logics are evident in the enterprise deployment of real megastructures - idiosyncratic clusters, discordant, intrusive, out of scale, dependent on a single logic - that clearly interfere with the understanding of the boundless urban .

The Arrábida node, for example, is a new urban place that, referring the advantages of its own position, combines the effects of physical and relational closeness with time-saving distances, hyper-scale shopping mall and hyper-specialized services. The access point to a highway node works as a means of shortening the space and improves the gravitational forces of attraction, enhanced with housing, commerce, business, a hotel and a private hospital.

Thus, it is not strictly endowed with abstract qualities by reference to an urban structure but with a potential that is valued differently by different social actors. So, one can explain the diversity of existing real estate deals, and, within each one the differentiation that exists (including the architectural one). Taken as a whole the externalities that the site offers enables a range of choices.
It represents a compact object, a concentration that allows various functional specialties and temporalities. It combines accessibility, directionality and identity acquiring the characteristics of a centrality. However, it is not central is peripheral. The use of the paradox permits to emphasize how the production of central condition may be very different from the widespread idea of the centre, both in subjects relating to geographical, functional or morphology.

5.2 Porto Urban Region Textures

The study of recent forms of occupation at Porto Urban Region large urban agglomeration shows the proliferation of construction, particularly housing, throughout the territory. Along the national roads, buildings use traditionally rural areas, usually associated with an absence of equipments, of infrastructures and of quality (the lack of quality is generally verifiable in the set even if the individual piece).

Industrial districts resulting from a proliferation of facilities at an early stage of industrialization, led to the emergence of mixed and complex urban areas. The urban grows over the field, not replacing it but living in coexistence with it. The term "rurbanization," which is often attached to this context, relates to the transformation processes of pre-existing rural structures by introducing elements of the urban lexicon, keeping, however, the two elements that came together and do not have a new autonomous identity.

Responsible for the suburbanization of cities, then the industry facilities would settle in areas more distant from the main centres which because of the job offer, would be accompanied by a further strengthening of urbanization in rural areas clearly.

The expansion of residential areas, resulting, initially, of the increase of employment peripheral areas associated with the industry, is followed by a second moment that comes up to today, in connection with the construction of a building for the middle class who demand superior comfort levels and a different environment from the traditional centres. These trends were reinforced by a more affordable real estate values caused by a lower ground rent.

This middle-class residential expansion is possible only thanks to heavy investments in road infrastructure, which have helped to increase the fluidity and speed of travel between residential neighbourhoods and traditional centres of employment (or large containers of employment).

The housing development projects, quite common at present time, coexist with a more ancient process of occupation by construction of the edges of local roads. When this process leads to conditions of contiguity these turn into the “street road”, or *A Rua da Estrada* (Domingues, 2009). The “street road” is a good example of an urban configuration that arises from the spontaneous linear occupation on the edge of the roads.

6 Conclusions

Confronting the difficulties on reading and understanding the contemporary city, but also searching for further improvement of its comprehension, the methodology of analysis emphasizes the importance of urban morphology to the study of city complexity.

The attempt to determine the components of the physical space reinforces the importance of physical urban form to overcoming conflicts and contradictions that persist among the different scales of urban resolution.

The priority is, therefore, to define the morphologies and to relate the different functions. Territories should be included as factors and not as mere support of their processing. One has to understand them from their formal structure, their physical image and their historical construction. It is essential to learn to read the landscape as a compendium of the history of transformation of the territory, and not considering land only as a support or merely as a perceptual landscape (Sabaté, 2002).

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Social innovation dynamics: a territorial approach to 3rd sector initiatives in the north of Portugal

Vera Diogo, Teresa Sá Marques, Paula Guerra

Escola Superior de Educação – Instituto Politécnico do Porto

E-mail: veradiogo@ese.ipp.pt; troiatdk@gmail.com

Faculdade de Letras da Universidade do Porto

Telefone: 22 6077189, Fax: 22 6077194

E-mail: tmarques@letras.up.pt; teresasamarques@gmail.com

Faculdade de Letras da Universidade do Porto

Telefone: 351226077100/351226077190 , Fax: 351226077190

E-mail: pguerra@letras.up.pt; mariadeguerra@gmail.com

This ongoing project addresses the recent transformations within social policy and practice that gave form to the concept of social innovation. Social innovation is understood as a significant change in the way a given society deals with a social problem. Its significance is measured by scale - number of people, geographical area involved, by scope - its capacity to affect multiple social dimensions, and by resonance - that is, the degree of intensity to which it attracts people's imagination (Nilsson, 2003). The question is to know in which ways the spatial development and spatial justice (Soja, 2010) is affected by the social innovation initiatives carried on within the third sector. The literature on social innovation refers to two main methodologies: working with and not for the people – the conviction that social actors' involvement on the projects that are designed for their benefit is a functional requirement; network cooperation – the understanding that organizations must come out of their walls in order to fully engage with society, for that is the only way to provide an integrated answer to social needs in a network society. The research will approach 3 case studies: a national project on gender equality run by a Local Development Association's network – *Animar*; a Private Social Institution focused on Health and Wellness – *Espaço T*; and, a Non Profit Association focused on Housing – *Associação Humanitária Habitat*. This third case is a methodology of housing support based on volunteer work and territorial network activation, therefore of particular interest for this conference.

Keywords: social innovation, spatial development, third sector

The guideline of the project that gives ground to this paper is *the relation between 3rd sector social innovation initiatives and spatial development.* The research question we pose is *In which ways can 3rd sector social innovation initiatives affect spatial development?* This question can be divided into two: *Can 3rd sector social innovation initiatives affect spatial development? If so, in which ways?*

The debate aroused by these questions comes from a wider reasoning about the role of 3rd sector's organizations, and the role of the civil society, in general, in the construction of the future of communities, regions and nations, which is in fact, the practice of development. Such reasoning is based on recognized literature and research on the identity and structure of the 3rd sector, on the ascending field of social innovation and on spatial development. These references give us reasons to believe there is a relation between the 3rd sector and spatial development, and that the first can affect the second. Far from assuming this relation as linear and unidirectional, our position towards research is focused on the role of the 3rd sector, particularly of the new generation initiatives that follow the principles of social innovation, in shaping the face of place.

The 3rd sector is defined as a wide group of organizations whose purpose is not to maximize profit but to obtain a social outcome, to provide a collective or public service that answers the needs and aspirations of a local community or a particular group of people. Their private nature is what

distinguishes these organizations from the public institutions. Although they provide collective or public services motioned by a social goal, they are ruled by private law and have autonomous management nondependent from the governmental or public administrative structures. At the same time, the 3rd sector organizations are different from the private market organizations in what comes to profit, there is no profit maximization in the 3rd sector organizations, once their focus is on the social value of their activities. Therefore there is no struggle between the use value and the exchange value of the services provided, once it is the value in use, the intrinsic value of the service provided that gives purpose to the economic activity. This can in fact be seen as the competitive advantage of the third sector over the market, once it is not subject to the market laws that exclude consumers according to the price of goods. And in comparison with the state, the 3rd sector organizations are not subject to the variability of political cycles, which represents a possibility of advantage in terms of inner coherence and continuity of services and programs provided by the 3rd sector (Evers, 1990). According to the John Hopkins University, CNPP – Comparative Non Profit Project, applied in a wide range of countries, including our country, in 2005, a 3rd sector organization is defined by five common traits: to have a formal legalized structure; to assume private nature; the absence of maximization or distribution of profits; the existence of an autonomous management supporting an ongoing activity run by a formally defined group of members; to admit only voluntary forms of membership(Franco, 2005).

An analytical approach to the 3rd sector initiatives distinguishes the activities of these organizations by the principles that are implied in such structures, such as the universal value of human life, and its superiority above the value of capital, the importance of freedom, justice and human rights, the necessity of promoting forms of cooperation to achieve a better commitment to the fulfilment of human capacities. According to Salvatore, the type of rationality that underlies these principles is the value oriented rationality, as defined by Max Weber, for its principal goal is the provision of services that will answer to social needs, problems or aspirations, differing from the instrumental rationality, the value oriented rationality is not focused on the means or costs that an activity might imply, neither on its probability of success. For the leitmotiv of such activities are the values and ideas that inspire it, hence these values give ground to the structural objectives of the organization. Weber's theory was designed to explain social interaction among individuals but it can also be useful to understand the organizational behaviour, moreover, there is an important relation between individual social interaction and the forming of organizations, once the origin of social organizations, as a general rule, is the reunion and collective action of groups of individuals with common values and common goals (Salvatore, 2004; Weber, 1922).

The 3rd sector arose from the need of cooperation and the understanding that in our world we live better when we work together, an individual cannot obtain by him or herself necessary resources and services to provide for his'/her own life goals and needs. Throughout history mankind has learnt the power of cooperation and institutionalized organization for the fulfilment of each person's individual freedom. Institutionalization means obtaining a formal legal structure, defining formal goals and rules and a body of members with distinct functions connected by the hierarchy line that grants the share of responsibility. Institutionalization is what distinguishes the 3rd sector organizations from the ground based groups or collectivities with no formal identity. So, the 3rd sector

can be seen as the organized and institutionalized part of civil society, existing therefore a connection between the 3rd sector and social movements, as well as with the social facts that arise in a society in each time period. Like it occurred when the Portuguese revolution of 1974 gave momentum to the explosion of the popular protests, already under course, for the right to proper housing and the *Right to the City,* spread in the biggest cities where the housing need was more severe, and lack of urban planning more crucial. This movement resulted in the gradual institutionalization of the Portuguese Housing Cooperatives, a strong group within the cooperative sector, until nowadays(Rodrigues, 1999;Faria, 2009) Cooperativism is itself an important piece of the history of the 3rd sector, developed particularly in the XIX century, in activities of major importance such as agriculture, education and primary goods consumption, and its legal framework was formed in the early XX century, as well as its distinction from the other forms of social organizations, associations and mutual organizations or societies(Quintão,2004).

The concept of social innovation is related to the current transformation in the field of social work, largely carried on by the 3rd sector. This transformation proposes an integrated and effective approach to social problems, since an integrated perspective of human existence in the context of social exclusion is the only way to invert the process and open a path towards social inclusion. This transformation requires new ideas that can provide solutions to increasing social problems, particularly new ways of posing such problems, new reasoning standards, focusing not only on people's needs but on people's capacities. As Einstein once said *today's problems can not be solved with the same reasoning standards that created them* (in Meneses, 2009). This is the basis of the idea of social innovation as Nilsson defines it, in his words, *a significant, creative and sustainable shift in the way a given society dealt with a profound and previously intractable social problem such as poverty, disease, violence or environmental deterioration*(Nilsson, 2003). Such a transformation process in the patterns of response to accurate social problems will imply a rupture with the established norms and the previous order of distribution of power, capital and resources. According to Mulgan, the process of social innovation depends upon three basic links of the socioeconomic system that sustains it: effective demand – the broad recognition of social problems; effective supply – the generation of new ideas that can solve those problems; effective strategies – the answer to the question *how to make the ideas work?* – involving the options taken, the methodologies, the forms of access to funds, and the relationships created with several actors(Mulgan, 2007b).

This step forward needs to be taken firstly inside the organizations that undertake the process of social innovation, for it means the adoption of a new methodology of social work, which is composed by two main pillars: the necessity of *working with and not for the people* and the awareness of the multiple benefits of *network cooperation* – these two pillars, operating at the procedural level, constitute the first set of conditions for social innovation to occur.

Working with the people and not for the people, means that the essential basis of social innovation work is relational and therefore must be focused not only on people's immediate needs but furthermore on people's capacities, goals and responsibilities. Therefore the excluded populations must be treated as capable, free and responsible individuals, who have a word to say and a central role to play in their own process of inclusion and life standards improvement. This idea follows the theorization on the concept of *empowerment* that we will not explore in depth on this article, but

whose basic assumption is that excluded groups and individuals must be the locomotives of social change. And in fact, as Mulgan states, *social innovation does not only serve vulnerable populations, it is served by them,* not so rarely, the excluded groups themselves create forms of organization to stand for their own rights(Mulgan, 2007a). Besides, creativity and the capacity of adaptation are common traits to human beings, in these capacities lies the complex of agency which gives social structures their balance throughout the evolution line. Agency and structure are, indeed, the two basic forces that form social systems; structure is maintained by the necessary continuity that a society relies on to keep its identity, and agency is the moving force that allows these structures to keep its resilience. Resilience theory is based on the assumption that change is the inner order of reality, from systemic change to systemic change, the ecosystems have a natural capacity of adjustment and reactivity that allow them to avoid disintegration or collapse. Coming from the natural sciences this model has been applied to social sciences in a wide range of disciplines, including sociology and geography. In this context the resilience capacity of social systems depend upon the connectivity and balance between agency and structure, for agency to be effective, the social capital must be reinforced, so that human capital can be strengthen and reinvested in the economy (Westley, 2008). Mulgan provides a general but clear distinction between the economic perspective of human capital, the sociological approach of social capital that recognizes the value of social bounds, and the insightful caption of relational capital which analyses the depth, quality, dynamic and stability of the configuration of social networks(Mulgan, 2009). For Isabel André it is the strength of relation capital, in other words, the communication and sharing of knowledge, ideas and information, through the architecture of power structures that can make social innovation happen(André, 2006).

Therefore, the second main pillar – *network cooperation*- is a crucial method for the process of social innovation. It implies an effective share of power in the process of innovation and a real distribution of credits for its results, thus it is only when organizations come out of their walls that social change at systemic level can occur. The *network cooperation* method is not only applied amongst social organizations, but as well between 3rd sector and governments, public institutions and market economy organizations. The relational network includes relationships between 3rd sector organizations and private companies, individual private donors, local, national and supranational governmental authorities, as well as, to put it briefly, the set of relationships among all the stakeholders, like, for example, the relationships between volunteers and staff members, or board members and fundraising event sponsors. The mixed nature of the network – in terms of economic sectors involved, is fundamental, once the ultimate goal of social innovation is much wider than what can be achieved within the boundaries of the 3rd sector. Social innovation aims social change, as a condition to put in practice an integrated and accurate process of development. Currently, the model of sustainable development is accepted almost worldwide, particularly in the developed countries, and it proposes an integrated view, implying that all economic actors are obliged to the harmony between social, environmental and economical development.

The perspective of spatial development can be very useful for structuring an integrated perspective, given the spatial allocation of people, services and resources. So, it is in place, that the three vectors of sustainable development can be achieved, and they can only be achieved at full extent by implying the active participation of all social and economic actors that shape the face of

place, and will build the future spatial forms and social structures. Furthermore, it is crucial to understand that space is place, that is, space is socially constructed, as well as society is constructed on space in such a way that, like a mirror reflection, space gains social identity, multiplying the social traits that gave it shape. From this reasoning comes the idea of spatial justice, defined as an integrated view of political, economical and social justice that people benefit from in a certain place.

The level of spatial justice is measured in terms of access to public decision making processes, and access to goods and services that allow the realization of human needs, such as housing, education, proper jobs and proper working conditions, clean water, heating systems and other important resources. Within the cities and urban areas it is clear that there are areas with quite different levels of spatial justice, in fact, this topic has been particularly developed in the field of City studies(Soja, 2009).

The main goal of all development theory is the Well-Being of the population which, briefly, can be understood as the improvement of people's life standards – the base of the main commitment of the State towards society. In an utilitarian approach, Well-Being is defined as the completion of human needs, such as access to basic goods, and other consumption goods, shelter, education, proper jobs, and others. Another fundamental approach is focused on the notion of *capacity*, defined by Amartya Sen as the effect of people's freedom of choice, that is, their range of possibilities in their own live choices. According to Sen, the maximization of individual freedom is a condition for development, because development can only succeed when people are able to participate in its process, and they can only do so, by accomplishing their own life goals and aspirations. This notion of Well-Being is connected to the previous explanation about spatial justice, for the fulfilment of individual freedom cannot be accomplished without justice criteria, as the principle of individual freedom implies a social commitment(Marques, 2004). In Rawls theory of *justice as fairness*, the basic principle of justice is the maximization of the minimum standards of Well-Being – the *maximin* principle – meaning that, the existence of social inequalities must result in the amplification of the opportunities of those who are in worst position in the unequal structures of resources distribution. Well, this principle is based on two important criteria, one of which is the recognition of difference, and the other is the right to individual freedom. Accepting the universal value of human life, every individual has equal right to freedom; therefore, the extent of freedom of an individual is connected to the extent of freedom of other individuals, not only meaning that others' freedom limits our freedom, but also that the completion of our own freedom depends upon our relationship with others, and their freedom too(Rawls, 2001). This view of justice and freedom are necessary ingredients of the process of systemic change that social innovation is about.

In order to understand systemic change, we must comprehend society as an ecosystem where the environmental situations – the form of structure in a given space-time social reality - such as *administrative structures and policies, geography and infrastructures, economy and market structure, culture and social patterns* impose conditions to the actors' freedom, and here, we must perspective all the actors and *interactors* present in the relational network as explained above (*partners, competitors, funders, sponsors, volunteers, supporters, opponents and spectators*). Again, we encounter the complex of agency, which can be understood as the capacity of actors to work upon environmental conditions. According to Dees, it is the relationship between actors and

environmental conditions that can generate systemic change, and there are two basic ways of promoting it: to impose a change in the environmental situations themselves or to create a stable and wide process of innovation that can create new standards of behaviour among actors towards the environment (Dees, 2008).

Here we arrive to the level of the second set of conditions for social innovation to work, that is the results level, which according to Nilsson ought to be measured according to 3 criteria: a) *scale* – the importance of dimension, in terms of number of people involved, dimension of the geographical area that is served; b) *scope* – the importance of integrated and multidisciplinary approaches in order to reach the several interdependent dimensions of exclusion, such as Housing and Education, for instance; c) *resonance* – the projects capacity for entering people's lives and imagination – not only the imagination of people in need, but the imagination and lives of all stakeholders, such as volunteers, staff, investors and the public in general, in order to promote the necessary re-interpretation of ideas to make them grow and spread. For the process of social innovation to be effective and design a clear and significant shift in the patterns of response to social problems, scale, scope and resonance must be visible in its outcomes.

From this conceptual framework we developed a hypothetical structure that will guide us on the analysis of the study cases. Crossing the two social innovation methodological pillars with the criteria of signification of the outcomes of social innovation projects, we obtained the framework pictured bellow on table 1:

Table 1. Hypothetical framework

1st set of conditions	**2nd set of conditions**	**hypothesis**
Working with and not for the people	scale criterion	1. Interaction between groups in different socioeconomic conditions, different sociocultural origins and with different social problems, can increase social inclusion of target populations
Working with and not for the people	resonance criterion	2. Volunteering experiences can affect the imagination of volunteers, target populations and general public 3. Promoting social change within the structures of 3rd sector organizations is a condition to improve the extension of that struggle outside its walls
Network cooperation	scope criterion	4. Different economic sectors interaction can consolidate spatial development by implying a wider range of social actors in the process, promoting more cohesive communities
Network cooperation	scale criterion	5. The use of global cooperation tools might increase social inclusion

This combination of hypothesis is grounded on the exploratory research undertaken during the selection procedure, which was based on the two sets of conditions explained above 1) the necessary inner change within the 3rd sector, based in the two main pillars – *working with the people and not for the people* and *network cooperation; 2)* the alignment of the projects outlines with the

fulfillment of the criteria of results significance – *scale, scope and resonance*(Nilsson, 2003). Therefore, this research will be focused on the evaluation of the effective fulfillment of the results significance criteria and the effective practice of the two main methodological pillars.

The study cases were selected through interviews with privileged informers whose experience in the 3rd sector and in social innovation projects in particular, provided the guidance we needed. A prior condition was to analyze projects that take place in the northern region of the country, given the time limits and limited resources available for this project, and the impossibility to compare diverse single initiatives in completely different spatial contexts.

After file analysis of several projects and organizations, following privileged informers' guidelines, with the precious help of the *EQUAL initiative* database and through participation in conferences of the subject, first contact interviews were taken by 5 organizations, from which 3 study cases were selected.

The first case study is a national project on gender equality run by a Local Development Association that is constituted as network – *Animar, Associação Portuguesa Para o Desenvolvimento Local* – created in 1993 for the purpose of promoting territorial cooperation work between organizations, groups and individuals in order to support and improve local development. *Animar* is an important network, not only for the Local Development Associations but also for several other kinds of social institutions that became their partners. *Animar* has run several national projects articulated by regions involving a wide range of institutions and concerning different social dimensions. Most of these projects have been financed by European funding and some of them were included in the above stated EQUAL initiative. The project under research has the purpose to promote gender equality within the 3rd sector organizations. For that purpose a diagnosis on the matter is being done, organized in workshops and web participative methodologies and together with the diagnosis, a list of improvements will be defined by each institution and follow up work on those commitments will be undertaken.

The second case study is a Private Social Institution focused on Health and Wellness– *Espaço T* – created in 1992 for the purpose of providing a positive and integrated approach to Health and Wellness issues in general, the methodology applied is the formula of *integration through art* – based on the therapeutic benefits of creative activities. This institution operates in Porto city, the town of Trofa and it is also starting to develop an affiliate in Lisboa, although that growing project won't be analyzed, once it is outside the geographical limits of this research. The target population of *Espaço t* is quite wide, from blind to drug addict individuals, passing through all sorts of health and wellness disturbances. These participants are referred to as *students* and the participation in different workshops and therapies is not based on their particular problem but on their psychosocial needs as individuals. The name *Espaço t* is based on the idea that there is space for everyone, *Espaço t* is therefore a place for everyone – *espaço para todos* – no matter what specific needs, no matter at which levels they follow the standards of normality.

The third case study is a Non Profit Association focused on Housing – *Associação Humanitária Habitat* – the Portuguese affiliate of *Habitat For Humanity International*, whose mission is to eradicate poverty housing from the face of the earth. *Associação Humanitária Habitat* was founded in 1996, in the city of Braga, by a group of friends who believed poverty housing is a crucial

problem in our country and that it is in our hands to stop it. Given the coincidence between this conference's subject and the nature of the social problem focused by this organization, this case will be explained in more detail further on.

The methodology for this research is of qualitative type based on the application of interviews to multiple actors, amongst target population, organizational leaders, staff and volunteers, key-partners in the networks of cooperation, and community members. In each case study, in total, 8 to 10 interviews will be done. Participant observation will also be carried on during a few of the projects' workdays, attending workshops and participating in general activities. The approach to the case studies is, as stated above, based 1) firstly, on the focus of the research – the influence of 3rd sector social innovation initiatives on spatial development, 2) secondly, on the hypothetical structure developed from the conceptual framework and 3) at last, on the specific goals of this research which are based on the hypothesis and will be stated bellow.

1. To understand how people in need live the experience of interacting with the working staff of these projects, the volunteers and general public. What effect does this interaction cause in their social representations and in their participation in the community?
2. To analyze the representations of volunteering experiences by volunteers, staff members and target population, in order to understand their importance in shaping people's view of the individual's role in society.
3. To understand the interactions that give form to the current process of change within the 3rd sector, to analyze the representations of staff members and board members about it and to comprehend the implications of this experience in these members' own value standards and attitudes towards their work and their organization.
4. To know the effects of network cooperation between agents of different economic sectors, evaluating benefits and disadvantages for different network members, and their spatial results on communities.
5. To understand how the global scale interacts with the local scale directly in such projects, and to analyze the effect of the contact with the wider scale for people in need, in terms of social representations.

The interconnection between this 5 research objectives, the hypothetical structure, the research focus and the conceptual framework that gave ground to it, can be visually analyzed on figure 1.

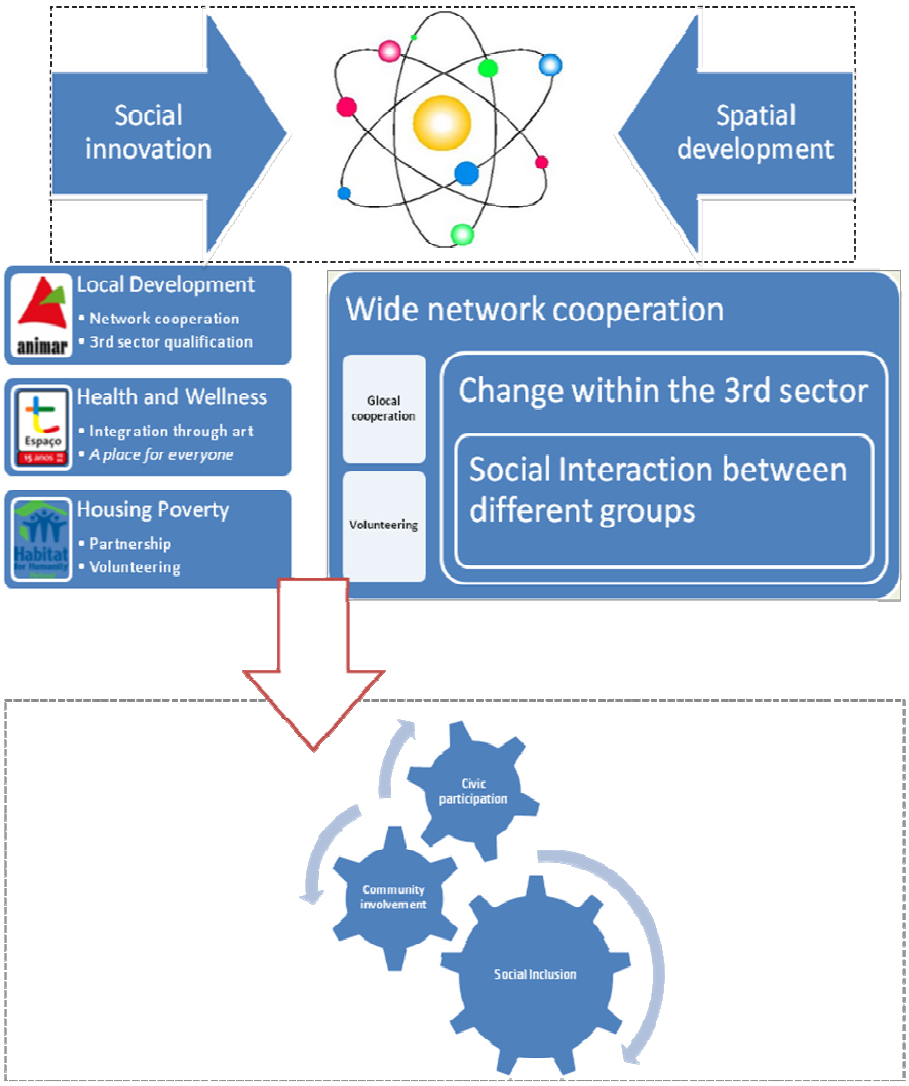


Figure 1. Analysis Framework

As we can see, social interaction occupies an important role, for it is relational work that gives fuel to the social innovation process, as the idea of *working with and not for the people* implies. In this topic, volunteering assumes great relevance, given its capacity for mixing groups from different socioeconomic and cultural backgrounds, which has effects, on the volunteers, on the target population, on staff members and on general public that comes to hear about these experiences. For the volunteers, these experiences have potential for changing their view about the social problems they encounter and the people that face such problems, and for changing their attitude towards social exclusion and inequalities, in general, triggering a more participative engagement in society. Our aim is to know how effective is the relational work in process on these projects, how effective are its results in the empowerment of target populations. In what comes to volunteering experiences, we will analyze the social representations in order to know the effective changes that these experiences have produced.

Inter-institutional and further cooperation between different economic agents assume a central place in the process of spatial development for it consists in creating integrated synergies between 3rd sector organizations, public institutions and business companies. Working at the local scale, these networks support the improvement of the human capital that will return more benefits to the economy, and moreover, they will improve the share of knowledge triggering the generation of new ideas that can answer to environmental, social and economic needs. On this topic we will analyze the dynamics and try to assess the effective share of knowledge and resources implied in such networks.

The cross scale interactions that these networks also carry out are crucial for the fulfillment of the goal of social change in a globalized network society. Nowadays, the intersection of global and local is an everyday reality, globalized consumption standards enter our homes every day trough TV, as well as information from all sources of social movement in virtually any part of the world can be obtained through the internet. The influence of global markets and global financial structure is more than a given fact in our societies, so much affected by the crisis that this system cyclically produces. The importance of regional supranational structures, such as the EU, is another trait of how the Nation-state has become a weaker link in defining paths for spatial development. Therefore this research will focus on the glocal cooperation synergies and try to assess their importance for the local spatial development of the communities under analysis.

Community involvement is seen as an expected outcome of these projects, through the process of empowerment that underlies the relational work, which includes the effective answer to the more urgent needs of the individuals, but particularly implies a process of change in the individuals' perceptions of their own capacities and responsibilities towards society as a whole, that may lead to an increased participation their communities. Civic participation can be an additional gain in this process; once it is connected to community involvement, only more commonly related to the political system. The individual that becomes more active in his or her community will have more reasons to vote, to defend ideas and perspectives or protest for a cause. Furthermore, civic participation can be spread in wider scales through the possibilities of long distant networks and global action chains. We will focus on analyzing the occurrence or absence of change in the representations of community involvement and civic participation of the target population participants in these projects.

In the end, once social innovations main goal is to promote social change towards a more cohesive and just society, we will try to understand if a shift towards social inclusion can indeed be seen as a general outcome of this complex process, in the limited scale of the three study cases.

The Case of Habitat Portugal

Habitat for Humanity International (HFHI) was founded in Americus, Georgia, in 1976, by Millard and Linda Fuller, a couple that gave up a life of wealth for a life of service to people in need. Habitat has Christian ecumenical inspiration, and was raised in the United States with much support from churches and religious congregations. However, Habitat is an international NGO not related to any church in particular, and nondiscrimination by religion, race or gender is included in its principles. In

fact Habitat has even started affiliates in non Christian countries such as Lebanon and Egypt, for example (Fuller, 1980).

Before HFHI had formed the structure that it assumes today, the experiences of Linda and Millard, struggling to gather funds for building shelter for poor and marginalized people, started in 1968 around the area of Koinonia Farm, in Georgia. In 1973, encouraged by the achievements at home, the couple made an attempt to take Habitat's model outside the United States of America, and the experience succeeded beautifully in Zaire (currently the republic of Congo). Today, HFHI is spread throughout 92 countries and has built around 300.000 houses sheltering about 1, 5 million people all over the world.

It was the inspirational example of the founders of HFHI, exposed in a magazine that drove José Cruz Pinto, a businessman and former pilot, to join a group of friends and create the Portuguese affiliate – *Associação Humanitaria Habitat,* in 1996. When the first project took place, in a very difficult location, on the top of a mount with limited area and poor road access, in Rechã – Vieira do Minho, it seemed hard to believe that volunteer work under a contractor's supervision could be enough to get the job done, but it was! Volunteers came from all over the world with Habitat's international volunteer program – Global Village, working side by side with future homeowners, and local volunteers.

Today, Habitat Portugal has built 25 new houses and repaired 11 houses that gave shelter to 36 families in the district of Braga. This year, Associação Humanitária Habitat has expanded its action to the town of Amarante in the district of Porto, with a house repair project. Habitat's houses are built, as much as possible, in the future homeowners' previous location, for the importance of social networks is taken under consideration. Land is in many cases owned by the homeowners, or donated by relatives, friends, the municipalities or other institutions.

Housing Poverty is indeed a global problem but with very important local specificities and social cultural dimensions, that can only be solved by the involvement of all community actors. In Portugal, *Associação Humanitária Habitat* struggles with the hidden poverty housing in cities surroundings and in semi-rural areas, whereas in the States it struggles more with effects of the urban marginalized communities. In Portugal, particularly in Braga, although there are housing needs in the city center, most of the houses are rented and inhabited by tenants, therefore it is harder to start projects in that location. On the contrary, in the less urbanized perimeters, families tend to own one piece of land, or a house or there are more probabilities of finding free and cheaper land.

Given the stated above, it is clear that the target population of *Associação Humanitária Habitat* is not the poorest of the poor, as it happens in other affiliates, such as Mozambique. However, Habitat Portugal gives support and guidance to people who knock on its door and are not eligible to own a Habitat House. Sometimes, finding a job for one of the couple members, or achieving a form of social security support is enough to increase the income of the family in order to afford the house. In any case, Habitat will never choose a family for whom the house mortgage would represent a problem more than a solution.

Habitat works in partnership with families, in the sense that there is a contract of commitment between the affiliate and the family. Families must give an amount of hours – sweat equity hours – to the construction project, Habitat must inform the families of the estimated budget and together,

according to the families' income, they agree on the amount of the mortgage. In Habitat Portugal, the amount applied is, on average, around 150€ per month, which is less than the regular price to rent a room in the same region of the country. The methodology of partnership extends from the homeowners to the private partners, such as donors, of construction materials and other goods, investors, that fund and support Habitat, for instance cooperating in fundraising events. Habitat works by side with the local governments, as well, partnering for land, architectural projects, partial funding of the construction projects, sometimes the municipalities also make donations directly to the families.

Habitat's second main pillar, after partnership, is volunteering. All board members and all committees that structure Habitat – the Construction Committee, the Families Committee and the Fundraising and Volunteering Committee – are by definition formed by volunteers. 90% of the construction work is assured by volunteers, local and international volunteers under the Global Village Program. This international volunteering program implies that, besides all travel expenses, each volunteer pays a fee of around 1.000 € to the affiliate in contribution for the cost of materials and as a way to help Habitat build more homes. The Global Village volunteers, generally, perspective this experience as their contribution to social equality and as a way to get to know the real world out there and make important connections with communities worldwide.

The Global Village program is an important connection link between local and global, volunteers entering this program commonly repeat the experience, and engage in fighting poverty housing all over the world.

Habitat Portugal is a famous destination for Global Village Programs, only last year it received around 16 teams. Every Global Village team has one or two team leaders that manage the teams' budget, motivate the team and work together with the local affiliate since the travel is scheduled, in order to organize free time activities and team logistics at the construction site. Generally the teams have around 10 to 15 members and work for a period of 1 to 2 weeks, with 1 or 2 free days for leisure activities. These activities may vary as much as visiting Porto city and the Port Wine Cellars from taking ceramic workshops at the Barcelos museum. International Volunteering Experiences are also available for International Schools, generally during one week and following, more or less, the same patterns of organization that Global Village teams do.

Local volunteering is organized in two main projects – School Volunteering and the Teambuilding Program for companies, these two programs have developed stable relationships between Habitat and important partners either in business, such as *Boehringer Ingelheim* and *Lilly*, as well as in education institutions, such as CLIB – *Colégio Internacional de Braga* and *Escola Profissional de Esposende*. For individual local volunteers the door is always opened, and they can be enrolled in workdays of Global Village teams or other teams. On special occasions, such as the Faith Building Week, workdays for local volunteers only are organized, or, whenever a small repair requires only the work of a few people. Local volunteering of private individuals is not as stable as it would be desirable; however, there is an important group of more regular members.

The Teambuilding program for companies is of particular interest; like the Global Village program, the Teambuilding implies a donation to the affiliate, much smaller however, but the companies tend to exceed the expected amount, and additionally provide donations in kind to the

families or to Habitat for distribution amongst the most needed homeowners. This connection to the business market is an important way to promote awareness of the housing matter and help companies to improve their external organizational responsibility practices. At the same time, these experiences provide important moments for social interaction among workers, promoting their teamwork abilities, and improving their motivation.

The project of *Associação Humanitária Habitat*, based on the principles of HFHI, gives evidence that Housing and Urban Planning are issues that transcend the local municipalities or the state's responsibilities. In our country, all associative forms have been expelled from this matter in the late 70's, when the municipalities gained control of Social Housing. Since then, only cooperatives stayed in the market of low cost housing. Habitat's model is essentially different from the cooperative structure; its simplicity might come from what Millard Fuller called the *economics of Jesus*, but the fact that makes it essentially different is the process of construction. In no other construction program in our country, families are builders of their own houses and are able to decide, depending on the budget, about the structure and shape of the house (Fuller, 1980). Here I would like to establish a connection with the history of assisted self-construction, for in practical terms, although the amount of work done by the families is limited compared to that of volunteers, Habitat does help families to build their own houses.

Self-construction projects were accomplished by Geddes in India, in the first decades of the XX century, based on the model of participative planning that became more mainstream among us, only in the 60's. The basic principles of this planning model state that residents have the right to participate in the decisions that affect the infrastructures and resources that will provide their own needs; therefore every public matter is subject of public decision. The State should focus on forming a coherent legal framework for the civil society's initiatives, providing access to land, preferably near the job centers, preparing the organization of infrastructures and promoting and coordinating the provision of materials and highly skilled workers for specific tasks. During the decades of 20 and 30, self-construction was carried away illegally in England, as well as in other countries, until the hygiene policies became more severe. In the 60's, Geddes example was followed by Turner in Peru, achieving great success with the participative planning model and creating the so called *Barriadas de Lima*, where ¾ of the 6 million inhabitants of Lima were living in 1990. Despite the stigma attached to these constructions, the living conditions were far better than those experienced in the overpopulated city centers. Moreover, in the *Barriadas* the inhabitants had an active role in shaping their own residence and neighborhood, which concurred to their own personal and social development as human beings. The impact of these experiences arrived to the North Hemisphere, in the United States of America with Jane Jacobs and Richard Sennet both implied in the battle against top down planning, from which results the Harlem of New York (Hall, 1987).

During the 60's and 70's, throughout Europe there are examples of citizen interest and concern about the shape and use of the cities, as it occurred in Paris, with the Les Halles Market, in London, with the Convent Garden Market and in Stockholm, over the Intercontinental Hotel. In England, in Macclesfield, Manchester, in 1971, it was built the greatest example of communitarian architecture, which started with a protest against a demolition order, during which the architect Rod Hackney supported the community in the contact with the authorities and in the building process. Rod

Hackney became President of the Royal Institute of British Architects, in 1987. Following that example, the self-construction model was also largely applied in Liverpool(Hall, 1987).

In Portugal, during the 50's, 60's and 70's self construction was the illegal side of the dual housing market, promoted by low income families, with less conditions to obtain houses in the legal market, which favored stronger contractors. The owners of small commerce facilities, textile industry, social construction and lower services' workers were the more regular adepts of self-construction. After the revolution of 1974, the numbers grow up until, between 1971 and 1981, self-construction represents 39,6% of the total housing construction, the highest numbers are in the south of the country, especially in Lisboa (52,4%) and Setúbal (52,5%), while in the district of Porto, the percentage was of 35,8%(Matos, 2001).

Besides the stigma attached to illegal construction, these initiatives did solve the material housing needs of a great amount of people and at the same time, allowed families to achieve the dream of owning their own house. And, in fact, once the illegal construction was under fewer restrictions in what comes to the structure of the houses, these people could use their creativity in shaping the house according to their life style and preferences. The quality of the housing, however, was not necessarily poorer, despite their appearance of somehow being unfinished, and the lack of water and sewage systems was common (Matos, 2001).

Bottom line, the lesson to learn from self-construction is that urban planning management authorities should never underestimate the origin of power in democracy – the people. People's rights must never be ignored or minimized. And the effective right to proper housing includes the ability to choose the kind of housing building process and architectural model that is more suitable to their life style. Another important right is to take part in the decisions that shape their own environment, not only those which concern housing, neighborhoods and proximity services, but also those who respect to public transportation and road and motorway planning.

The perspective of posing the city inhabitant in the centre of urban planning politics is nowadays defended by several documents of City Policy. And it was also present in the methodology applied in – *Anima-te* – a network of cooperation between several institutional actors and communities involved in environmental and social projects, a program of the EQUAL initiative. However the effective participation of communities in territorial decisions is still an exception. The success of social innovation programs would be to make this philosophy a common practice. The effect of resonance may take time to allow social innovators to be inspired by these pilot experiences and develop their own projects (EQUAL, 2008).

However, the literature on the matter defends that the best test for a social innovation idea is to face reality, that is, to be put into practice, in order to expose its full potential. Just like Habitat For Humanity, that started by a local experiment that simply worked, and whose leaders had the courage to believe it could grow bigger(Mulgan, 2007b)

Final words

Once this is an ongoing research, there are no conclusions, only the perspective that social innovation is, as the EQUAL initiative foreclosure document, synthesizing and evaluating 8 years of work, proposes – *a national opportunity*(EQUAL, 2009). This means Portugal has proven to detain

the necessary capacities in human, social and relational capital to promote social change at the scale of several projects spread over its territory. The challenge now is how to increase this innovation outside of the restricted area of such projects, how to improve scale, scope and resonance, how to empower more people and promote the development of wider geographical areas, how to trigger the inclusion process moving all important exclusion dimensions, how to share these new ideas with society to grow stronger plants?

Such questions are still to be answered. And the answers can only be found if the ideas flourish and are tested in diverse and wide realities. Therefore, best moment for social innovation is, in fact, now! Because now is the time to build tomorrow.

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The role of urban amenities in attracting creativity: lessons from Oporto city-centre

Isabel Breda-Vázquez, Carlos Oliveira, Rita Guimarães, Renato Dias, Diana Silva, Filipa Gomes

CITTA - Research Centre for Territory, Transportation and Environment

Faculty of Engineering – University of Porto, carlosol@fe.up.pt, ivazquez@fe.up.pt

Phone/fax numbers: 00 351 225 081 903 - 00 351 225 081 486

The thriving literature on the "creative cities" has drawn attention to the importance of pysical, social-economic and physical features in the location of creative activities and the creative class in historic city-centres. The paper analyzes the role of such urban amenities in the location of culturally creative activities in Oporto city-centre. Using semi-structured interviews with local actors in Oporto city-centre, our findings show the spatially differentiated intensity of urban amenities within the area. Urban amenities seem to influence spatial dynamics in diverse ways, according with the characteristics of the activities, locations and clustering processes. Moreover, the same urban amenities that contribute to the attraction of creative activities do not seem to influence creative workers in the same extend, and vice-versa.

Keywords: creativity, urban amenities, city-centre, locational patterns

1. Introduction

Literature on the "creative industries", the "creative cities" and the "creative class" often emhasizes the importance of urban amenities of historic city-centres in attracting these activities, as well as their workers and consumers. The same literature inspired many urban policy initiatives focused on city-centres, seen as the privileged setting for the flourishing of creativiness. City-centres often provide some of the vital elements of "alternative" lifestyles, including an attractive built landscape, a vibrant social and cultural scene and a thriving economy (Pratt, 2007; Mommas, 2004), urban amenities that should trigger creativity by attracting innovative activities and talented people.

Although the common idea that creative industries and talented people are, for the most part, concentrated in historical city-centers is challenged by empyrical observation in (Musterd, Musterd and Deurloo, 2006), it seems undeniable that some factors which are preferentially located in the city-centres use to exert a strong degree of attractiveness on culturally creative activities (Florida, 2002, 2007; Landry, 2000; Scott, 1997). The qualities offered by the historical city areas are physical - relating to the specificities of the buildings and the public spaces of the historical areas and the real estate offering -, social-cultural - relating to the predominance attitudes and values that are different from other areas - and economical, in the way that the effects of the economical clusters can also be felt in the historical areas.

Historical city-centers are generally compact and hold a strong identity. High densities seem to attract creative people especially because they offer more opportunities for interaction and the exchange of ideas (Barnes and Hutton, 2009; Hospers, 2003). On the other hand, their built environment holds a high degree of authenticity and specificity, contributing to the assertion of strong feelings of identity and civic pride drawn from life experiences and memories. The small scale of the buildings and the large endowment of public spaces invite intimacy and conviviality (Hutton, 2006; Montgomery, 1995, 2004; Wansborough, M. and Mageean, 2000). Very often these attributes, which recall to a remote history, are intermingled with contemporary design elements, reinforcing a sense of "uniqueness" strongly appreciated by large segments of the urban middle classes (McCarthy, 2006). A diversified, highly adaptable property offer, well fitted to the varied characteristics of the built

environment, may encourage the comimng of the culturally creative activities as well (Crewe and Beaverstock, 1998).

Many historical centres are also attractive for their social and cultural environment as well, wich also contribute to their "uniqueness" (Miles, 2005). Creative workers feel attracted for the confortable and relaxed environment of these places, which they find inspiring (Hutton, 2006). They find these places "authentic" and "dynamic" at the same time. They appreciate their "café culture", which offers them opportunities for the diffusion of new information, new values and new practices (Florida, 2002). Very often, these informal interactive practices revert to powerful associative movements and strong place-based mobilisation. The juxtaposition of diversified identities and lifestyles, which can be found in the most dynamic historical centres, is closely related to a sense of tolerance, another important cultural factor of attractiveness of historic centres, as it contributes to look beyond conventional wisdom (Florida, 2007).

An attractice physiscal landscape and a unique social and cultural environment often contribute to foster a new, 'symbolic' economy which transacts abstract products and lifestyles symbols such as information, the arts or fashion as their main raw materials (Zukin, 1998). Such economy is often based on small and medium-sixed companies, which tend to cluster around specific places where the most qualified labour force and the more exigent consummers tend to concentrate. For all what have been said above, the historic city-centres are the prefered places of location for these industries. They tend to integrate different segments of the value chain, coordinate complementary sectors such as tourism and cultural facilities and promote common branding policies. They mobilize coaltions of public and private actors around regeneration strategies (Mommaas, 2004; Pratt, 2008, 2009; Storper and Manville, 2006).

This paper explores the factors that may contribute to the recent emergence of creative cultural activities in Oporto city-centre, based on interviews conducted in 54 establishments in the area. Interviews were focused on the main factors of attractivity for the location of these establishments and the kind of relationships between the public and private actors, which contribute for the attractiviness of these places, as well as the main residential options of those who work in these activities. By assessing the residential preferences of those who work in these activities, we also aim to evaluate the influence of place effects in talented people. The paper aims to identify some of the reasons that led to the formation of spatial patterns.

The next section presents the mains results of empirical research, notably the findings from-structured interviews among culturally creative managers and workers in Oporto city-centre. The last section presents the main conclusions.

2 The case of Oporto City-Centre

The city of Oporto (250,000 inhabitants) is at the core of the second-largest Metropolitan Area in Portugal, which comprises 16 municipalities and 1,5 millions inhabitants. Oporto and its surrounding Municipalities form an agglomeration that comprises most high-level infrastructures and functions in North-western Portugal, a traditionally industrial conurbation which faces intense global competition from lower-cost locations. As Oporto struggles to redefine its identity, from the core of an industrial region to a tertiary urban centre, urban creativity occupies increasing attention on debates about Oporto future. In the last couple of decades, it emerged in the form of flagship projects such as *Porto*

2001, European City of Culture, and new or refurbished cultural facilities, including Casa da Música (House of Music) and Serralves Contemporary Art Museum.

Culturally creative activities also emerged in a less imposing manner, visible in the growing number of new establishments, including art galleries, design studios and fashionable stores and cafes, in some parts of the city-centre. A recent inventory (FundaçãoSerralves, 2008) identified 296 cultural creative organizations in the city, including theatre companies, publishers, art galleries, and music and cinema producers, among others. Retailing is the main function, representing about 68 % of total establishments, followed by design and conception (27 %), manufacturing (3 %) and distribution (2 %). About 60 % of all establishments were created in the last decade, which testifies the novelty of this phenomenon.

The paper aims to contribute for a better understanding of the reasons for this preference for the city-centre. It aims to identify some of the motivations that may lay behind these activities location patterns, along with those of their workers residential preferences. Methodology is based on documental research from technical reports and academic studies, along with 64 in-depth semi-structured interviews with the workers and managers of 54 local establishments. Interviews were centred on the main location factors of these establishments, as well as on the most important reasons for their employees and managers residential options. The average age of interviewees is 35 years old, 62,5 % are females and 34,4 % have University degrees.

2.1 Culturally creative activities

The inquired 54 establishments belong to seven cultural creative sectors in the arts, design and leisure areas (Figure 1). Fashion design is the most represented sector (15 establishments), mainly concentrated on retailing activities. It is followed by decorative arts (14 establishments, including furniture, contemporary jewellery, interior and exterior design), ‘night economy’ establishments such as fashionable cafes and restaurants, second-hand product stores, music stores, art galleries and craft activities. Other projects include commercial spaces gathering several different establishments. Many of these projects are not constrained to one single activity. They embrace varied cultural features, such as some of the bars and restaurants, which also organize spectacles, art exhibitions or training activities.

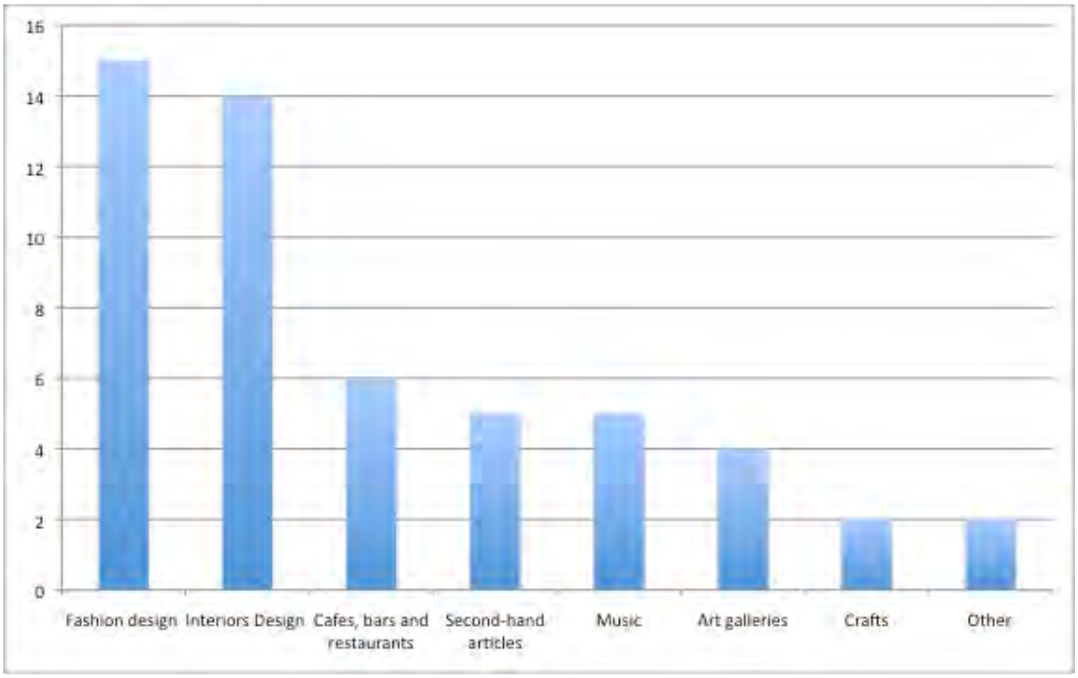


Figure 1. Number of culturally creative establishments by sector. Source: Based on interviews developed in 2009.

The inquired commercial establishments differ from more traditional retailing activities not just for their eclectic nature but also for the sort of merchandise they offer. It is mainly composed of avant-garde products, designed for exclusive segments of market, which contrast with the more generic offer of traditional retailing. 98,2 % of interviewees characterize their products and services as innovative, endowed with a specific identity drawn from their authorship character. They extend these observations to their establishments, including their interior design, ambience and personalized treatment. Their schedules also diverge from those of traditional retailing, as most of them open up later than noontime (in 55,5 % of cases) and close not before 8 p.m. (81,5 %), not including in these statistics the 'night economy' establishments.

Establishments are generally very small, having 32 of them no more than two workers (Figure 2). Part of them (22 %) received some kind of support from public institutions, either at national level (job-creation incentives from the Institute for Employment and Training or support from the Economy Ministry MODCOM/Retail Modernization programme) or at local level (advice and technical assistance from Municipal Oporto de Partida programme). They seem to be successful, as almost 78% reported a strong demand for their products, although variable in time. Beyond their small dimension, they are characterized for their newness. Only a fifth were created before 2004 and 37,5 % set up less than one year before the interview (Figure 3).

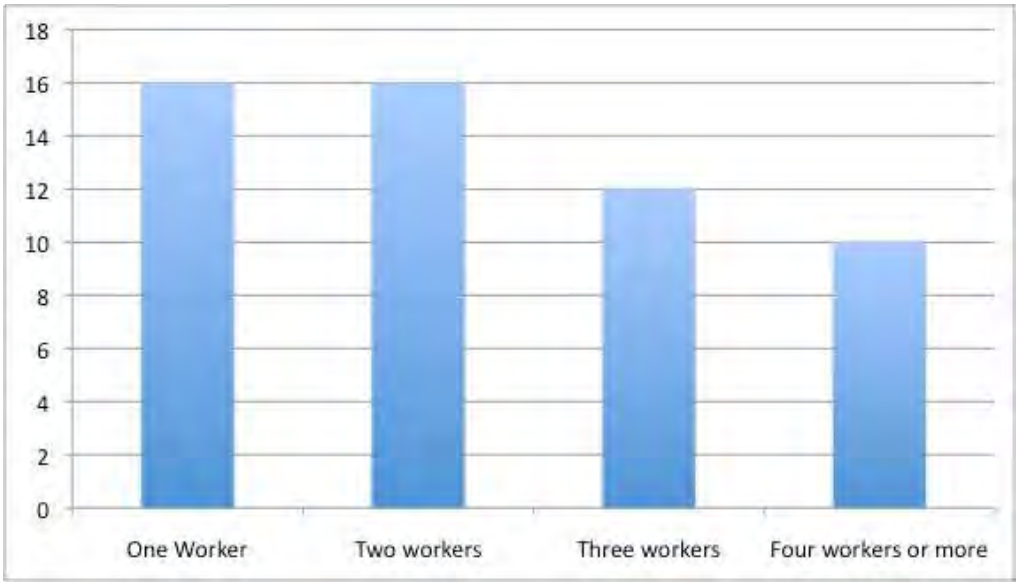


Figure 2. Number of establishments, per size. Source: Based on interviews developed in 2009.

The small dimension of projects is convergent with their manager's multi-faceted profile. The vast majority (75 %) of managers are also sellers, designers or programmers. Before starting the project, 86 % already played other functions beyond managing. 56 % have previous experiences in the same business. For the most part, they were influenced by similar experiences in other cities and countries, having decided to open up their projects in Oporto as a desire to fill in what they perceived as a gap in this city.

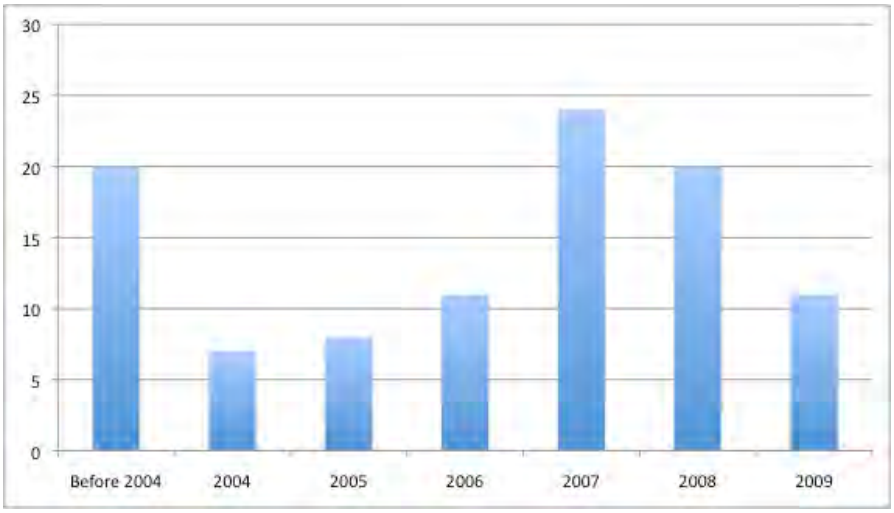
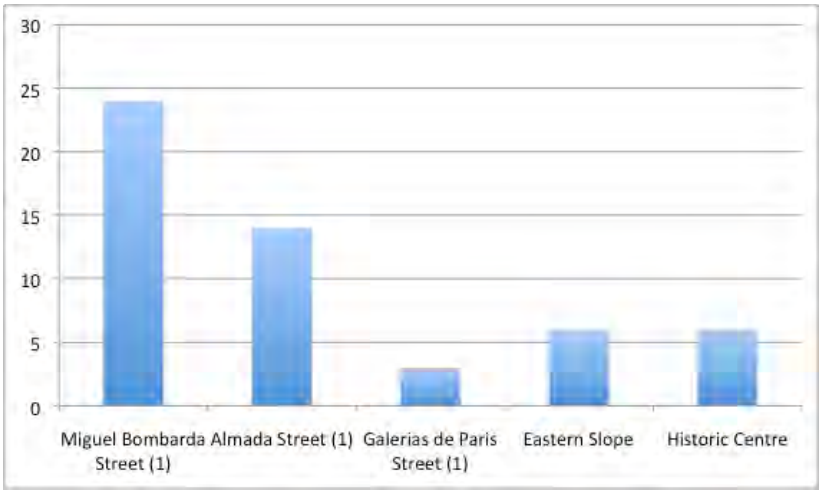


Figure 3. Number of culturally creative establishments, by opening year. Source: Based on interviews developed in 2009.

As shown in Figures 4 and 5, most inquired establishments are concentrated in 5 areas within the City-Centre, notably Miguel Bombarda, Almada and Galerias de Paris streets (along with their nearby areas), the Historic Centre45 and the Eastern slope. Although our sample illustrates some mixture of cultural creative activities within these areas, a certain degree of specialization may be observable in some of them, particularly the presence of Art Galleries and interiors design in and around Miguel Bombarda Street.



(1) Includes nearby areas

Figure 4. Number of establishments by area. Source: Based on interviews developed in 2009.

There is some coherence between the profile of the five areas and the reported reasons for the choice of location (Figure 6). In the Historic centre and Galerias de Paris areas, which are located in more touristic parts of the city, all respondents identified the symbolic and aesthetic value of the built environment as the main location factor for their activities. In these cases, the increased number of tourists seems to be an important driver for their business success. However, this is not even mentioned in other areas, as Miguel Bombarda, Almada and several streets in the Eastern Slope do not possess particularly attractive aesthetic qualities. In these cases, the reasons for their attractiveness must be found in other aspects, such as the previous location of other establishments, their central location and the the affordable and varied offer of available spaces.

[45] Although the whole City-Centre may be considered “Historic”, the so-called Historical Centre, mainly built in the 14th century, is usually distinguished from the remaining parts of the City-Centre, which were for the most part built in the 19 th century.

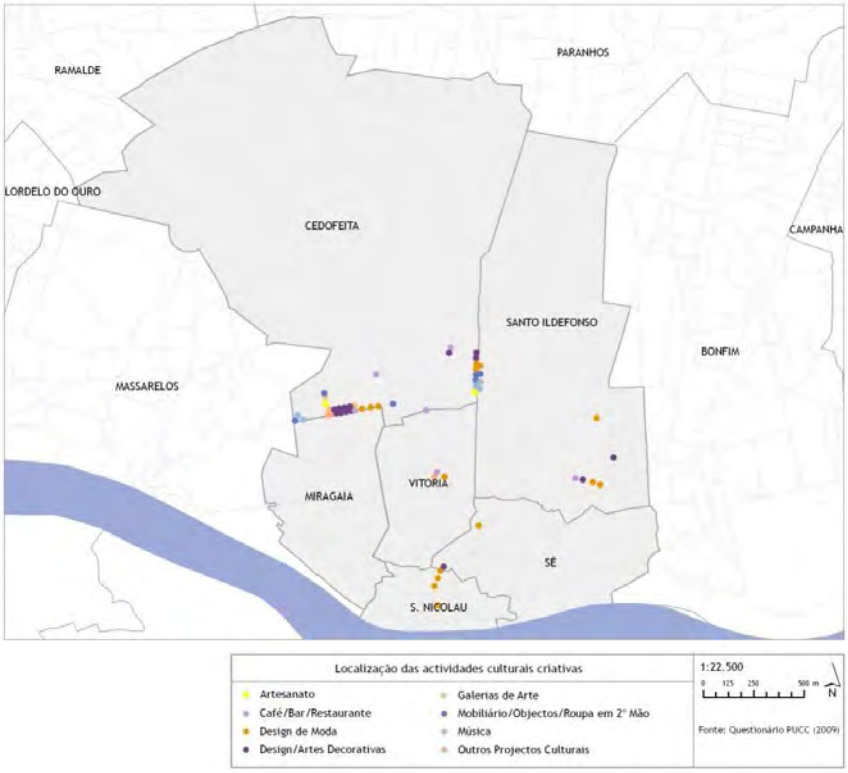
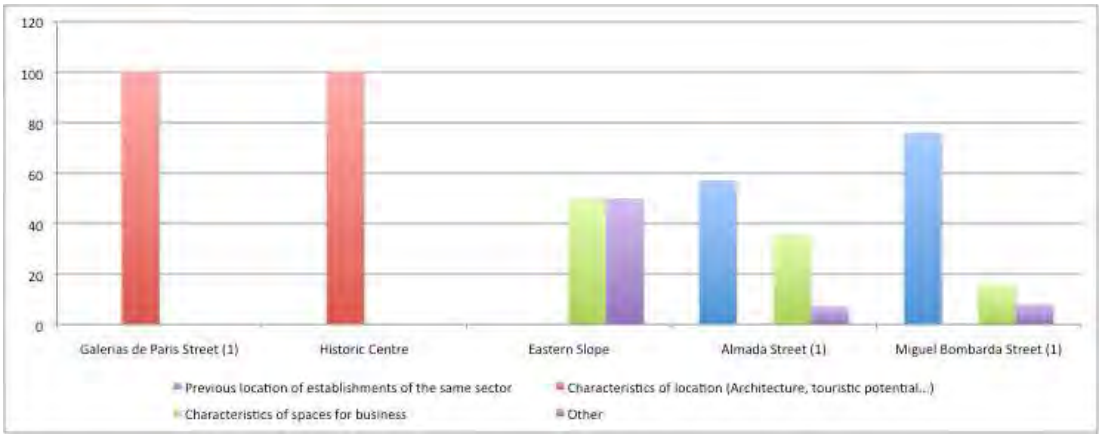


Figure 5. Main areas of location of culturally creative activities in Oporto City-Centre.



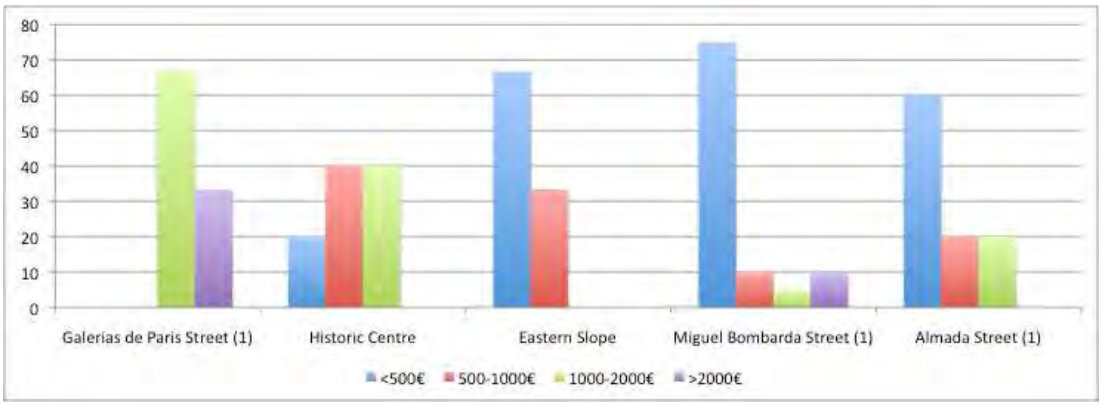
(1) Includes nearby areas

Figure 6. Location factors of establishments, by area**.** Source: Based on interviews developed in 2009.

Miguel Bombarda Street is a good example of the presence of agglomeration economies comparable to those found in 'cultural quarters' around the world (Brown et al, 2000; Montgomery, 2005; Porter and Barber, 2007). In the last couple of decades, several culturally creative establishments,

particularly art galleries, began to establish in the area, thanks to the role of a few art entrepreneurs. Since then, and particularly after *Porto 2001, European City of Culture*, the number of art galleries and other cultural creative activities increased rapidly, given the growing demand (Bastos *et al*, 2009). This is due to several factors, notably physical proximity, formal and informal interactions among local entrepreneurs and recurring events, such the synchronized inauguration of exhibitions in the first Saturday of each month. Location factors related with the property market, such as the physical diversity and adaptability of available spaces for business and the wide range of prices, also contribute to the area attractiveness. Comparable phenomena, although in a less extent, can be observed in other parts of Oporto city-centre, such as in Almada Street.

The large majority of business spaces (87 %) are rented, preferebly located in buildings that were previously used for retail. As many previous commercial establishments have their stores at street level, while keeping the first and second floors for warehousing, their closing as a consequence of lack of competitiviness against new Shopping Malls in the periphery, left many buildings vacant. This offered new opportunities for the culturally creative sectors, such as the availability of large, easy-to-adapt spaces at affordable rents. Figure 7 shows an important divide between more touristic areas such as Galerias de Paris, where reported rents are of above 1000 €, and less expensive areas such as Miguel Bombarda and the Eastern Slope, where an important share of rents are bellow 500 €. Almost 89 % of interviewees stated contentment with the place of location of their establishments, while the remaining referred the appaling state of many buildings as the main reason for their worry.



(1) Includes nearby areas

Figure 7. Monthly rents of establishments . Source: Based on interviews developed in 2009.

Social relationships with local communities seem to be generally good, although predominantly informal. Despite some moderate resistance in the initial stage, related with the unusual character of the projects, almost 93 % of interviewees defined ther relationships as systematic and very good. Nevertheless, normal institutional relationships are much weaker. Beyond the organization of promotional events and other occasional situations, most interviewees hardly cooperate with their local agents, and most relationships are established with external actors, usually other companies in the same or complementary sectors, either nationally or internationally-based. Strong interactions involving the Town Council are rare. Only one interviewee declared to have a systematic relationship

with *Porto Vivo*, a public-public partnership between the Town Council and the national government charged for urban regeneration in the City-Centre. Many interviewees complained against bureaucracy, lack of information and reduced receptivity from the Town Council to their ideas. Relationships with the national government seem to be reduced to bids to *ModCom*, an Economy Ministry programme destined to support traditional retailing modernization.

2.2 Residential choices of culturally creative workers

Most interviewed workers (59,4 %) reside in the city of Oporto, though not necessarily close to the City-centre (Figure 8). The more central parishes such as Cedofeita, Santo Ildefonso, Bonfim and Sé represent about 45 % of those who live in the city. Among the 40,6 % interviewees who reside and other Municipalities, neighbouring Vila Nova de Gaia and Matosinhos represent almost two thirds of the total. While suburban residence is proportionally more common in fashion design activities, those who work on interiors design and on the 'night economy' (bars, cafes and restaurants) tend to live in the city in a higher proportion. Culturally creative workers seem to differ from the majority of Oporto Metropolitan Area population in two respects. Not only a large proportion moved to their present homes relatively recently (in 40 % of the cases, less than five years ago), as they do not seem to follow the general 'centrifugal' demographic trend observed in the last few decades, when the move from Oporto to the neighbouring municipalities has been the dominant trend (CMP/GEP, 2007). On the contrary, a large share (39,5 %) of interviewees who live in the central city moved from other municipalities.

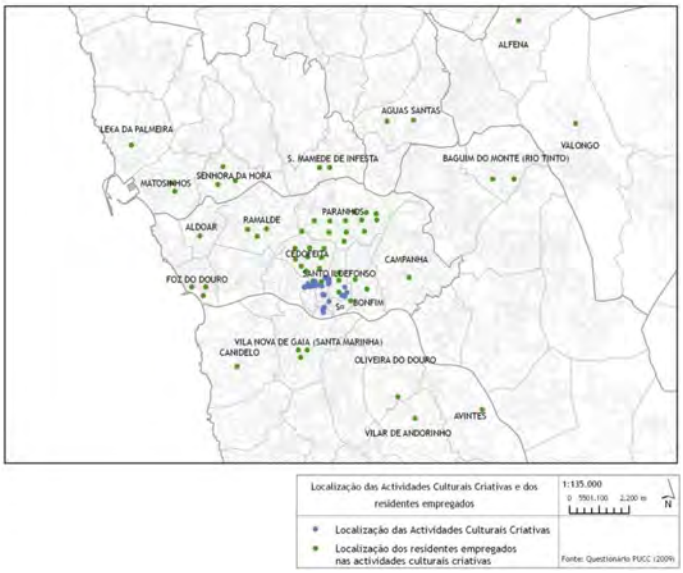


Figure 8. Location of inquired culturally creative activities and of their workers places of residence

Reasons for residential location vary considerably among the three selected areas of residence, Oporto City-Centre, other parts of Oporto and other municipalities (Figure 9). While residents in other municipalities referred housing costs and personal relationships, notably family and friendship ties, as the main reasons for their preferences, residents in the City-centre mentioned proximity to work as the leading factor. As the former, residents in other parts of Oporto also mentioned personal relationships, but the two groups diverged in relation to housing costs, which were mentioned mainly among those who live in other municipalities. The characteristics of the area, such as the quality of public services including education, culture and transportation, or crime rates, did not seem to exert a strong influence on interviewees residing in any of the concerned areas.

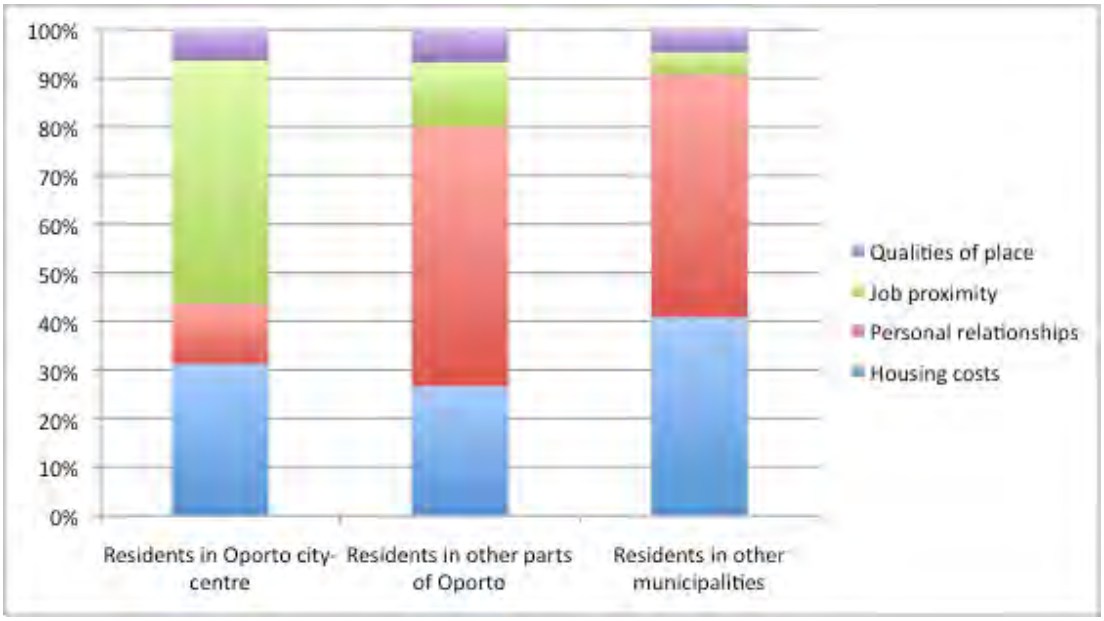


Figure 9. Reasons for residential choices of culturally Creative workers. Source: Based on interviews developed in 2009.

Interviews also focused on levels of satisfaction with areas of residence (Figure 10). In coherence with previous responses, approval levels related with housing prices are higher out of Oporto, while city-centre residents emphasize proximity to work as a main reason for satisfaction. The fact that only 11 % of city-centre residents stated satisfaction with personal relationships within their area of residence may be unexpected.

As referred above, attractiveness of the city-centre as a place to live is often related with the quality of cultural and leisure activities, with the presence of social facilities and with 'social atmosphere' subjects, such as tolerance and openness. Nonetheless, the city-centre ranks poorly on issues such as the cost-of-living and the quality of public space, which are major strengths in more peripheral locations. Results in Oporto parishes that are not included in the City-centre are mixed. This may be related with the fact that this area is strongly heterogeneous.

When asked about the possibility of living in the city-centre, most interviewees who do not live in the area envisaged it at best in a remote future, given the present situation characterized by congestion, pollution, high rents and a degraded built environment. While the poor state of many buildings may be adequate for culturally creative establishments, which after minor maintenance works remain in the market at affordable rents, housing offers a far more complex context. Most housing buildings in the area are in such an appalling state that major refurbishment, if not entire reconstruction, would be needed, in order to make them liveable. Major investment, combined with intense speculation in this highly accessible central area, keeps housing prices beyond the reach of most people.

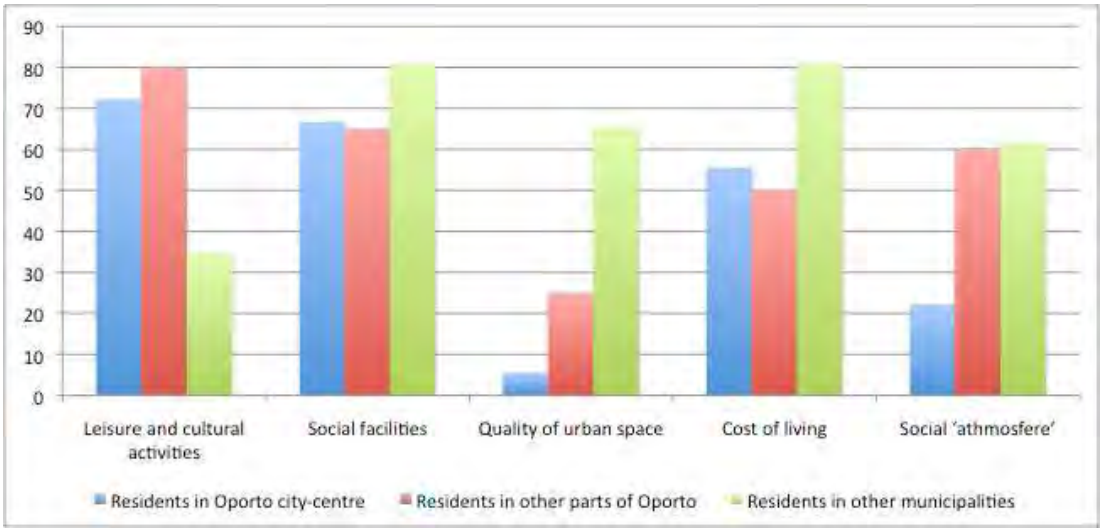


Figure 10. Proportion of creative workers who are 'satisfied' or 'very satisfied' with their places of residence (%). Source: Based on interviews developed in 2009.

Conclusions

Interviews conducted in Oporto city-centre point some attributes that, according with the literature, work as main factors of attractiveness for culturally creative activities. While these attributes may have a physical, social-cultural or economic nature, their intensity varies according with the specific activity and place of location. In parts of Oporto city-centre, which are gifted on elements of a strong historical identity, particularly a rich architectural heritage, interviewees emphasized these attributes as the mains reasons for the location of their establishments. Such is the case of the historical city-centre and the areas surrounding Clérigos Tower, the *ex-libris* of the city. This fact reveals the influence of the physical identity of the territories in the localization of a certain kind of culturally creative activities, in spite of the recurrent references to the highly degraded state of the buildings. In such places, tourism plays a major attractiveness role, which may be reinforced as the "night-economy" develops in some of its streets.

In less gifted parts of the city-centre, from a physical point of view, other aspects may have played a more decisive role in attracting culturally creative activities. In Miguel Bombarda Street and some of its nearby areas, where some dynamic interaction at the enterprise level is visible, the city center can constitute an opportunity for the strengthening of social interactions. Here, strong interactions are associated with the art market, conducted mainly by local entrepreneurs, as reported by Bastos et al (2009). However, even in this context informal interactions prevail. Regarding the formal institutionalized relations the scenario is is also characterized by a clear weakness. Although relationships between workers of cultural creative activities and society are generally positive, the survey results indicate that the relations between these activities, the City and associated institutions such as the Town Council and *Porto Vivo,* the Urban Rehabilitation Society, remain distant. Moreover, the weak residential function linked with the degradation of the main buildings, keep the public spaces in a situation of underutilization, in spite of their potentialities for interaction. Nonetheless, As long as these places continue to offer a flexible and affordable property market,

cultural consuming functions and increased interactions may contribute to the continuous reinforcement of agglomeration economies.

The interviewees results also suggests that, in the Oporto city-centre, the identification with the architectural heritage and the availability of adaptable spaces at affordable prices still does not have a similar expression at the level of residential preferences. In Oporto, the sense of "belonging to a place", many times referred in the literature devoted to the theme of historical city-centers, faces the effects of a long demographical and economical decline. Residential patterns of most interviewees present a degree of dispersion superior to what would be expected, compared empirical evidence from studies regarding the options of talented people residing in other urban agglomerations, (Barnes and Hutton, 2006; Musterd and Deurloo, 2006). Confronted with the image of physical degradation and high residential costs, many of the interviewed tend to delay the possibility of residing in the city-centre.

In sum, we conclude that 'place effects' may vary widely within the same city-centre. As different activities often have divergent needs and varied location logics, they may generate a wide range of complex location patterns. The same could be stated about talented people, particularly concerning their residential preferences, which not allways fit with the findings of international literature on urban creativity. Local specificities, such as those related with the caracteristics of the property markets (which may be attractive for creative activities, though not for residence) may produce divergent kinds of urban amenities. The particular 'place effects' they generate should be addressed in further research.

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Space matters: fine-tuning the variable geometry of cities

Rodrigo Cardoso

Universitat Politècnica de Catalunya / Centre de Cultura Contemporània de Barcelona

rodrigo.v.cardoso@gmail.com

Phone/fax: +351 22 9375130 / +351 93 9365244

The boundaries of what is interdependently urban have long ago overflowed a coherent, recognizable entity, both in the territorial and in the social sphere. Cities have a multi-scale geography, a virtual territory larger than themselves, resulting from a series of juxtaposed layers that operate in an analogy to variable geometry, as their non-coincident scale, meaning and boundary generate their general integrity. Notably, there is a difference between geographical and relational distances, and the relevant scale problems operate in that distinction. Nevertheless the physical dimension and territorial context of city-regions must be included in the debate on how cities use certain projects as catalysts to detach from their geography and re-centre their position in broader and more fluid maps. Detachment from geography is not the same as independence from it, and relational effects and deferred interactions are forms of emergence of traceable spatial processes. Taking Porto's metropolitan area as a case study, the paper will try to show that, quoting author Edward Soja, "*space takes precedence*". The city-region's morphology shows us a pattern of complementarity of centrality factors spread over a wide territory, leading to the idea of centrality over an axis. But at the same time, the political frames for decision-making are too broad, too narrow or too weak. All these scales must be fine-tuned according to the specifics of our territorial context, for potential catalysts to achieve their purpose. The region's spatial context must be internalized by a model of governance and by a strategy of parallel processing of urban nodes.

Keywords: variable geometry; scale; city-region; governance; strategy

1. Introduction

Contemporary urban territories are increasingly developing complex maps with juxtaposed layers of meaning that influence the way cities can use certain projects as catalysts to detach from their own geography. Understanding the word '*project*' in its widest sense, as every idea, vision or decision that can be put in practice in order to generate effects of change, one can say that, as this phenomenon develops, the nature, meaning and importance of a city or region may be less attached to its geographical location and its national context than to its relational standing towards other broader and more fluid processes. What a city is, where are its limits, how much it overlaps with other territorial nodes, is also becoming more open to interpretation and answers vary if one looks at the built territory, infrastructure, cultural identity, political borders or economic interaction. All these layers have different scales, meanings and boundaries although they must be addressed as a whole if one wants to understand the city's general integrity. In that sense it can be argued that a notion of variable geometry is central both to understand the enormity of the 'urban condition' today and to build a prospective tool devoted to *invent* the future of a given city-region.

However, the tendency to consider these processes as increasingly virtual and independent of geography is deceiving, as traceable spatial constrains and phenomena still affect the world of relational effects and deferred interactions. As stated by Edward Soja, quoting Edward Said "*just as none of us is beyond geography, none of us is completely free from the struggle over geography*" (Soja, 2008), suggesting that "*the geographies we live in can have negative as well as positive consequences on practically everything we do*" (ibid.); also, the consequent struggles faced by cities in their quest to re-centre their position in more comprehensive maps, however fluid and non-spatial they may be, are mainly about space: location, infrastructure, built and natural environment.

Development catalysts are shaped by political, economic, cultural and spatial forces that are in turn reshaped by them according to their own development. As emergences of spatial processes, these forces have a common characteristic: although their path can be traced and described, they always include amounts of simultaneity and uncertainty that make the anticipation of future scenarios go beyond mere cause-effect forecasting. In fact, looking at the multi-scale geography acquired by urban regions undergoing such processes demands a paradigm of complexity, intersecting threads from many fields, in order to identify interactions between apparently disconnected events and to generate questions absent in partial disciplinary views that come to surface once the full scope of phenomena becomes clear. Such an investigation must take into account the generative effects of space as well as time, and the reflexive character of large scale urban processes, as they redefine the very broad contexts that once defined them.

The way those processes evolve changes according to the different geographical and functional model relevant in each city. By choosing Porto, in the context of its metropolitan region, we are looking at a middle-sized European city-region, a "*smaller commercial centre controlling 'provincial' territories*" (Hall, 2002), at the periphery of European space, in the rather interesting situation of being a 'second city' in its national context. A research about Porto may be the gateway to address the specific conditions of European 'second cities', in the context of their larger urbanized regions, and their possible development models- newer, flexible and changeable- as an alternative to the more rigid and hierarchical standing of capital cities.

1.1 Variable Geometry

Variable geometry refers to the way a given device is free to move, warp or oscillate without losing its properties or its physical integrity. Examples of this behaviour are the wings of certain airplanes that can sweep back and forth, rotate or change their angle during flight and then return to their original position. Another example is the gyroscope, as a device that can freely alter the geometric relationships between its different components while keeping the general integrity and the integrity of the elements themselves.

Variable geometry is at the same time robust and flexible, generic and case-specific. In urban terms, this notion is used to express how cities are many different things at many different levels, how the nature, scope or boundary of what is 'urban' does not coincide at the layers of political maps, infrastructural distribution, cultural identity, patterns of mobility and built continuum, while there still seem to exist some invariant properties that make it definable and recognizable. Finally, variable geometry also stresses how seemingly incompatible layers are in fact expressions of the very same concrete conditions that, altogether, represent the city and define its future.

2. Cities as complex systems

The more agents, interactions and differentiation act on the city, the more it develops uncertainty and surprise. There is however a crucial point for everyone giving preference to the spatial nature of cities- the real systems at work, the sets of elements with a causal connection, are not necessarily physically linked or related. According to Christopher Alexander, "*in every city there are thousands, even millions, of times as many more systems at work whose physical residue does not appear as a*

unit in those tree structures. In the worst cases, the units which do appear fail to correspond to any living reality, and the real systems, whose existence actually makes the city live, have been provided with no physical receptacle." (Alexander, 1965)

The problem addressed by Alexander has been called many things and can be intuitively felt by anyone living in a city. In fact, urban complexity makes it all the more difficult to trace the meaning and importance of space in every urban process. But the key issue is not the lack of physicality of the relevant systems, but the excessive abstraction of the models used to analyse them. In fact, modeled systems never have a self-evident existence; they must be synthesized *a posteriori*, with no guarantee that all problems are perceived and even that all features point in the same direction. On the other hand, spatial thinking is less abstract and more applied to practical knowledge and specific conditions. Lacking mathematical precision and univocal directionality, it offers much more concrete evidence and a richer set of possible scenarios, as "*thinking about space has changed significantly in recent years, from emphasizing flat cartographic notions of space as container or stage of human activity or merely the physical dimensions of fixed form, to an active force shaping human life.*" (Soja, 2008)

Contemporary interpretations of complexity in urban research are based on the notion that the laws governing the behaviour of a system are not the same as the ones describing its individual units. Therefore the conditions and future of a city or a region cannot be viewed as the sum of the conditions and partial futures of its many layers. Complexity is increasing in the territory as a whole, since the boundaries of what is 'urban' are becoming more uncertain and the term 'city' refers no longer to a coherent entity; but complexity also grows in the social sphere, through the multiplying of participating agents in every process of decision (due to democratisation and decentralisation); the increase in interaction between those agents (through globalization and technology); and the growing differentiation between their actions (increase in wealth, individualism).

3. How large is Scale?

In such a complex context, each problem has multiple scales where we can find its causes and implications, and the forces shaping an intervention are often detached from the local problem they are supposed to address. The world of politics and decision-making has simplified the problem, by defining more or less stable governance levels in cities and nations, but there are many intermediate scales between them, leading to regional clusters and networks of cities, which often play stronger roles than traditional nation-states. Moreover, there are also many scales above the nation and most relevant and comprehensive interventions in the territory are actually being shaped at that broader level.

In this sense, the term 'scale' loses its immediate materiality based on mere size or distance, to be interpreted as a measurement of relational contexts, not physical ones. This view of scale involves looking at the many layers of meaning inside each city, project and decision, all with different scope, boundaries and impacts. It includes not only the question 'how large', but also 'how long', 'how much' and 'how come'.

3.1 Relational Distance

Notably, there is a relational distance 'measuring' city-regions, different from simple geographical distance. Relational distance looks at the type of relationships which no longer depend on physical proximity or local friction. This kind of distance is measured in time or informational units and not in terms of space. The media through which relational connections take place can perhaps be divided into four groups: physical and *territorial*- roads, highways, high-speed trains; physical and *hidden*- water, energy or communication infrastructure; virtual and informational- electronic communication, economic transactions; and virtual and hierarchical- decentralized forms of government, international institutions. Their acknowledgement is essential to correctly define the relevant map of a city; their manipulation is an important source of power, an idea clearly expressed in the recent discipline of spatial justice, mostly analysed through the lens of 'the urbanization of injustice', in works such as Stephen Graham's *Splintering Urbanism* (2001).

3.2 From 'Point-city' to the Plateau

"*The most frequent radicalisms normally result from denying the complementarity and interaction between both models- agglomeration and dispersion- which is a powerful obstacle to the global understanding of what builds the new urban reality and the complexity of the system- the elements composing it and the networks giving it more or less consistency.*" (Portas, Domingues, Cabral, 2007).

The first two types of media referred above- the physical ones- are responsible for building a network of relationships that touches most traditional urban cores, irrigating the space in-between with what could be called an ability to be urban, thus giving way to the diffuse, extended urbanization of the territory, while generating strong polarization of flows at its most charged nodes. Since ancient times, the basic condition to be *potentially* urban is to have installed infrastructure- from a river to *cardus* and *decumanus* to fibre optics today. The map of infrastructural networking reduces territorial friction and allows relationships between distant nodes that interplay and generate a field, which in turn creates what can be called an 'urban condition'. All those layers have different boundaries and laws, resulting in the variable geometry of the city.

Thereby, the relevant urban scale (often a 'hidden' scale, not necessarily recognizable or culturally defined) can be found in the realm of those broad relationships between landscape, building, infrastructure and movement. Of course, if the spatial constrains and processes are still what informs our analysis, we need to expand our notion of 'urban space' beyond the conventional categories of building and compact form, and address the 'forms' of "*that 'other city', whose lack of attention is paradoxal if one takes into account the growing importance of the population and activities located there. Also here it is urgent to review the conventional dichotomies between centre and periphery, city and suburb, etc., powerful epistemological obstacles to the comprehension of the new urban condition [...].*" (Portas et al, 2007)

The vision of this urban condition as a Deleuzian 'plateau', a field of potentials lacking fixed hierarchies, a "*continuous, self-vibrating region of intensities whose development avoids any orientation toward a culmination point or external end*" (Deleuze, Guattari, 1980), will be useful as we further describe Porto's metropolitan region, and find out how this notion corresponds not only to the

processes occurring in expansive urban spaces but also- once again we address space- to an actual physical depiction of territorial patterns in the region.

3.3 Polis, Civitas, Urbis

The second group of media structuring city-regions- the virtual links- are more purely relational. They can be truly global in reach and tend to allow simultaneity everywhere, although they highly depend on the installed infrastructure mentioned in the previous group. Here, we can address the now over-discussed issue of communication and economic transactions, but also other relational linkage such as the wide impact of city-marketing and the new geometry and scope the city acquires when seem through that prism. Another subset of this type of logic has to do with decentralised government structures that have enormous impact in local issues. All of these are examples of very broad relational spheres with a true influence in the territory and people's lives but whose scope does not coincide with the municipality, the nation, or any recognizable structure. Christopher Alexander's argument about the most important systems in a city lacking a physical receptacle seems to show how the many answers to the question of what a city is work inside a similar conceptual framework.

Geographer Álvaro Domingues mentions three terms we have historically used to refer to the city: *Polis, Civitas, Urbis* (Domingues, 2008 [conference]). Originally, they addressed different spheres: *Urbis* corresponds to city-space, the built environment; *Civitas* refers to the social organization of the city; *Polis* describes the city as a political entity. Domingues shows how the replacement of a geographical logic for a relational one was processed, by suggesting that formerly all three spheres, were physically in the same place- and therefore, we could add, inhabitant, citizen and user were the same person. The Greek city-state was, in fact, the home of *urbis*, *civitas* and *polis*, and a direct correspondence existed between them.

The point is that this simplifying interpretation continued to be the common definition of 'city' and the three concepts still tend to be confused, although they are now very different and do not coincide anymore- we all belong to different territories in all the three spheres. Each has extended beyond geography, and a current interpretation reuniting the three concepts would have to propose a *territory-less* city. Looking at Porto, we could speculate that while the *Urbis* is expanding through the 'real' territory, *Civitas* is scattered around a much larger region (as well as blogging in virtual space), and *Polis* is probably half in Lisbon and half in Brussels.

Another interesting angle of this discussion is the way this complex map of immaterial relationships and transactions seems to physically affect and be affected by territory, in terms of density, usage and development of city-regions. This process has been studied by Saskia Sassen, who describes a complementarity between macro-scale 'abstract' dispersion and local 'real' agglomeration, and by economist Paul Krugman, in *The Spatial Economy: Cities, Regions and International Trade,* researching where and why cities and economy coincide[46]. Not daring a discussion about the book itself, one may find notable that the scale of the nation-state is missing in its title.

[46] See Krugman et al, *The Spatial Economy: Cities, Regions and International Trade*, Cambridge, MIT Press, 2001

4. Case Study: Porto

This paper looks at a specific case study to show that the physical dimension and territorial context of city-regions must be taken into account in the debate on how they use certain projects as catalysts to detach from their geography and re-centre their position in more fluid maps. Even with the detachment of *urbis*, *civitas* and *polis*, space still "*takes precedence*" (Soja, 2003), in the way it does or does not correspond to the new spheres occupied by those terms. In other words, spatial potential also works by negation, by clearly affecting the development of cities when their political, social and cultural layers are totally alienated from the territorial reality that gave them origin. In fact, "*a new emphasis on specifically urban spatial causality has emerged to explore the generative effects of urban agglomeration, not just on everyday behaviour but on such processes as technological innovation, artistic creativity, economic development, social change […].*" (Soja, 2008)

A spatially based view of Porto must consider what Peter Hall calls the "*geographical-functional categorisation*" (Hall, 2002), the link between how a city functions, where it specializes, how it grows and its geographical context and constrains, since "*the precise form and degree of this development varies significantly from one part of Europe to another* [and] *the precise urban form that results is influenced strongly by the strength of planning powers.*" (ibid.)

The case of Porto is rather specific, due to its strong extensive urbanization lacking a comparatively strong core, which we will explore further, and, quite importantly, to its condition of being an important centre without being a capital city- the nation's second city.

4.1 On the nature of second cities

By labelling Porto as a 'second city', we enter a field not very well defined. Obviously, there are many different criteria to qualify a nation's second city: population, economic weight, historical importance, political significance. There is therefore no agreed definition of what this could be, although in some countries the position of the 'second city' seems clear: Porto, Barcelona, Milan or Gothenburg do not offer much contestation, while in countries like Germany or the Netherlands, the criteria are harder to establish. With more or less ambiguity it should be said however that it is not very relevant for a second city to be third or fourth- what comes out of qualifying as a 'second city' is that it does so against some kind of comparison, against a usually more hegemonic entity, a political capital, like Lisbon or Madrid, or a non-capital city behaving like one, like Amsterdam or Zurich.

The ultimate sense of the second city, and probably a better term, is to be the alternative city. Most of these places have been distinguished throughout History by a fresh and liberal environment, a political non-allegiance with the capital's dictates, and a progressive view on development. Such cities, agile, flexible and pragmatic, can take on any role, against the more rigid position of a capital, stuck with the ballast of its role as source of political power, national 'identity' or economic decision centres.

As alternative cities, Porto and many European cities of similar size[47] share some common features. An important seaport and airport, special emphasis on a central university, and in the case of Porto, Basel, Barcelona, and others, to be arguably the architectural 'capitals' of their countries, concentrating the most regarded schools and offices and some of the nation's best buildings. Of course this can be discussed, but it necessarily reveals a certain cultural uniqueness and a creative, autonomous voice in cultural discourse.

Historically, this condition of relative importance without the ballast of a capital, together with being a port city on an important river, allowed Porto to find alternatives for growth by connecting to the exterior. This was specially based on trade, and on what it brought along: a liberal environment, openness to foreign influence, and a business-oriented society, with an anti-aristocratic standing. Like other 'second cities', Porto has a history of resistance against the installed interests of the capital, and gave birth to some of the nation's liberal and progressive institutions. Porto could have been an alternative model to centralization, not trying to be a hegemonic capital, but a networked hub, demanding autonomy and self-governance to develop its extroverted vocation- maybe for this reason, while most cities find their symbols in monuments, main squares and other centralizing elements, Porto's symbol has always been its bridges, the clearest possible representation of movement and openness. While this spirit can still be found in several places in Europe, one cannot deny that the current potential of the region is being undermined by its governance model (an almost powerless region in a centralized country); its demography (ageing, less educated national population when compared to other cities with younger more qualified residents, and high percentage of foreigners); and its economic engines (weakened industrial sector, low-value activities against specialized, high-value clusters typical of other cities of similar size)[48].



Figure 1. Porto's privileged geography *(available on the Internet- original source lost).*

[47] The reference to other case-studies comparable to Porto follows the author's Master Thesis for the Metropolis Masters Program in Architecture and Urban Culture, in Barcelona (UPC-CCCB), presented in 2009, called '*Three Tenses of Reality: a complex approach to the multi-scale geography of cities*'. In this thesis, on which the present paper is based, the city of Basel, Switzerland, is used as a case-study and compared to Porto in several areas, namely its spatial conditions, and evaluates the 'fine-tuning' of the corresponding political, economic and cultural layers. The study is more focused on two large-scale projects working as catalysts in both cities, namely Porto Airport and the Novartis Campus in Basel.

[48] About strategies used by cities of similar size to re-think their development, see van Boom and Mommaas (eds.), *Comeback Cities*, NAi Publishers, Rotterdam, 2009

4.2 *Hansestadt* Porto?[49]

The spirit of freedom and alternative thinking typical of second cities was also present in the hanseatic cities of Northern Europe, the league of semi-independent cities that held a century-long trade monopoly from the North Sea to the Baltic. Those cities practised a pioneering version of restriction-free transnational trade, with mutual obligations that held no mandatory ties to their respective nation-states, when they existed. Porto was never one of them, but there are surely certain analogies: hanseatic cities needed a specific geographical condition- a river or the sea; a social trend- a liberal, pragmatic society; and a political model- autonomy and decentralization.

To these basic features we could add one more criteria to allow a vigorous 'alternative city'. Alluding to the growing complexity of global economy, Saskia Sassen (2005) argues that the more companies tend to install their headquarters in larger cities, the more they need to disperse ever-growing amounts of supporting services that can be better performed by smaller and more specialized companies. This is a complex economy of its own, and middle-sized cities, for their flexibility to adapt to different roles, and for their quality of life at more accessible prices, are a more appropriate place to locate those high-value services. If it is true that middle-sized cities are in a favourable position to perform these tasks, and if their political project acknowledges this, we may be before another source of power- specialization- and a new alternative for tertiary growth.

Second cities must be proposed as liberal and free-minded alternatives to hegemonic capitals, and not as small-scale imitations, not competing for the same functions but understanding their unique abilities. In summary, a privileged geography, an autonomous cultural, economic and political discourse, and a will to be different, together with the rise of European regionalism and its various recent institutions, are the ideal conditions for second cities to enhance their power and use their catalysts to detach from their geography.

Here we face a problem. This idea of Porto having such a unique 'spirit' may be an argument to justify more autonomy, but that identity begins and ends in Porto-city, and a consistent solution for the region needs a wider consensus. And, as we will see afterwards, Porto is not really Porto anymore. To be relevant, to achieve critical mass, it must be working in 'variable geometry' mode, meaning that Porto actually is its wider region, an extensive urbanized territory lacking a single core or a common feature. Without a distinct language or historical borders, like Spanish autonomies, and no central city whose influence clearly 'justifies' the existence of the surrounding territory, the danger is that if 'Porto' is everything then maybe it is nothing- an entity so thinly covering such a wide area that it is not recognizable anymore.

4.3 Porto as a city-region

The term 'city-region' is normally used to describe not only a metropolitan conurbation but also its wider field of relationships, in terms of mobility, built continuum and economic impact. Although in Porto technical or administrative terms like 'greater metropolitan area', 'metropolitan conurbation' or

[49] The analogy between the 'spirit' of Porto and the historical hanseatic cities has been detected, among others, by the president of the Porto Commercial Association, Rui Moreira, in the 2009 conference cycle *Olhares Cruzados sobre o Porto*.

'metropolitan arch' are used more often, referring to different boundaries, the ambiguous term 'city-region', whatever its precise definition may be, seems more appropriate to describe the area, not only for its more politicized echoes, but for stressing the nature of an urbanized region whose boundaries vary according to the angle we choose to address it, and are hard to define in any case.

The Porto city-region is a pulverized territory of diffuse urbanization, covering many cities, districts and constituencies, and irrigating in a fragmented way the space in-between. It consists basically of a denser core area encompassing several municipalities around Porto, and an extensive urbanized area starting to the South in Aveiro and touching Viana do Castelo to the North. In this very large region, distinctions between compact city and suburb or between rural and urban are often diluted. It is a model of extensive occupation- a diffuse 'urban condition' irrigated by infrastructure, and with little temporal detachment and density oscillations- which is not the same as expansive- the typical 'oil stain' radiocentric growth, spreading along a clear timeline from a dominant centre (see figure 2).

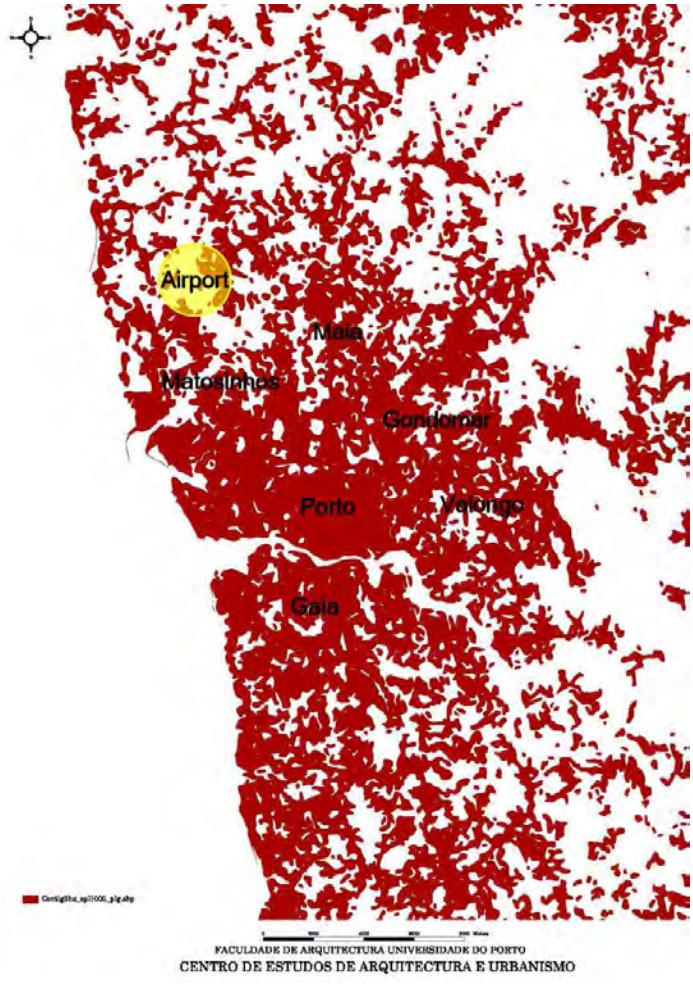


Figure 2. Porto Metropolitan Region- Built Continuum (<50m), 2009; *PROT- Arco Metropolitano (provisional document)*, CEAU-FAUP, Porto.

As a city, Porto has not been able to grow beyond its 19th century ring road, and everything after that limit is outside the municipality, but there is no visible break in the built continuum (see figure 3). Conventional urban areas, industry and agriculture all participate in a shredded, disseminated territory that demands three paradigm shifts: one that overcomes the old dichotomy urban/rural, in geographical and sociological terms; other that acknowledges that the 'urban' has long ago overflowed the city; and finally one stating that the logic of land use is no longer hierarchical through functional zoning.[50]



Figure 3. Porto Metropolitan Region: Satellite Image h=20km, *Google Earth.*

Unlike Lisbon Metropolitan Area, which is clearly gravitational, with a strong centralizing pre-existence forcing a more binary logic between the dominant city and a diluted periphery, the context of a hegemonic centre expanding into the countryside never existed in Porto, because dissemination has been there since the beginning. The 'centre' never had enough critical mass to be really significant as an autonomous entity and what we call Porto is a small part of a discontinuous, polymorphic and incoherent urbanized territory whose main anchors happily stroll over political boundaries and administrative sectors. This happened mainly because the type of industry that

[50] The provisional document for the *PROT- Metropolitan Arch*, developed by N. Portas, A. Domingues and M. Fernandes de Sá (2009) at the Centre for Studies in Architecture and Urbanism, Porto Faculty of Architecture, clearly states this triple shift.

spread diffusely over the territory as a main source of employment, often following very local and specific locational logics, never generated the concentration of wealth and services, as well as the demands for an ‘urban’ quality of life that a larger and higher-value employment market would have. Thus, the tertiarization of the ‘centre’ and usual concentration of population in a ‘city’ with pendulous movements to industrial areas never happened.

It is also interesting to note that this model, rather different from classical metropolitan sprawl, finds even older roots in medieval cadastral division, when agricultural land began to be divided in very small lots for each family to cultivate and dwell: dissemination was independent of a critical mass- a city- to support it. This process has generated a proliferation of farms, houses, small municipalities, and huge amounts of infrastructure- paths, roads, informal crossings- that irrigated the whole territory with an ability to be urbanized: a porous, sponge-like territory, where urbanization advances as in percolation. From then on, as in a filigree piece of jewellery, it was just a question of densification around a pre-existing infrastructure, now coinciding with the major mobility axes, and economic development and new land uses were unable to delete the traces of this palimpsest. Unlike Lisbon or Barcelona, ‘black holes’ that absorb most of what happens in their regions, Porto is everything but a hegemonic city.

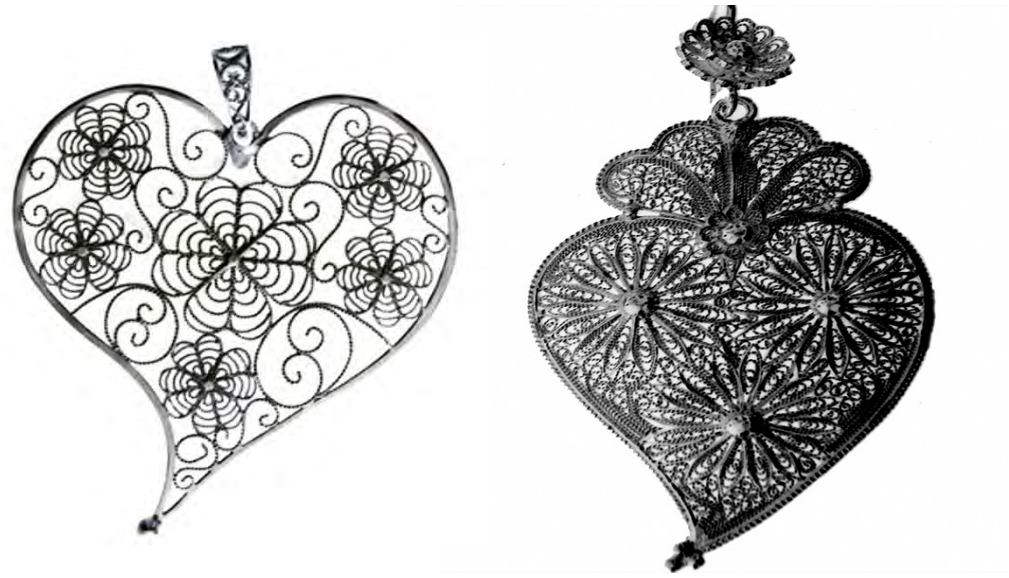


Figure 4. Portuguese Filigree Jewellery: Densification of a pre-existing structure; *Available on Internet, original source lost.*

4.4 Multi-polarities

If we ask where the ‘centre’ of this large and diluted urban region is, the answer depends on what we look for. When ‘point-city’ gives way to the ‘plateau’, new and differentiated conditions for centrality emerge everywhere. In fact, the relative gravitational weakness of Porto ends up favouring the wider region, as services, infrastructures and housing for every economic strata cover the territory in a more generalized way. There are hardly any ‘pure’ suburbs- they immediately turned into “*post-suburbs*” (Portas et al, 2007), or have never been conventional suburbs at all.

Therefore, if ‘centre’ stands for enhanced and polarized accessibility, it would be more or less between Maia and Matosinhos, near the Port and Airport, along the metro line and the major highway

with its respective nodes. On the other hand, if by ‘centre’ we mean concentration of services and economic tertiary functions- jobs, consumption, offices, hotels- we must look, together with some areas inside Porto, for the ‘edge city’ growing to the South of Douro, around the major shopping malls. More conventionally, if we look for a ‘centre’ as producer of institutional and cultural identity-power- we can come back to traditional areas in Porto-city. But if we look for the same references of identity and culture in the ordinary city-user mental map, the major shopping malls, as references for meeting and entertainment, are hard contenders too. Along with these poles of attraction, endless socially diverse centralities rise with relative ease in every corner of our diluted region, not suffering the ‘black hole’ effect typical of hegemonic cities (see figure 5).

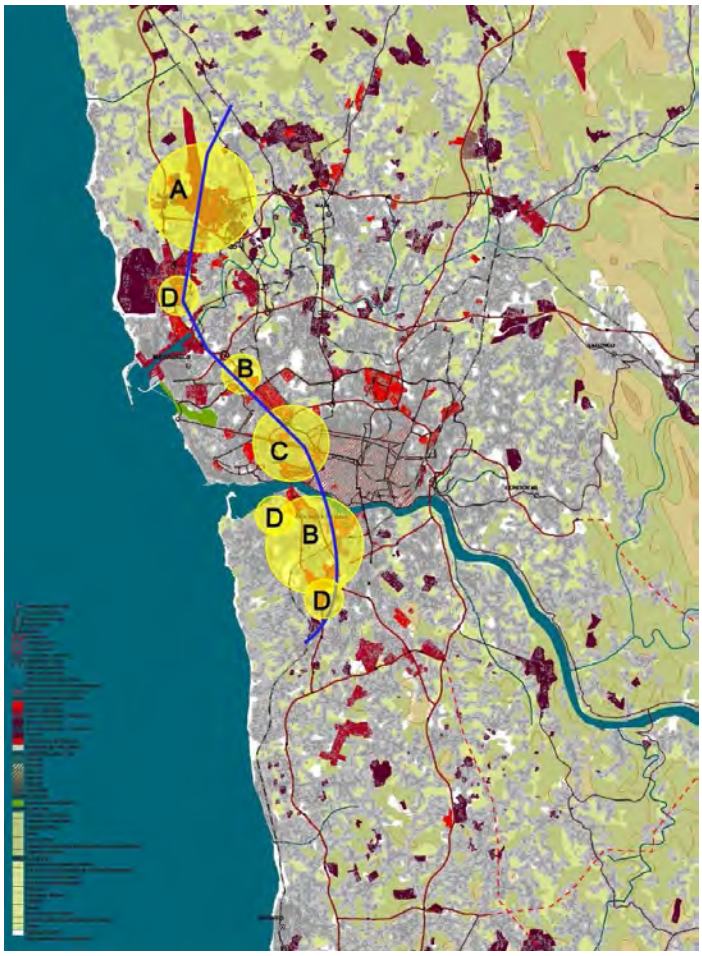


Figure 5. Multi-polarities (A to D) and ‘axis of centrality’; juxtaposed information over Porto Region-Structural Plan, 2009; *PROT- Arco Metropolitano* (provisional document), CEAU-FAUP, Porto.

The crucial point here is that none of these ‘centres’ complies with all the parameters for centrality, but altogether they do- looking at the major poles we can talk about centrality over an axis, coincident with the major highway, which has nothing to do with the limits of Porto-city and is clearly the core and engine of the entire region. The axis includes, from North to South, the Airport, shopping malls and logistics parks, the Port, light industry and office buildings, the main cultural equipments and the historical centre, a university pole, an edge-city-like aggregate of hotels, health services,

shopping and office areas, and more logistics and industry. All are involved in a relational logic based on mobility, beyond constrains of proximity and territorial friction, and produce therefore an autonomous geography, indifferent to municipal limits of sectoral divisions of territory.

The notion of centrality over an axis and the logic of complementarity between its elements, explains why the major poles cannot be understood in isolation and why each location is so relevant to the whole- actually, most locations end up being appropriate to feed the attractiveness of the axis, although it cannot be said that it corresponds to any kind of intentionality towards building the hard nucleus of the region. The axis "*developed in unarticulated steps through the action of both the public powers and private agents*" (Portas et al, 2007), but it did not grow randomly: it developed a reflexive process of feedback in which its growth enhanced its attractive power to produce more growth.

This also leads to the significant argument that unlike other regions, where new suburban centres, edge cities, service parks and airport cities add to or compete with original city centres, here this aggregate is all we have: there is, at the time, no alternative or precedent in the traditional city from which those new things spinned off. Things only work, as in a complex engine, in the larger scale: Porto's reading as a 'city', its centrality features, its integrity as an entity assembling all the aspects of urbanity, only exists- or exists in a complete way- at the metropolitan level, and the city itself is only a representative section of the full set, more relevant in some layers of variable geometry (institutional power, tourism, etc.).

In summary, Porto's understanding as a complete entity only takes place in the territorial multiplicity. A paradoxal urban condition: the more fragmented and diluted the more interdependent and synergistic. This is why, in this region, the discourse must be much more about cooperation and parallel processing that about competition and mutually excluding alternatives.

Unfortunately, what could be a strong and articulated metropolitan region is cross-sectioned by endless municipalities, circumscriptions and sectoral authorities, who worry more about programmatic, localized and short-term objectives than about networking. Many of these entities' geographies are of a different nature and scale than the physical logic beneath them, even if their intervention has strong impacts in that logic- see the example of a highway authority.

The larger frame, namely the Greater Porto Metropolitan Area (GAMP) is still incipient, since its administrative entity has very little power and depends on partial interests of its constituents. Moreover, its exact correspondence with the political limits of the municipalities also creates a frame too rigid to act on phenomena more dependent on relational logics than physical boundaries. There are macro- and micro-level problems and scales, public projects, private agents and public-private partnerships, and this fragmented and complex web of interests does not ensure that a fixed, region-level decision context is operative to every objective and policy. To apply the notion of variable geometry at this level is essential to ensure that each problem can be addressed by the most effective and inclusive frame possible.

Therefore, in such a territory, the scales seem all wrong: the political frame for decision-making is either too broad (central government), too narrow (municipalities) or too weak (GAMP). This becomes clear in the way every new project appears on the map- as a sectoral intervention of an autonomous entity (municipality, airport, port or highway authorities)- lacking a more general and more knowledgeable vision to articulate it, as if the coherence of the whole was no more that the sum

of the parts. This absence is visible in the kind of ‘urban arrhythmia’ around the major large-scale interventions, highly coherent and predictable inside their boundaries but totally unarticulated with the general environment.

4.5 An exceptional catalyst?

Porto Airport is arguably a project that might qualify as a catalyst for the wider region. In a context of disadjustment between territorial scales and political frameworks, sectoral interventions and general articulation, it is even more notable how the airport ended up playing such a strong role.

With a double digit annual growth and ambitious expansion plans, the airport is the most important transport infrastructure in the Iberian Northwest, with a strong polarizing effect extending to Galicia and the Portuguese interior. Its highly networked location and accessibility is also an important asset, since it stands at the Northern end of the aforementioned centrality axis. However it was never part of a larger territorial strategy: from its inception it has been managed by a purely sectoral authority, with very low levels of intentionality towards the region. Its boundaries, as well as its expansion plans must deal with the very specific cadastral divisions of its diffuse surroundings, mixing logistics, small-scale industry, agriculture and disperse housing.



Figure 6. Urbanized areas in Portugal showing a continuous stripe from Lisbon to Galicia, Spain; *Google Earth Screenshot (NASA Earth at Night layer).*

The discussion about the airport’s future basically involves scenarios of a centrally-run ‘satellite’ of the future Lisbon Airport, against an autonomous structure flexible enough to be a development engine for the entire region, making the framework for decision-making correspond to the airport’s physical hinterland. There are several shades between both options but most opinions in Northern Portugal defend autonomy. We can explain this as an attempt to solve Porto’s problem of ‘double periphery’ (a peripheral region in a peripheral nation) through the notion of parallax: the region stops being peripheral if our perspective is re-centred in the Iberian Northwest. If that is our scope, the airport starts acting as a much more influent catalyst.

Apparently a bureaucratic/technical question, this debate has triggered a regional movement involving the public and private sector and the civil society, mixing cultural pride, political non-allegiance and economic common sense, which even brought up again the discussion about regionalization which Portugal cyclically addresses. The region's 'living forces' got together to defend their view, stimulating a single, unanimous standing emanating from a political frame which *does not exist yet*. In other words, it brought up a strong and articulate 'position' by a potential but still fictitious 'Regional Government'. Just as transportation, water or energy infrastructures generate an urban condition before the urban form is there, the catalyst triggered a political/social infrastructure which is shaping a political condition before the political form (regionalism) appears.

The important point is that such catalysts can help to fine-tune the scales of the real territory and the scope of planning and decision-making, although it is too late to prepare the process prospectively. As a functional and technocratic project, the airport is badly articulated with its environment, and has to be considered retrospectively- the object is already there and the surrounding frameworks- political, territorial, economic- are the ones shifting their position. Ideally, instead of starting from an abstract model landing on the territory, projects should be prepared in a complex and gradual way, internalizing risk and uncertainty, receiving feedback from their own evolving process, and following frameworks for decision-making with the right strength and scope.

While Porto is struggling to detach from its geography and to end its double periphery handicap, by producing the first statements of a still inexistent common project, other cities in Europe are enhancing their long-acquired centrality aspects, by fine-tuning the scales of territorial conditions, economic models and political frameworks and waiting for the catalytic multiplication effects that happen in those specific conditions of geography, politics and economy. In Porto, on the other hand, building up a new and common project and entering a still unexplored territory brings with it the added sense of adventure and surprise. It is therefore imperative to struggle for the spatial, political and social conditions for that adventure to be fully lived.

5. A body that is not a body: the rhizome

We have seen that the discontinuous and polymorphic urbanization punctuated by sectoral and closed-off interventions is, nevertheless, more than a sum of casual facts. The 'whole'- the city-region as a complex system accumulating change across different scales- acquires new and explainable properties that were not visible in its constituents. As in all complex systems, we witness phenomena of 'emergence', with the number of interactions increasing exponentially with the number of components. But, to be precise, the city-region is not even a coherent 'whole', especially in the case of extensive urbanization: it is so fragmented and partial that every kind of planning option falls onto its territory, mostly stressing the disadjustments and hiding potential qualities of this territory. The quest for coherence is thus seen as a lost cause, forcing the most consistent interventions to address only the classical, compact city-space that occupies an increasingly small proportion of urban space. There, the big picture seems uncontrollable and we normally behave like the blind monks trying to explain an elephant[51]- the one holding the tail says it's like a rope, the one holding the leg says it's like a tree. The problem is that the 'urban' extends through such an immense territory with so many

[51] Thanks to Álvaro Domingues for the clear analogy.

interactions that even large scale interventions are too limited to affect the entire body. Those interventions need a model of anchoring to the 'even-more-macro' logic, by addressing their strategic position in the big picture of politics, economy, culture and territory.

Accepting this incoherence, the territory may no longer be a 'body' in the sense that some type of 'urban acupuncture' can be applied in a certain pressure point to re-establish the balance of the whole. However, it is a 'body' in the sense of a complex, self-organizing, living system: its parts (its 'cells') may be- have to be- in a continuous process of imbalance, life and death, attack and protection, in order to achieve the stability of the system. Authors like Edgar Morin illustrate this notion by comparing the human body to a car engine: while the former consists of highly fragile and volatile elements whose fluidity does not affect a very robust and reliable whole, the latter is a set of very resistant and stable mechanical elements, but their partial failure will ultimately lead to the breakdown of the whole system.

If the city is like a complex system made of volatile, ever-changing elements that build urban form, it is also true that those elements are what they are in a certain location, but can be many other things in other places, planting somewhere else effects originated by causes coming from somewhere else too. We have mentioned urban space as a Deleuzian 'plateau'[52], a "*continuous, self-vibrating region of intensities […]*" (Deleuze and Guattari, 1980) and can now analyze what processes work on that plateau. To illustrate this, maybe the notion of a rhizome is useful.

The rhizome- the 'image of thought' proposed by Gilles Deleuze as well as its botanical counterpart- is a structure with no centre or hierarchy that can ramify, thicken or flourish at any given point and that evolves in an apparently erratic, reflexive way: each new event changes the equation to all the next. Unlike roots, any point must be connected to any other point, but the connections may not be hierarchical or of the same nature. Its components are not units but vectors with motion and direction, each more codified to a specific field of interest. Therefore, there can be no 'pivot' to reference the whole rhizome- it is "*always in the middle, between things, interbeing. The tree is affiliation but the rhizome is alliance, uniquely alliance.*" (ibid.)

The rhizome seems to be a clear representation of how complex urban processes evolve: no hierarchy, beginning or end for interactions; 'alliance' as synergy between any two processes; no single centre of decision, but loose communities of interests with no formal structure and multiple interdependences, codified in different ways; deferred impacts with broken cause-effect links, under conditions of reflexivity.

But the rhizome is also an approximate depiction of real physical territory, in the case of extensive urbanization, as described for Porto (figure 7). In a rhizome, the ramifications are vectors of different nature and states of intensity while the nodes are moments of stability around an 'attractor'. If we interpret vectors as infrastructure with different intensities (from highways to paths, energy, communication) and see nodes as highly charged places attracting urban concentration- a city as stabilization around an attractor- we can depict once more the nature of the polycentric and polymorphic urban dynamics most visible in the region, with a capillary 'urban fluid' irrigating

[52] Actually the notion was first proposed by anthropologist Gregory Bateson (1904-1980), for rather different reasons.

everything like water through a sponge. What is this urban condition but a ‘plateau’, with no climax or single directionality and with a different set of conditions and probabilities at any given point?

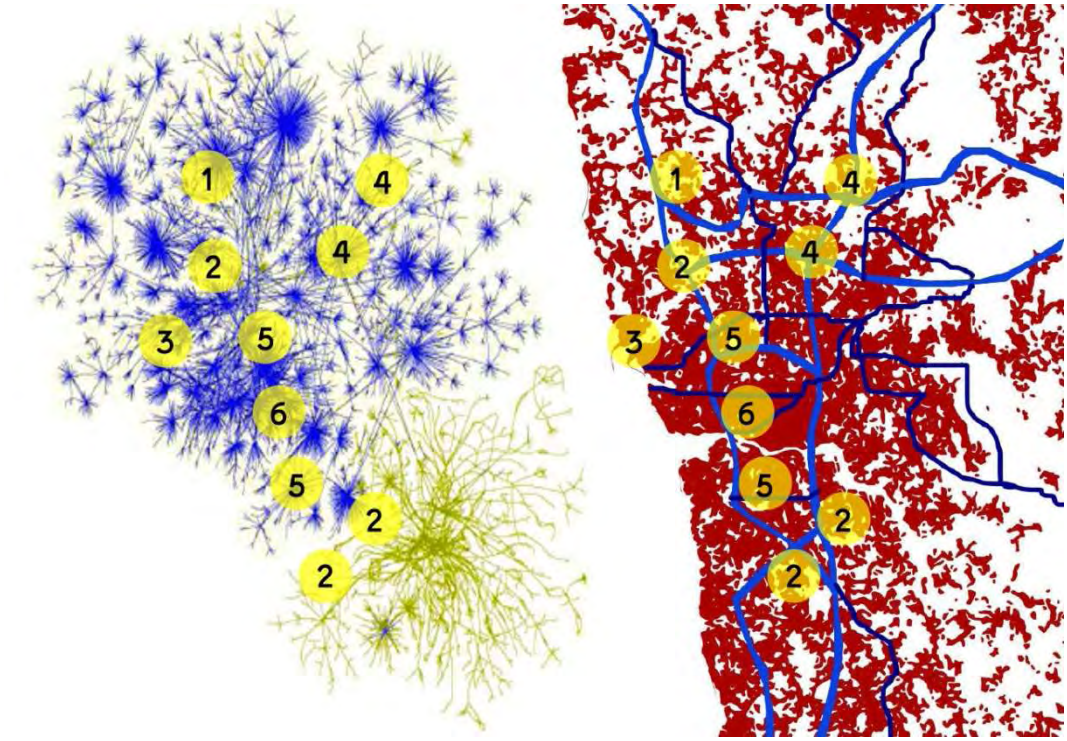


Figure 7. Territory as rhizome: nodes and vectors; juxtaposed graphics over: Rhizome, *posted at http://laboratorioarquitectura.blogspot.com* (left); Porto Region, Built Continuum, 2009; *PROT- Arco Metropolitano (provisional document)*, CEAU-FAUP, Porto (right).

If the territory is rhizomatic we must re-evaluate what polycentrism means- there are partial features of centrality in many different places, but they are not equivalent in what they induce in the territory, due to their own nature and the nature of their surroundings. Therefore, the same type of intervention in different areas of urbanized space will have very different effects. This seems to indicate once more that even with all the dispersion and variation, even with the relevant systems acting more on a relational than a physical logic, spatial context matters.

6. Space matters

Even the relational logics and multi-scale geographies acquired by cities affect and are affected by each one’s specific spatial context. We have suggested that spatial determinism does not exist, and that detachment of geography is achieved by a variety of tools with catalytic effects. However, detachment of geography is not the same as independence from it. Things may happen in abstract worlds of virtual relationships- *polis, civitas* and *urbis* somewhere out there- but they emerge from local conditions dependent on physical devices. In simpler words, “*space takes precedence*” (Soja, 2003)

Space itself has a causal impact in societal, cultural and every relational development affecting a region. We saw examples of ideal spatial conditions for historical hanseatic cities and today’s

second cities, as well as descriptions of how agricultural and industrial spatial patterns constrained not only the current territorial distribution but also the region's political and economic frameworks.

Other physical devices have shown themselves crucial: the location of the airport and other major regional attractors is decisive for the empowering an axis of centrality, which is in turn made of, and dependent on, spatial features- building and infrastructure creating nodality and movement. But if we suggest that this axis is an engine able to re-balance the regional economy and to trigger a new political framework, we can argue that the whole process of economic and political transformation is an emergence from spatial conditions.

Notably, our Porto case-study describes the spatial processes occurring first, and political and economic frameworks still as potential conditions, unexplored territories waiting to emerge, although sometimes planning disciplines see space/form as a procedural consequence of the latter. Here we can find a striking parallel to Edward Soja's writings about synekism, the conditions of stimulus that derive from coming together in a particular place, when he argues that the spatial process came before all other societal and cultural developments: "*I see cities and urban life […] as generatively and causally spatial. […) the historical development of societies doesn't just take place in cities, but it is also generated from cities. […] it wasn't the creation of a social surplus that made cities possible, it was the formation of cities that allowed the creation of social surplus.*" (Soja, 2003).

The Porto city-region faces a tension between the virtues of synekism- agglomeration- and the dispersion movements countering it. If, as we suggested, one must expand the notion of the agglomerate to encompass the wider meaning of 'Porto', the subtle leap to irrelevancy must be avoided, since, as we said, lacking strong and wide-ranging cultural distinctions, it might become such a generic entity so thinly covering such a wide area that it is not recognizable anymore.

6.1 Parallel Processing

To do that, one must "*take advantage of territorial structure to diversify the city structure*" (Portas et al, 2007). To believe that 'space takes precedence' leads ultimately to inter-city cooperation, consensus on wider objectives, and a fine-tuning of the scales of what is today the "*exploded city*" (ibid.). Naturally, this does not happen by magic. It needs a political project that internalizes it, a territory of governance based on a meso-scale system of regional continuities and on common goals and opportunities, together with sufficient autonomy and tools to achieve them: "*cities are far from realizing their power […] inventing this new political project they will need; part of that new politics will have to be thinking about groups of cities that share concerns, challenges and how do they produce their instrumentality.*" (Sassen, 2005).

In the case of Porto, with its filigree structure and its integrity diluted over a multiplicity of territories, the need to articulate governance grows exponentially. One might argue that in hegemonic cities, holding all the necessary features inside their perimeter, the periphery needs as more autonomy as it can get, to avoid the 'black hole' effect. But in Porto, as in other non-hegemonic regions, the best option would be to create a network of cities in parallel processing. There are many competing centres in the region and some have outgrown the city itself in population and specialized activities. Only by hierarchical prejudices or ignorance of what reality tells us should this be a

constrain, if 'Porto' airport and industry is in Maia, the port in Matosinhos, offices and natural parks in Gaia and housing is going towards Gondomar and Valongo anyway.

Our understanding of 'city' and 'identity' should therefore expand to encompass all of this. One of the best examples of that expansion is the diversity of large structuring projects being developed in the region- waterfronts, cultural facilities, natural areas, infrastructures- clearly reaching beyond artificial circumscriptions, strolling over boundaries that, some years ago, would have undermined their full potential. A networked parallel processing of activities can provide a very important alternative to the more generic and coordinative Lisbon hegemony, and we have seen how the advent of European regionalism may help 'second cities' to emerge- assembling geography, autonomy, coherent discourse, differentiation and critical mass. An eventual regionalist project for Porto needs a corresponding territorial model of urbanization based on territorial coherence and not artificial boundaries, something which is still missing from many current debates. The political way to build regionalization and its spatial-administrative counterpart (municipalities, boroughs, districts, sectors, etc.) must be considered as a whole and make sense at all the scales of territory.

All of this must be communicated as a risky, opportunity-full adventure, internalizing change and uncertainty, and not as a mechanical cause-effect phenomenon. The idea of 'rhizome' may not only describe urban form and processes, but also motivate socio-political relationships and new ways of thinking. In that sense, visions should be based on active 'futurecasting' which is more about proposing than predicting, taking into account spatial specificity, political model and strategic articulation, and "*exploring the realm of what is possible without restricting to what is formally probable*" (Morin, 2005). For "*all good narrative has the property of exploring the unforeseen, of discovery; the novelist's art is to shape the process of that exploration. The urban designer's art is akin.*" (Sennett, 2007)

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Analyzing the configurational impacts of architectural intentions

Tatiana Trindade*, Gonçalo Furtado*, Miguel Serra**

* FAUP - Faculty of Architecture, University of Oporto, tatiana.ntrindade@gmail.com, gmfcl@hotmail.com

** CITTA – Research Centre for Territory, Transports and Environment, Faculty of Engineering

University of Oporto, alvim.serra@fe.up.pt

Phone/fax numbers: 00 351 934211461 - 00 351 936493590 - 00 351 964884274

This paper reports a space syntax study on the building of the Faculty of Architecture at Oporto University (FAUP), a work of the masterly Portuguese architect Alvaro Siza. The study's main objective is the exploration of the relationship between the architectural and programmatic intentions behind the building's form and their configurational outcomes. Besides, the spatial analysis of an academic institution raises other pertinent questions that the present study explores. How can a building internal configuration induce patterns of movement and co-presence, and consequently social and inter-relational potential situations? How can architectural intentions affect spatial experience and patterns of use in educational buildings? How can spatial layout promote a better use of this kind of installations? The paper is divided in four parts. First, it reviews the FAUP's design process, identifying the architectonic, programmatic and conceptual options behind the building's form. Second, it explores the configurational properties of FAUP's spatial system, using several syntactic analytical methods (graphs, convex maps and axial maps). Third, empirical findings based on direct observations (movement flows and people following) of the actual spatial use of the building by its users are reported. Finally, conclusions are drawn on the configurational impact of the architect's spatial and programmatic strategies, which cast some light on the actual space use patterns of FAUP's academic community.

Keywords: FAUP; space syntax; architectural intentions; configurational impact

1 Introduction

In the history of 20th century architecture, there is a tradition of material symbolization of "architectural schools", i.e., of specific ways of thinking and doing architecture, through their own institutional buildings. The building of the Faculty of Architecture at Oporto University (FAUP, 1987-1994), by the masterly Portuguese architect Alvaro Siza, can be inscribed in this lineage. As Kenneth Frampton (1992) refers, "*in terms of representing a specific ideological culture through the school building itself, this complex promises to be the third important didactic institution to be built in this century, the other two being the Dessau Bauhaus and the HfG, Ulm*". In this sense, FAUP's building is sometimes regarded as a 'material manifesto' of the so-called 'Porto School', of which Siza is the most prominent element. Perhaps more plausibly, it can also be seen as a celebration of Siza's own architectural *ethos*, imminently tactile and tectonic. (Testa, 1996; Frampton, 1992).

Moreover, the FAUP's building is a key work in Alvaro Siza's *oeuvre*. It marks the scale transposition of a personal architectural language, developed mainly in private and smaller works, to the larger public and institutional scales. Acclaimed by critics (Figueira, 2002; Frampton, 1992; Solà-Morales, 1995; Testa, 1996) and object of many studies (Fonseca, 1996; Miranda, 2005; Portas, 1995; Vaz 2006), the FAUP's building has been raised to the status of contemporary architectural master-piece, which undoubtedly it deserves. Nevertheless, it has always been approached under the scope of traditional architectural theory and critique, which focuses mainly on the aesthetical coherence of architectural form and its relationships to an historical context, using discourse-based methodologies where the metaphor plays a fundamental role as a tool for description and

conceptualization. We cannot, however, expect to obtain stringent morphological explanations based on metaphors. On that process, the deep and structural aspects of form are usually neglected and the relations between form and functioning remain unclear.

Space syntax was created in the mid '70s of the last century, at University College London, by Bill Hillier and others (Hillier, 2007; Hillier and Hanson, 1984), in part to cope with this problem. The endeavour behind space syntax is the definition of a theoretical and analytical framework capable of unravelling the potential causal relations between the form of human spatial systems (buildings or cities) and their patterns of social use and occupancy. Therefore, its main research object is the relationship between form and function in architectural spaces. Using rigorous and quantitative analytical techniques, space syntax studies have empirically shown that the link between architecture and social life passes not so much through built elements geometries or imposed programmatic functions, but mainly through spatial configuration, i.e., the global topological structure of the system of spaces that constitute a building or a city. This structure is inaccessible to discursive analysis, based on words and verbal concepts. Its nature is non-discursive; there are no words capable of describing complex configurational characteristics. Rather, space syntax uses innovative spatial representation techniques and mathematical formalisms to explore and study the structural properties of architectural spaces.

This study arises from the will to approach FAUP's building from a syntactic point of view, bearing in mind its significance as an architectural master-piece and its role in its users' life. In this sense, the study proposes to read the building not only through the common discursive methods of architectural analysis, but also through the configurational properties of its spatial form. The main objective is to try to understand how architectural strategies, programmatic options and contingencies behind the genesis of the building's form determine its configurational patterns, and therefore its actual social and functional performance.

The paper is divided in four parts. The first, points out some central concepts and principles of space syntax theory and its analytical methods. The second describes the case study, regarding the principal directives of FAUP's project, i.e., the history of its development and its morphological, programmatic and pedagogical intentions. The third part depicts the empirical procedures of the study, including configurational analysis, movement observations, questionnaires data and the findings obtained by each method. In conclusion, we resume and report the main findings of the whole analysis and produce some final considerations regarding the relation between the building form and its use patterns.

2 Space Syntax theory and analysis technique

Space is a rather illusive object of analysis. It is not material, but still it is space that we use when moving around in cities and buildings; not walls, ceilings or floors. We live in three dimensional spatial systems, which we experience through a fourth dimension that we call time. When exploring a city or a building we are bound by the temporal dimension, that is, we have to move through space and experience it piece by piece in order to see the whole. Yet, it is obvious that the overall spatial organization of a building or a city does not depend on observers moving through them; it is global

and independent of the observer's time. So, how can we explore the structural organization of spatial systems without losing these essential properties, of globality and synchrony?

We can represent the elemental structure of a simple spatial layout by means of a graph, in which individual spaces are represented by nodes and their relations (of access and permeability) by edges linking those nodes. This allows for the codification of all the relations between all spaces in the system into a single, synchronic formalism (figure 1).

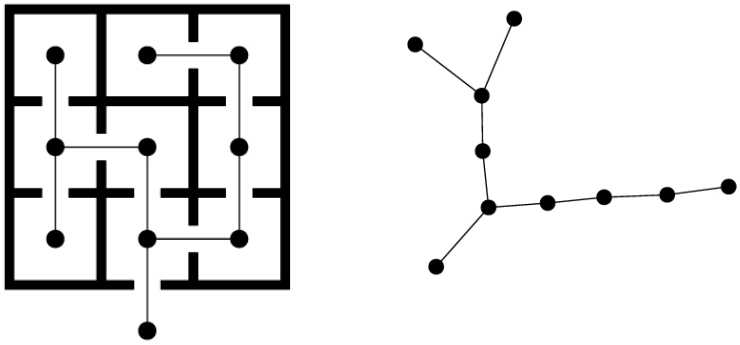


Figure 1. Representation of a spatial layout by means of a graph.

One could object, however, that with this procedure all the geometry shaping the layout is lost. In fact, it does not matter how the nodes are scattered on the plane, or how long the links are. All that matters is the connectivity pattern established by the linkage of the nodes. Graphs are topological, not geometric representations. But because nodes are representing individual spaces and edges the permeability relationships between those spaces, the graph is in fact encapsulating the overall permeability pattern of the layout, i.e., the set of all movement possibilities within it, which is ultimately a product of its morphology. Moreover, it is doing so in an 'all-at-once' kind of representation, thus effectively internalizing the global and synchronic nature of the layout.

By representing spatial systems this way, it becomes clear that each individual space in a building or urban layout must have at least two kinds of properties: intrinsic properties, which are local (such as shape, scale and surface attributes); and extrinsic properties, which are global (such as the relation between that space and all others or its overall location in the layout) (Hillier, 1999). In fact, what the graph is doing is stripping space of all its intrinsic properties (except for the individuality of different spaces), while making explicit their extrinsic properties. Although our visual experience of space is dominated by the local (or intrinsic) properties of space, it has been found that the global (or extrinsic) properties are much more critical to the way we use it. This may seem counter-intuitive but, as Bill Hillier (1999) points out, when we define a layout within which a programme of activities is distributed, what we are in fact doing is creating a "*system of potential relations amongst the distributed spaces and their activities, which will to some degree be realized through movement. This emergent pattern, rather than the located activities themselves, is what we tend to think as the 'functioning' of the layout as a whole*". It is this emergent pattern that the graph is able to capture.

Using this kind of approach to the form-function problem, space syntax studies have found that these emergent patterns of co-presence through movement are the primary functional correlates of spatial organization and that they are predicted by extrinsic measures of the graph. However, this

depends on how space is conceptualized into discrete elements in order to be codified as a graph. Human activity has its own spatial geometries, which space syntax tries to capture by using different kinds of spatial representations (Hillier, 1999). Static activities, such as those with clear programmatic content in buildings (normally involving some kind of group interaction) happen in convex spaces, that is, spatial areas of visual stability where everyone can see each other. Dynamic activities, such as movement through different parts of a building, are linear by definition (we move in lines if not bounded by obstacles) and depend more on how far we can see from where we are, than on local inter-visibility. We can represent every spatial system both ways: as a map of convex spaces or as map of lines of visual and movement continuity, called axial lines. Each representation method captures different aspects of the spatial geometry, convexity its local differentiation and axiality its global extension. Each convex space or axial line can then be represented as a node in a graph, and every relation of adjacency between these elements as links connecting the nodes. We can then explore the relative position of each (convex or linear) space in the system, regarding all the others. Now, it is evident that for reaching a certain space within the system from the exterior, or for moving from one space to another inside the system, we will have to (most of the times) cross a certain number of other spaces. What is not so immediately obvious is that the number of spaces that we will have to cross may differ (sometimes quite drastically) between distinct locations within the system. Space syntax uses justified graphs (also called j-graphs) to make these differences clear (figure 2).

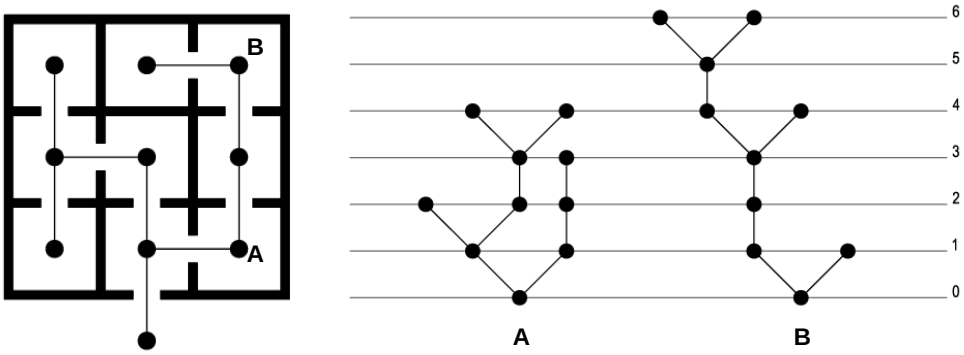


Figure 2. A spatial layout seen from different spaces, by means of a j-graph. Seen from B, the system is deeper than seen from A.

J-graphs represent the graph nodes in ordered layers, starting from the root node (the one we wish to examine), then the nodes directly connected to the root node, then the nodes connected to those, and so on, up to the last node in the system. Each layer represents one unit of topological distance (which space syntax calls ‘depth’), from the root node. This is different from metric distance. Here, we are counting the number of (convex) spaces we need to cross to go from one to another. Looking at the example in figure 2, we can see that the system changes significantly when viewed from different spaces within it. Although they look very different, all the graphs in the figure are exactly the same. Moreover, the system´s maximum depth (the total number of depth layers) is different when measured from different spaces. It is as if some spaces were more close to the system as a whole than the others. Seen from some spaces the system is deep, from others shallow. This is not an illusion, but a concrete fact. Each space can be characterized by its mean depth regarding all the

other spaces, a measure of its global accessibility within the system. And it is exactly this kind of depth differences that are exploited when differentiating activities spatially in a building or streets in an urban network (Hillier, 1998).

We should also take into consideration that the spatial properties of continuity and globality in a building are structured in a different way from those in the urban space: the architectural space has to be understood according to its own internal spatial structure and in relation with the exterior (Hillier and Hanson, 1984). In this sense the boundary plays an important role in order to understand the spatial functioning of buildings. It defines the relations of permeability and control (visual and physic) between spaces. Obviously, in a building there are fewer randomized movement patterns than in urban space. The intrinsic inter-relational logic is therefore affected by a more rigorous and programmed spatial layout, notwithstanding the effects that spatial configuration also generates, in shaping the internal flows of movement and interfaces amongst users.

As we have seen, architectural space can be analyzed according to its occupancy and movement patterns through convex and axial maps, respectively. Space syntax provides a large set of spatial representations, in such a manner that each one is particularly focussed on particular spatial specificities. When approaching FAUP's building from a syntactic point of view, we will use some of these methods of representation (namely graphs, convex and axial maps), in search for the deep and structural aspects of its spatial morphology.

3 The case study – FAUP's building

FAUP building's form was progressively shaped and conditioned by several contingencies, encountered even during the period of the University campus' design process. The challenge started with the implementation site of the new Oporto University campus in Campo Alegre area. Even though it has a strong landscape potential (views over the Douro's shores and mouth), the area is crossed by a complex street system, with several heavy traffic routes, causing an urban barrier effect that divides the area and isolates it from the nearby lively urban area of Campo Alegre. Thus, the campus' urban strategy ought to solve efficiently the transition between two divergent circulation systems - a motorway system and a more local circulation system, linked to surrounding city and mostly used by the university population - and set, in a coherent way, the dedicated sites for the pedagogical facilities of the campus. The University campus was intended to be inserted in the large scale system of the city as a new educational, cultural and scientific centre, a green axis along Douro's shores. Mostly of these intentions were not carried out, bringing new contingencies to FAUP's project. As a result, the campus was not well-connected to the city, with an inadequate and insufficient street system and the FAUP's site, a triangular area close to an existing 19th century villa (which was already property of the University), was separated from its urban context.

Regarding the long-established typology of some institutional buildings in Porto, Siza developed a previous idea of a single and massive volume, semi-buried in the slope of the site, with several levels, and organized around a central cloister (figure 3). This spatial solution of a more centralized building guarantees, on one hand, short circulations and a close relationship between spaces, but, on the other hand, it does not benefit the intimate and personal relationships between professors and students that were sought by the institution. In fact, the initial pedagogical and

programmatic strategies, based on an educational method that intended to mimic the conditions of the professional context, required more individualized spaces.

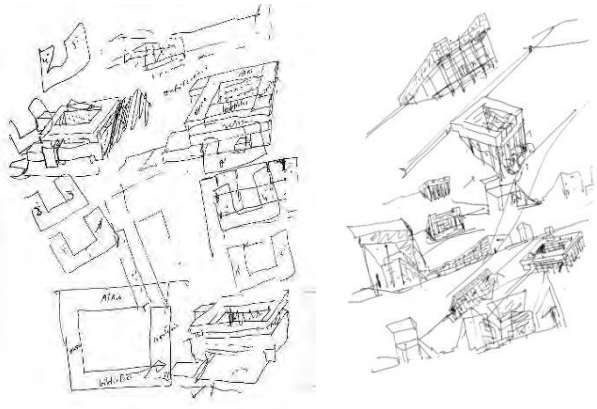


Figure 3. Siza Vieira's drawings. First sketches of FAUP's building.

The proposal was progressively modified in the direction of a decentralized arrangement of a set of volumes in the area (figure 4). This meant a better and more harmonious integration of the new building in Douro's slopes, since it valued the irregular topography, the sparseness of the urban plot and the openness into the surrounding landscape. At last, the building scheme adopted a "V" shape as basic organization, catching the triangular shape of the area and opening the central hole to the landscape and the public urban surroundings.

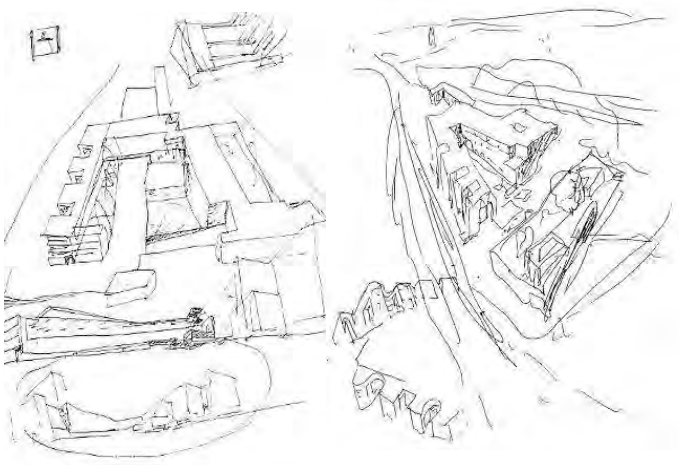


Figure 4. Siza Vieira's drawings. Evolution of the building's shape.

The north wing, continuous, protects and isolates the site from the nearby highway. This wing is composed by three basic volumes, joined by interpenetration and deformation. The south wing, in its turn, is discontinuous, fragmented and individualized into four singular towers. This strategy not only provides different views across the river valley from the central patio, but also ensures the extension of the green Douro's slopes (figure 5). The composition joins together alignments paths and reference points (existing built elements – villa, annexes, ancient property's walls - and the highway) in a west point of the site – the symbolic faculty's West Door. As Adalberto Dias refers (cited in Trigueiros, 1995) "Siza drew up a kind of archaeological map or plan" of the site's peculiar aspects and of the relationships between its physical elements, in such a way that he could still respond to the intended pedagogical and programmatic intentions.

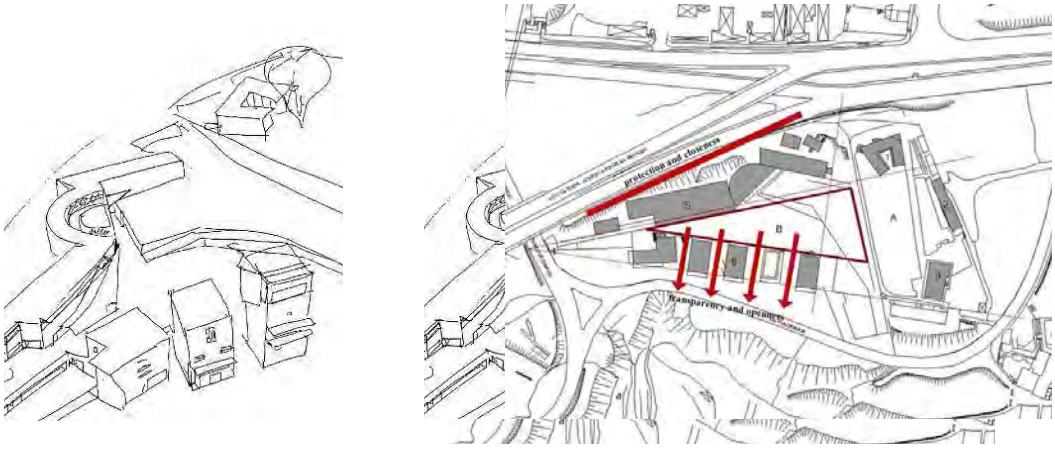


Figure 5. Siza Vieira's drawing. Main axis and implementation strategy of FAUP's building.

In terms of its spatial organization, the final solution fills out undoubtedly all initial intentions, through a high level of sensitive integration. The central patio becomes part of the urban public space. Here, we must stress the peculiar and intentional relationship between FAUP's outdoor spaces and its surrounding area, in so far as there is any frontier or physical barrier separating the faculty site from the urban public space. This boundary is also subtly experienced due to the full / empty game on the southern wing that at the same time causes a sense of enclosure and openness to the surrounding landscape. Moreover, the central patio is also a faculty's space on its own, even being exterior, since it is 'the' space that enables the external routes between the north wing and the towers. Several volumes spread out in the area, creating multiple possibilities of entrance in FAUP's indoor spaces, whether at the street level or at the patio level, in such a way that indoor and outdoor spaces are spatially and functionally connected (figure 6).



Figure 6. FAUP's building. North wing and towers.

On the other hand there is a noticeable clear relationship between the formal and spatial arrangement of the volumes and the programmatic and pedagogical intentions. Academic functions are sheltered in the towers, in close relation to the river and landscape, while administrative and reception spaces are concentrated in the north wing.

The towers perform the concept of 'school as an atelier'. In this way, their interiors are modelled on single programmatic units – ateliers – with an autonomous and interiorised spatial character. These singular rooms provide a closer relationship between students and professors, in order to make teaching more personalised and therefore more profitable. The vertical circulation system of the towers is extremely directed, straight and controlled. There is also another peculiar aspect relative to the Architect's purpose of introducing a huge variety of spatial conditions inside the towers, that is, playing with proportions, possible arrangements and directions of the classrooms (figure 7). However, it is important to notice here, as we did in the previous section, that besides the presence of local formal or aesthetic elements (ateliers' openings have different forms and positions) spaces are mainly differentiated by their location on the global spatial system.

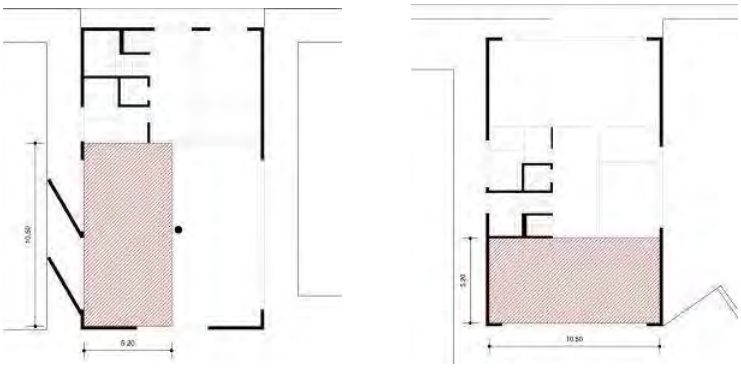


Figure 7. Ateliers' different arrangements.

The architectural options, resulting from both topographical and urban preceding and programmatic and pedagogical intentions, leaded to two different circulation systems. While the north wing has a complex, continuous and fluid circulation system, partly required by the interconnection of the activities it shelters (mainly common use, administrative and receptive spaces), the towers have a traditional vertical circulation (staircases and lifts), being linked by the semi-buried gallery. FAUP's

circulation system is therefore a key aspect of its interior spatial organization. It links two opposed spatial organizations through a particular and sensitive use of architectural themes as a system of ramps and stairs, organizing a sort of architectural 'promenade', followed by different views into the landscape and light variations. The reception area, the auditorium, the museum and the library, inside the north wing, are organized by this architectural 'promenade', which starts in the main hall in the ground level (the exclusive interior linkage space between the two wings) and ends at the library space. In spite of all beauty this architectural walk can give to us, we should recognise the long way we have to cross to achieve its last space - the library.

Another peculiarity is the strategical location of the cafeteria – besides its important social role, it works as an autonomous two storey volume, situated near the main entrance, the faculty's West Door, where both circulation systems of the building's wings converge.

Having described and identified the phases and directives of FAUP's design process, we come now to conclude that, notwithstanding the Architect's concern in taking into account all contextual circumstances (urban and paisagistic), external to the programmatic conception of the new building, there were many plastic and spatial solutions that tried to answer both programmatic and pedagogical questions. To see how FAUP's morphology works when its space is used is, therefore, an informative exercise. Next we will look at the configurational outcomes of those solutions in terms of the simultaneous relations between spaces in the building's spatial system.

4 Methodology

The methodological procedures included configurational analysis, movement observations and questionnaires data. To study the configuration of FAUP's spatial system we used three different syntactic methods - graphs, convex maps and axial maps. For the first method – graphs – the functions of all spaces in the faculty were classified by use type. In the end, each space was associated with a number and a specific colour, which represented its function. We identified five space classes: a) common or circulation spaces – orange; b) academic administrative spaces (ex. Professor's offices) – red; c) academic theoretical/practical spaces (ex. classrooms, auditorium) - yellow; d) administrative spaces (ex. reception, executive offices) – blue and e) service/ technical spaces – grey (figure 8). This allowed for a quicker visualization of the general spatial and functional structure of the building.

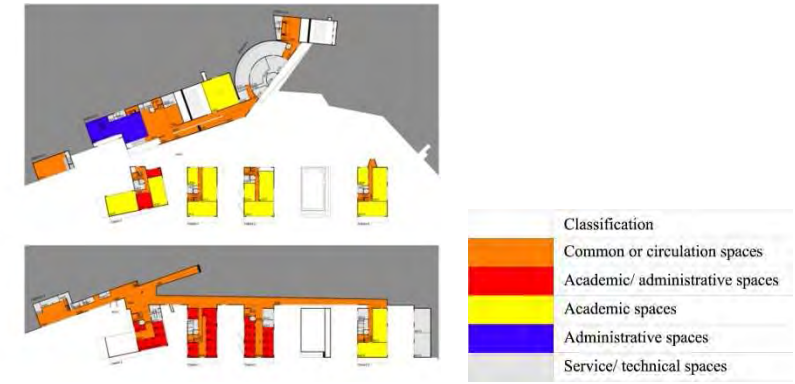


Figure 8. FAUP spaces' classification by use type – ground and first floors.

Afterwards, the syntactic models were prepared to study FAUP's configuration (convex maps and axial maps), bearing in mind all aspects related with its spatial organization / programmatic intentions we have pointed out before. Lifts, balconies and FAUP's property storage area in the ground floor (an area sealed to public circulation) were excluded of the syntactic model.

Then, a criterion of spatial representation, for each type of analysis, was established. Because FAUP's building presents a complex multi-level structure, the representation of the vertical interconnections, particularly in the towers, had to be taken into account. For the convex analysis, staircases were represented in each floor as a convex space which was manually connected to the next space in the upper and lower floor. For the axial analysis, staircases were represented by two axial lines, each one corresponding to both stairways, which were linked alternately between two floors (figure 9).

The convex maps were used to study the topological relationship between all spaces with clear programmatic content, such as those we had identified in classification by use type. In their turns, the axial maps reveal axis of movement and continuity of visual fields. For that reason, we decided to include the central patio and other outdoor spaces by considering its significance in terms of main faculty's circulation routes.

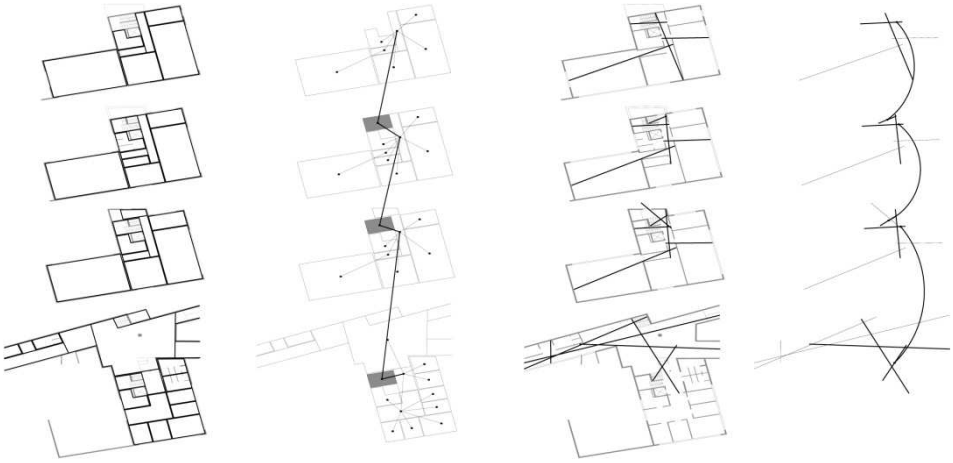


Figure 9. Linkage technique for the staircase of tower E, in convex and axial maps.

However, it is only through the direct observation of the use of space that one may understand how the building works, on social and inter-relational terms. The focus was on the movement flows of FAUP's population, using two different methods.

The first method involved tracing the movement of specific persons for 5 minutes each. The observers followed 59 persons: 14 professors and 45 students. It allowed investigating the pattern of movement from east and west entrances, the relationship between routes and the spaces/ areas with more flows (circulation axis) or with more stops (relation use-function). In the end, this method gives us a sense of how people move and use the building space in different ways.

Gate counts were used to count the number of people crossing "virtual lines" in either direction inside the building. The observation involved 34 gates, strategically located, in which each observer took two 5-minute samples, from 9.30 am to 12.30 am, during one day.

We analyzed observational data in relation to the configurational properties taken out from syntactical representations. Those correlations were then complemented by questionnaires data, related to the FAUP's space use patterns. Questionnaires were directed to FAUP's students and sent by e-mail. From 250 students inquired, we obtained 87 valid answers: 73% of students attended the 5^{th} and the 6^{th} year and the 2^{nd} year was the worst represented (2%).

4.1 Configurational analysis

4.1.1 Graphs

FAUP's spatial structure was represented with a non-justified graph (figure 10). Each node represents a specific space, coloured according to its classification by use type. Some nodes were grouped in order to distinguish important parts of the building. The graph reveals, in an immediate and visual way, the general spatial strategy of FAUP's layout.

Figure 10 shows that the building is formed by two completely different spatial systems: the north wing presents a complex relational structure with various circulation rings; the towers are trees with a linear and acyclic spatial structure. Besides these configurational differences, we can distinguish two distinct ways of organizing space: while in the north wing there are alternative route choices between spaces, in the towers there is only one route from each space to each other space, resulting from its vertical circulation system and suggesting movements extremely directed and straight. The depth of the library and its tree's spatial structure, are noticeable as well. The introduction of the patio gives an alternative route to access the towers, through the exterior. Both spatial systems correspond also to specific functions: the north wing houses "noble" functions as reception, directive and administrative ones; the towers, in their turn, house mostly academic functions.

Another aspect we can extract from the graph is that there is only one point connecting both systems – the ground level main hall (marked in figure 10 with a black circle). This means that whatever the internal movement performed from one system to the other, it will be necessary to go through this space and that without it, the building becomes two. Besides its central position, this space is also important at a visual level because from there starts the architectural promenade of the

north wing and it is possible to retain visually the whole towers' access gallery and the cafeteria (figure 11).

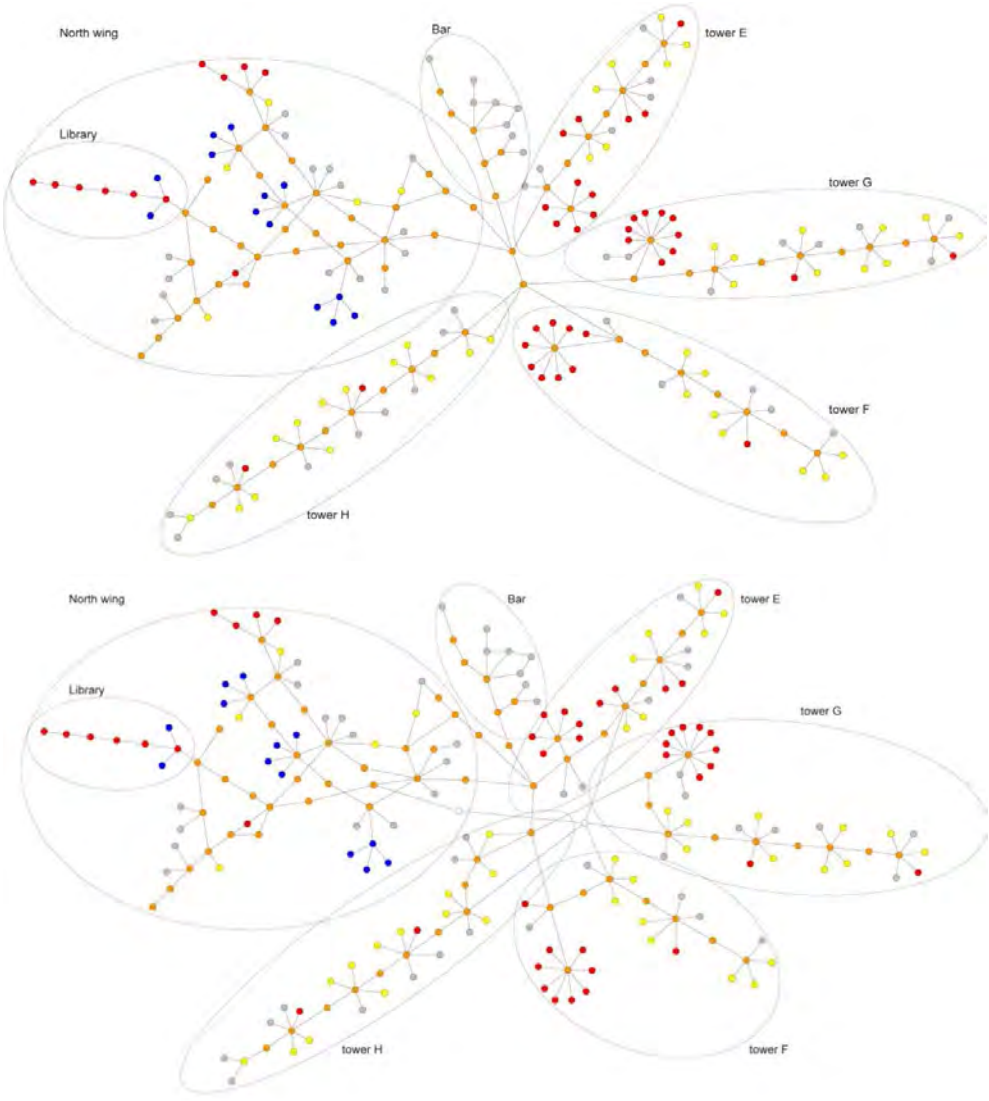


Figure 10. FAUP's non-justified graphs, excluding the central patio (above) and including it (below).

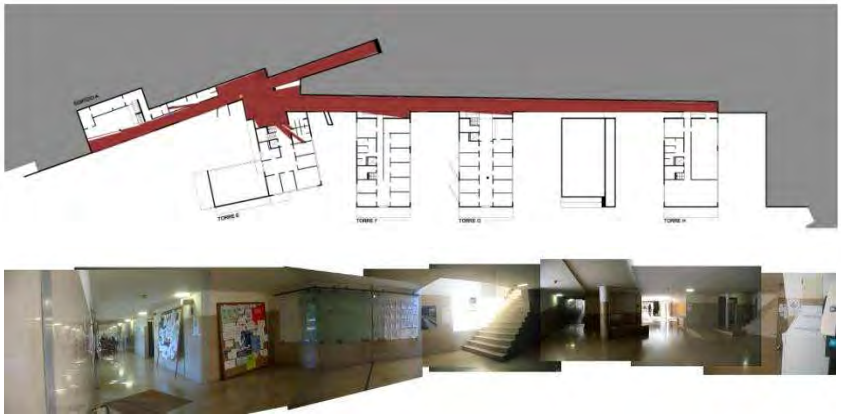


Figure 11. Isovist and general overview from ground level main hall.

4.1.2 Convex maps

Convex analysis allows for the investigation of the relationships between programmatic functions and their configurational location within the global system, i.e., the spatial hierarchy that the several components of the programme assume. Global and local integration and choice were the attributes investigated (figure 12).

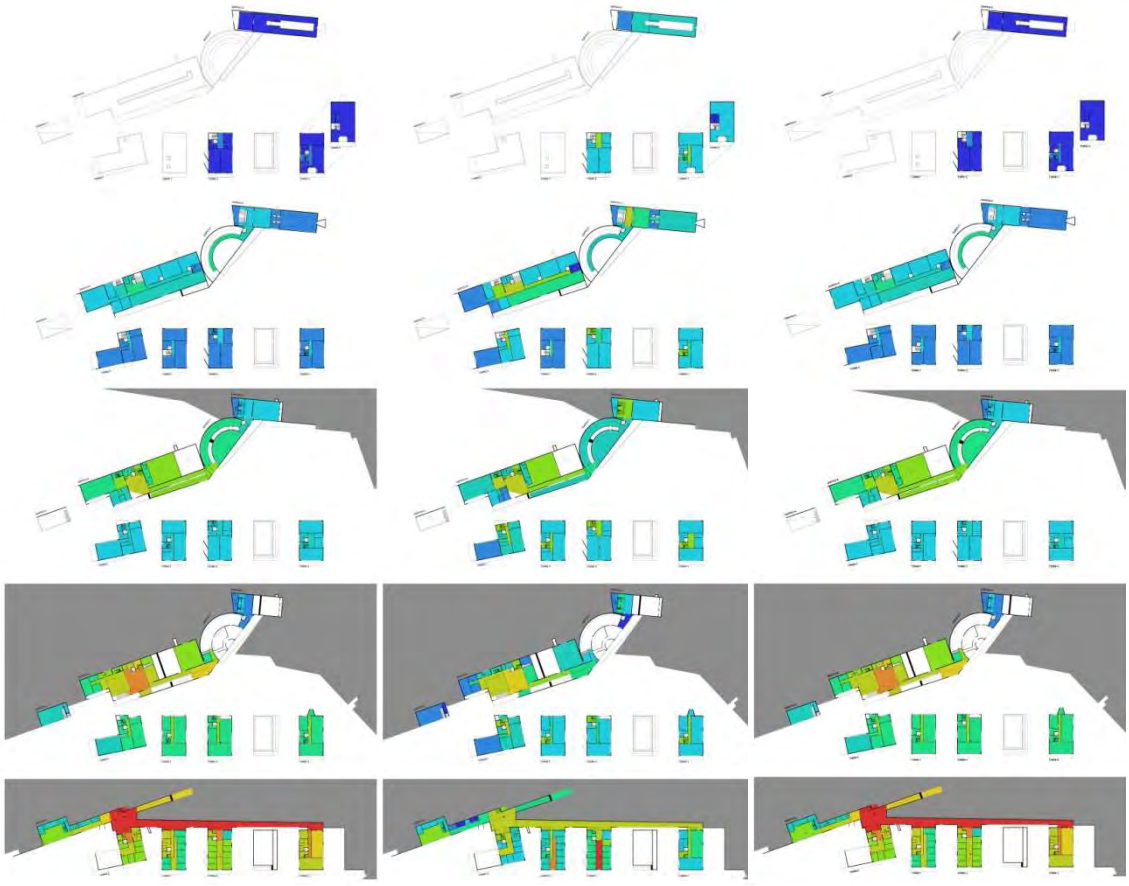


Figure 12. FAUP's convex analysis. From left to right: global integration (Rn), local integration (R3) and choice.

Global and local integration convex maps show visually the values distribution of indoor's spatial accessibility. Spaces well integrated are spaces with high accessibility and centrality, because topologically speaking they are nearer of all other spaces in the system. Local integration was calculated for radius 3, allowing for the exploration of the degree of accessibility and centrality of each space only in its vicinity.

In global terms, looking to the programme spatial hierarchy, we note that common and circulation spaces located on the ground floor are the most integrated spaces in the system while academic spaces in the towers and the library are the most segregated ones (only 80% of the students said that they visit the Library only once a week). However, in local terms, common and circulation spaces are more segregated. Access corridors to professors' offices are the most local integrated spaces because they are next to a large number of other spaces. On the other hand the distribution halls in the towers show now higher values. This means that there are two different scales of spatial circulation within the building: the main and the secondary circulation spaces. In both scales they suggest to act as important connection spaces, potentially with a high level of users interaction. On the other hand, academic spaces remain locally segregated, constituting more isolated areas.

The distribution of choice values consolidates what was mentioned with graphs: it confirms the central position of the ground floor main hall, as a space where the two circulation systems of the faculty converge (figure 13).

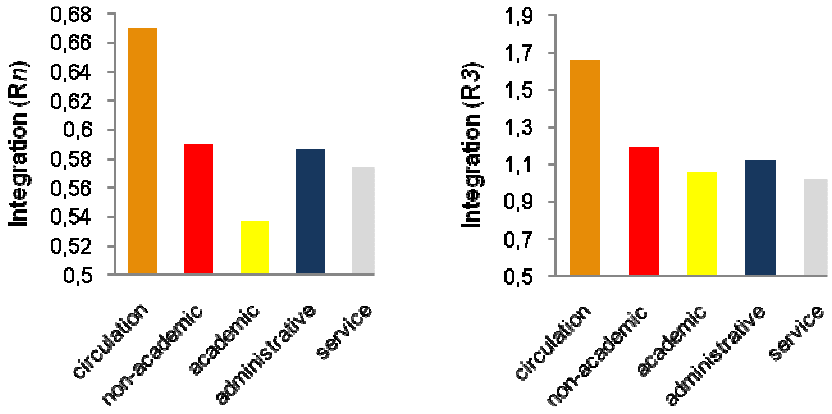


Figure 13. Average of integration values by spaces' use type.

4.1.3 Axial maps

Axial analysis corroborates convex analysis' results, now including outdoor spaces and regarding movement flows and visual continuity of FAUP's spatial system. We verified that common and circulation spaces stayed among the most integrated spaces in the system while academic spaces, mainly those located in the towers were amongst the most segregated. (figure 14).

In global terms, the dominance of the common and circulation spaces on the ground floor verified in convex analysis as the most integrated spaces is now noticed, in axial terms, at the level of the central patio. This shows how the patio is important in global movements and how it works as a building's common space establishing the connection between the north wing and the towers - the main hall of the ground level is not the single connection anymore (according to the questionnaires

the movement between the towers and the north wing is mainly done by outdoor spaces, through the central patio - 59%).

The high values of choice for the patio reflect the high probability of this space be part of the shorter routes of the system, mainly regarding through-movements. In local terms, the common and circulation spaces of the ground floor are again among the most integrated ones with high probability of encounter rates. The main circulation structure of the building is here clearly identified - gallery and hall in the ground level, bar, reception hall in the first level, ramps and museum area.

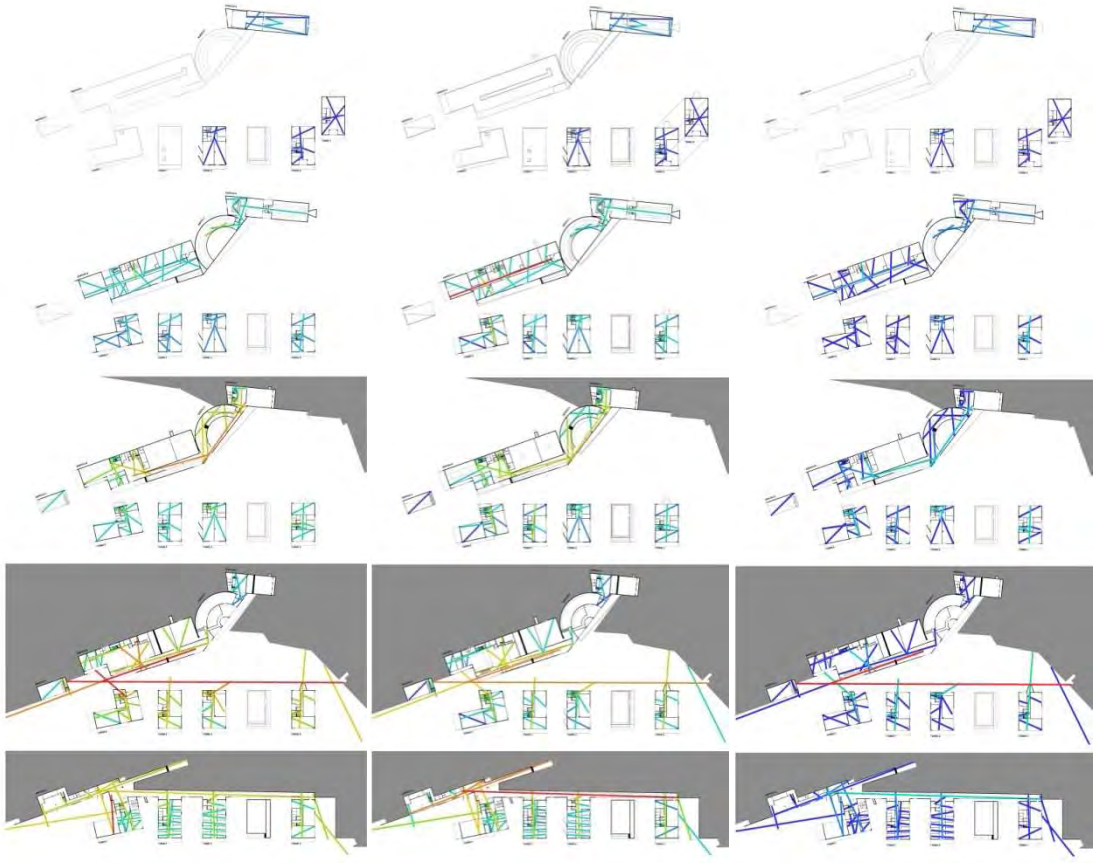


Figure 14. FAUP's axial analysis. From left to right: global integration (Rn), local integration (R3) and choice.

The relation between FAUP's parts and wholes is investigated through the property of intelligibility (the correlation between global and local axial integration values).

The scattergram and the axial analysis allows for the evaluation of the intelligibility level of FAUP's system. The building is globally less intelligible than in its parts, with a relatively low correlation between global and local integration values (R^2 = 0,4748) (figure 15).

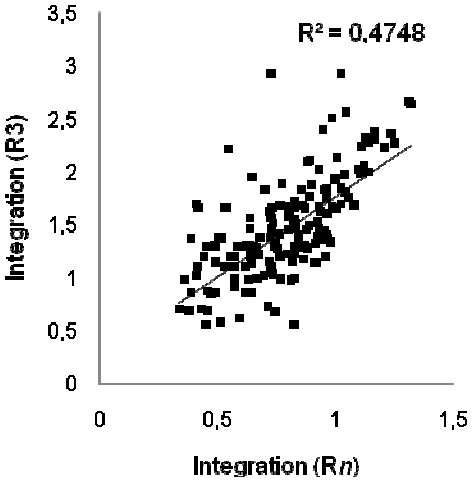


Figure 15. FAUP's intelligibility scattergram.

There is a set of intelligible spaces that identifies the building's main circulation structure – the architectural 'promenade' (gallery and hall in the ground level, bar, reception hall in the first level, ramps and museum area). This result corresponds to the obvious legibility of this part of the building proved by its real spatial experience (R^2 = 0,6615) (figure 16).

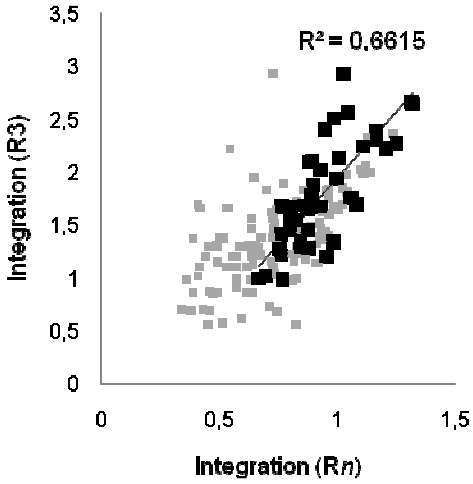


Figure 16. FAUP's intelligibility scattergram (partial). Intelligibility level of architectural promenade.

This effect spreads throughout the north wing, although with lower global integration values. The north wing reveals a system highly intelligible, becoming progressively more segregated as we move away from the central circulation system (figure 17).

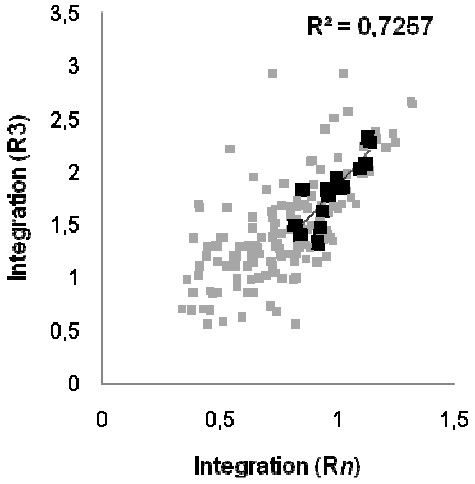


Figure 17. FAUP's intelligibility scattergram (partial). Intelligibility level of architectural promenade.

On the other hand, the towers, together or individually, present low intelligibility. This happens due to the towers' segregation level and to their vertical circulation system. Their confined spatial organization (close staircase and narrow corridors) and vertical development, implies short visual axis, not providing a global image of their structure (figure 18).

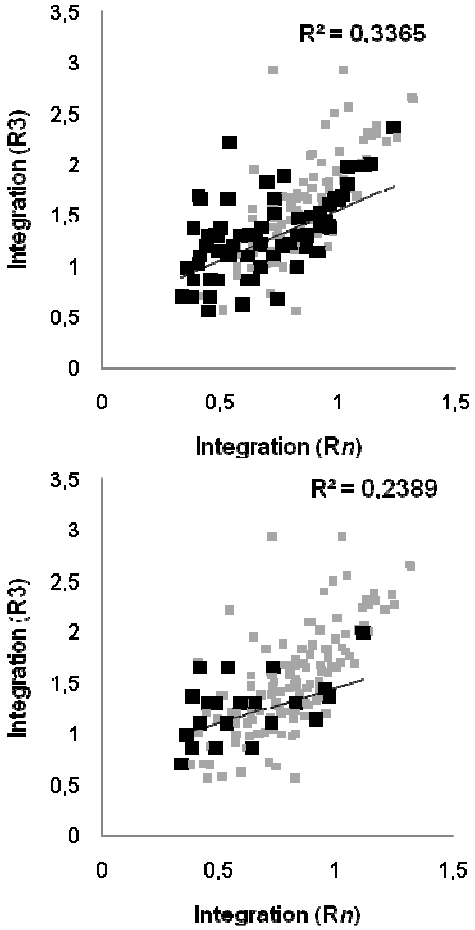


Figure 18. FAUP's intelligibility scattergram (partial). Intelligibility level of towers' interior space.

Axial analysis highlighted more aspects of the deep structure of FAUP's building as its movement and visual accessibility and intelligibility. Again, it was possible to recognise structural and organizational differences between north wing and the towers.

4.2 Movement observations

4.2.1 People following

By tracing people routes, we could understand better the complex nature of FAUP's movement system, mainly what are the main movement flows arriving and moving inside FAUP´s building (figure 19).

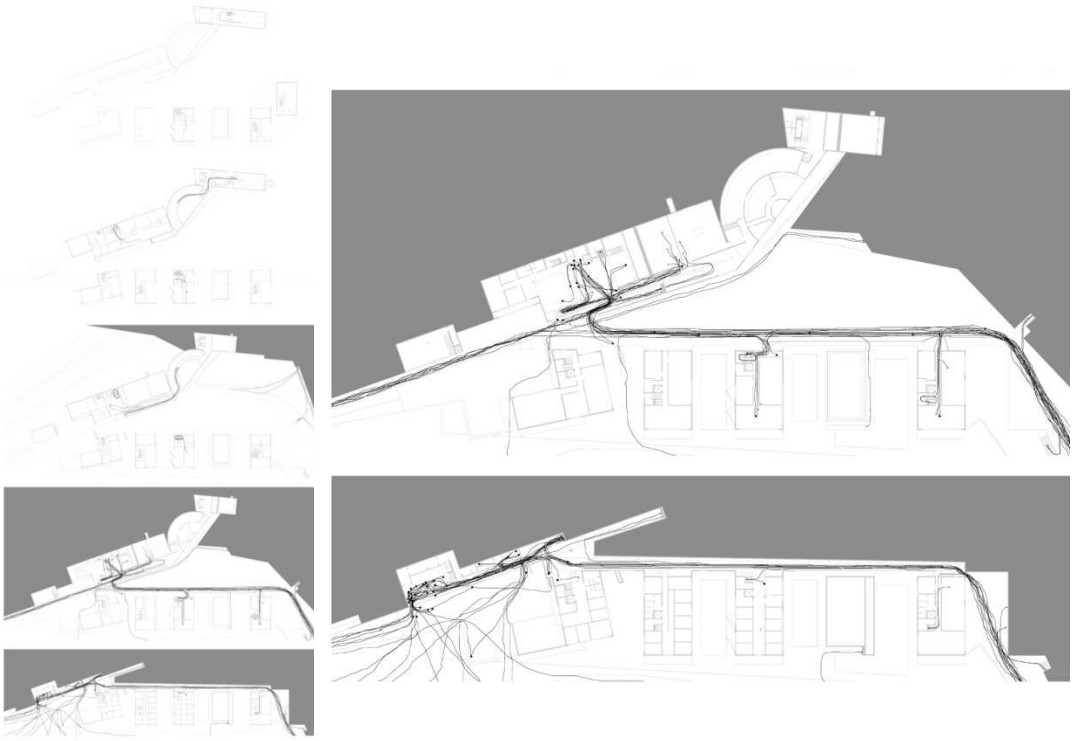


Figure 19. People traces in FAUP (ground and first floors in detail).

Figure 19 shows a sample of the possible routes people choose to enter FAUP's building. This fact confirms one of the most noticeable aspects of the building arrangement in the area: the multiple possibilities of routes and entrances in its indoor spaces. From the east there are two possible ways: through the gallery's east entrance, in the ground level or through the entrance of the reception hall in the first level, crossing the central patio. On the other hand, from the west, people can enter directly in the bar and in the hall in the ground level or go all over the ramp which access the same hall in the first level.

The strong use of the east entrance of the building, apparently with a secondary role, reveals an emergent and very interesting effect of the overall circulation system that was not expected (the questionnaires showed this preference as well, with 64% of the inquired population answering the

east entrance). This happens due to the fact that this door gives direct access to one of the most important and central circulation spaces of the system – the gallery.

Thus, the most concentrated pedestrian movement flows (bar, hall and gallery in the ground floor, central patio's path close to towers' entrances and reception spaces) corresponds clearly to the most global and local integrated axis of the building (figure 20). The more common used stop spaces (bar and reception) are, in convex terms, well integrated as well.

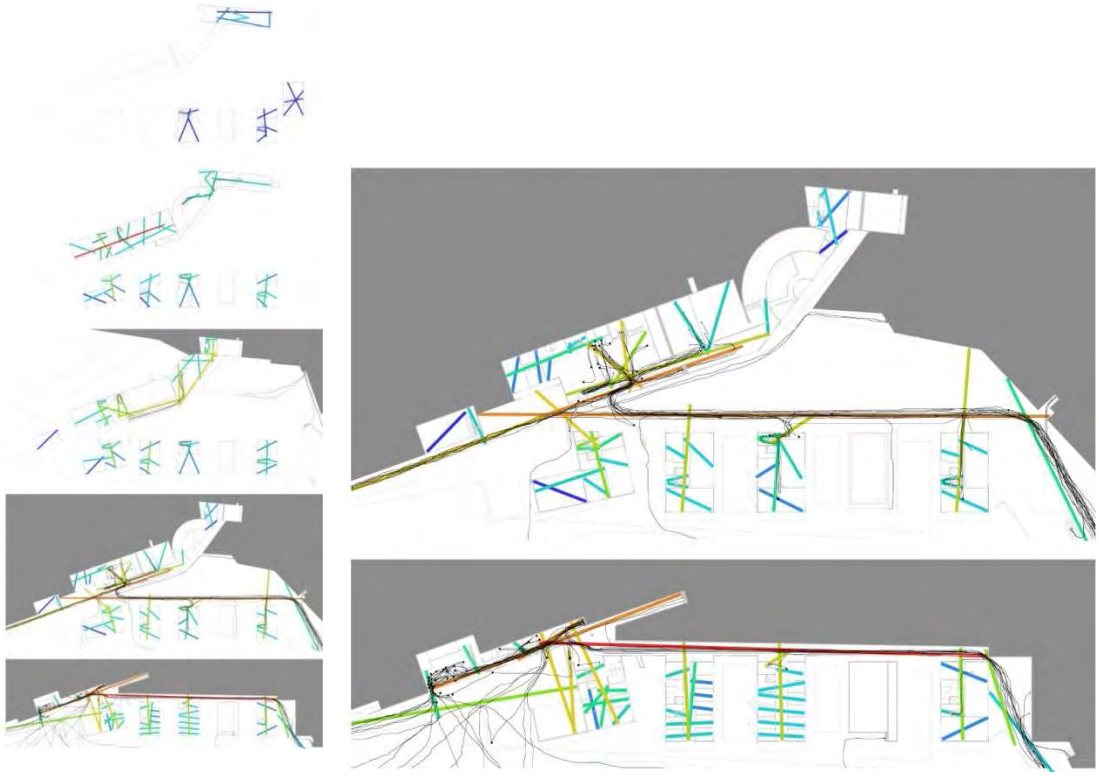


Figure 20. FAUP's axial analysis – Local integration(R3) and traces.

4.2.2 Movement flows (gate counts)

Once more, the syntactic results were corroborated when counting flows of people across the building. Figure 21 shows a colour-coded graph of the observed flows of people, ranging between flows of 270 – 315 people per hour (red) and 0 – 45 people per hour (dark-blue). The gates located in the main circulation system we have identified in syntactic analysis (bar, hall and gallery in the ground floor, reception areas in the first floor) have high flows of pedestrians. Surprisingly, and despite the fact that the towers are the most segregated spaces in the system, gates located in the middle floors of the towers have the highest values of flows (figure 22; table 1).

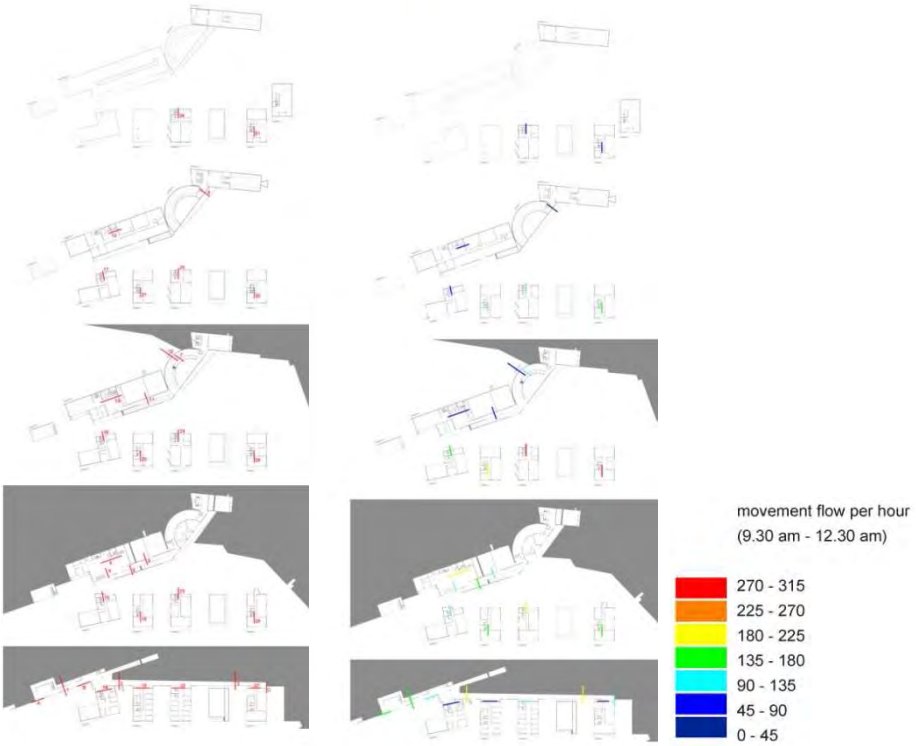


Figure 21. Gate counts: location of the gates (left) and count of flows colour-coded (right).

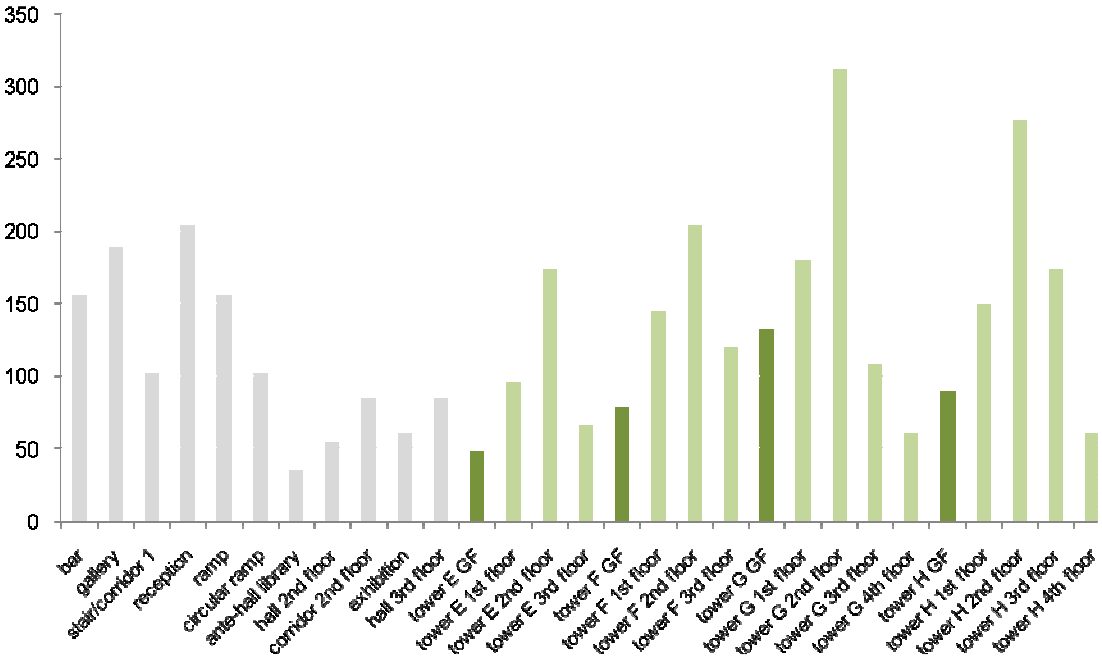


Figure 22. Gate counts.

Table 1. Gate counts

		students	professors	pax/h (people/hour)
	entrance A	10	1,5	138
	entrance B	9	0,5	114
	entrance C	9	0,5	114
bar	**1**	9,5	3,5	156
gallery	**2+3**	15,75	0	189
stair/corridor 1	**4+9**	7,25	1,25	102
reception	**5**	13	4	204
ramp	**6**	10	3	156
circular ramp	**7**	8,5	0	102
ante-hall library	**8**	2	1	36
hall 2nd floor	**10**	4,5	0	54
corridor 2nd floor	**11**	5	2	84
exhibition	**12**	5	0	60
hall 3rd floor	**13**	5,5	1,5	84
tower E GF	**14**	3,5	0,5	48
tower E 1st floor	**15**	7	1	96
tower E 2nd floor	**16**	12	2,5	174
tower E 3rd floor	**17**	4	1,5	66
tower F GF	**18**	4,5	2	78
tower F 1st floor	**19**	12	0	144
tower F 2nd floor	**20**	15	2	204
tower F 3rd floor	**21**	10	0	120
tower G GF	**22**	11	0	132
tower G 1st floor	**23**	14,5	0,5	180
tower G 2nd floor	**24**	25,5	0,5	312
tower G 3rd floor	**25**	9	0	108
tower G 4th floor	**26**	4	1	60
tower H GF	**27**	7,5	0	90
tower H 1st floor	**28**	12,5	0	150
tower H 2nd floor	**29**	22	1	276
tower H 3rd floor	**30**	14,5	0	174
tower H 4th floor	**31**	5	0	60

system 1 (north wing, bar, gallery, towers' ground floors)

System 2 (towers)

both systems

By associating the gates to the axial lines they cross, we can extract more information about the relation between the movement flows and the building's configuration. In global terms, there is a very low correlation between movement flows and global (R*n*) and local (R3) axial integration values (figure 23). This result was expected because the building, as we have identified, has two distinct and independent movement systems: one includes north wing, cafeteria and gallery and the other the towers.

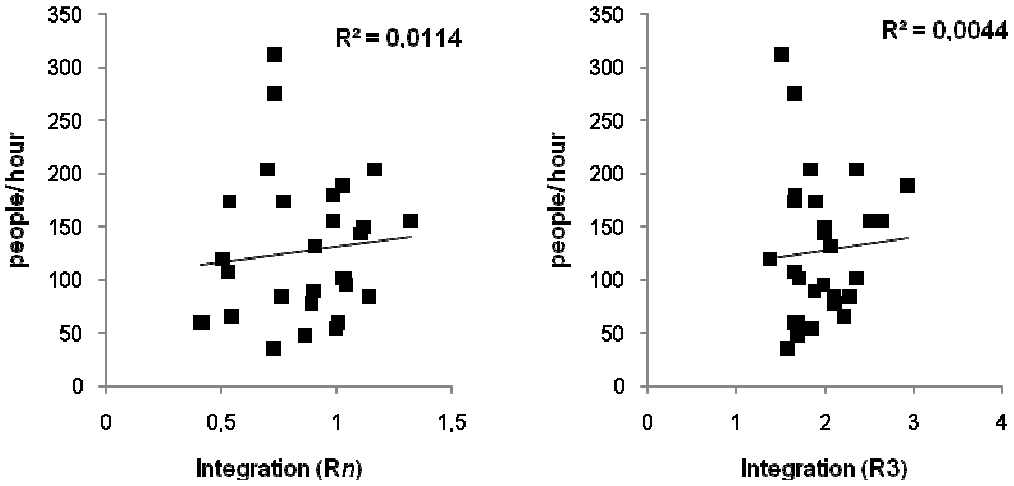


Figure 23. Scattergrams plotting pedestrian movement rates against Integration (R*n*) (left) and Integration (R3) (right).

However, if we select the values relative to the 1st system (north wing, bar and gallery), we notice a significant correlation with local integration values (R^2 = 0,6673) (figure 24). Once again we verify that the correlation is higher at the local level because the building does not work, in terms of circulation system, as a whole.

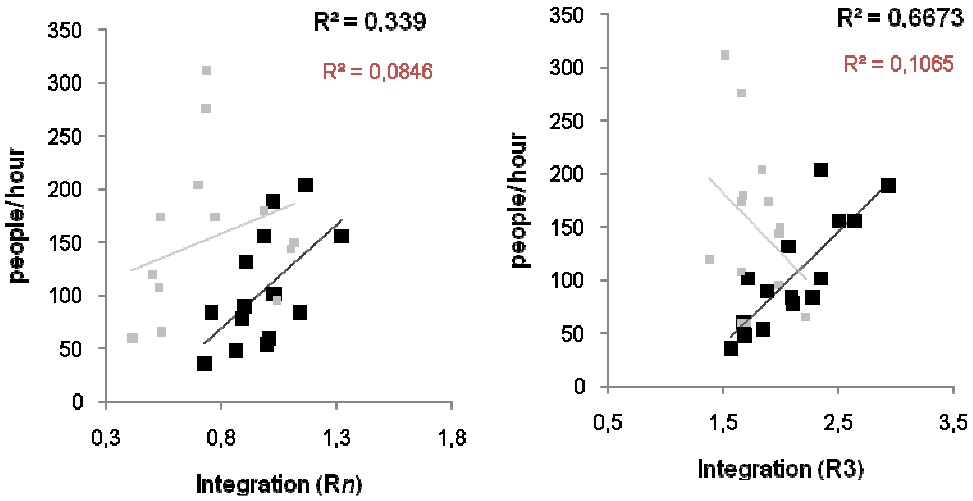


Figure 24. Scattergrams plotting pedestrian movement rates against Integration (R*n*) (above) and Integration (R3) (below) (partial).

In their turn, the towers behave in a different way. As their spatial structure is linear and acyclic (in graph terms, they are 'trees'), the highest values of movement rates are located in the middle floors, merely due to a probabilistic reason. In all origin-destination movements inside towers, the most crossed spaces are the central floors (from 2nd floor up). In this sense, we correlated movement values with "step depth" values, from those floors (figure 25). The correlation is negative (regression line with a negative slope) because spaces with low depth values are the ones with higher movement rates. But it is significant, with an R^2=0,5971.

It is important to highlight that this movement behaviour is due to the fact that users have shown a clear preference to use staircases rather than the lifts, as confirmed in questionnaires (94% use of staircases).

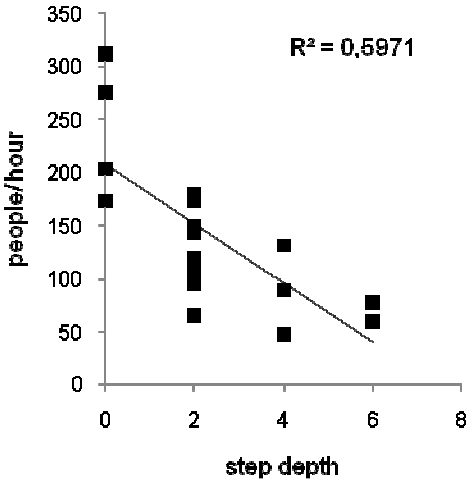


Figure 25. Scattergrams plotting pedestrian movement rates against step depth values from the 2nd floor (partial).

Movement observations data allowed to access the actual flows of people in and outside FAUP's building, and to relate them to our syntactic analysis. Thus, all results were confirmed and emphasized more precisely.

5 Conclusions

Besides the reflection about architectural strategies, programmatic options and contingencies behind the genesis of the building's form, the study involved several methodologies to a better understanding of FAUP's spatial system, including syntactic analysis as well as field observations of FAUP's movement flows. The main target was to understand the configurational impact of those architectural intentions and spatial options on the actual social and functional performance of the building.

The building's shape was influenced by a set of both geographic and topographical aspects and programmatic and pedagogical questions. The triangular area, together with the highway next to its north border and the natural potential of the site, leaded to a decentralized arrangement of the volumes and a spatial organization in "V". The result combines two distinct wings defining a central patio and converging in a west point of the site: the north wing continuous and protective, the south fragmented and open to the landscape. The central patio is in such a way well integrated in the

spatial organization of the building that, albeit exterior, we might consider it as a space of the building itself.

The syntactic analysis revealed the configurational effects of this kind of spatial organization, identifying a deep spatial structure divided into two distinct systems. The north wing presents a complex relational structure with various circulation rings and alternative routes; the towers present a linear and acyclic spatial structure. Both systems are connected either through the main hall in the ground level or, outwardly, through the central patio.

We noticed the high intelligibility and integration values of the main circulation system of the building (cafeteria, hall and gallery in the ground floor and the architectural promenade of the north wing). These spaces guarantee the cohesion of the overall circulation system, where most movement interactions happen. Regarding the strong correlation between pedestrian movement rates and local axial integration in the north wing, cafeteria and gallery, we can now conclude that this is due to the fact that the structure of this subsystem is stronger than the functions it houses. Thus, movement flows according to the accessibility of each axis, i.e., it is the configurational structure of space that induces movement patterns. The probability of encounters and interactions between different origin-destination movements is high, particularly in the most integrated spaces.

The academic spaces inside the towers and the library are the most segregated spaces of the system. However, the towers house the main function of the building, i.e., teaching and learning architecture. That is why that, in spite of their spatial segregation, they show the highest movement and occupancy rates. Moreover, their vertical spatial organization induces a concentration effect of movement flows in the middle floors, which is merely probabilistic, as we have explained before. The staircases, especially in the middle floors, have become the spaces where the greatest movement densities and personal encounters happen, although it seems that they have not been thought to achieve that target, due to their spatial exiguity and lack of architectural plasticity. In spite of all our findings, the ateliers undoubtedly work according to their initial purpose, performing exemplarily the intention of benefiting close and personal relationships between professors and students.

At last, we would like to emphasise the importance that the Architect gave to the relationships with the site and its landscape potentials. In FAUP's building, the concern with spatial composition and architectural and plastic mastery seems to overlap other possible concerns with its users interaction and encounter, that could be created from other ways of organizing the programme. Again, we would like to stress the effects of those architectural intentions and options in terms of their specific configurational properties and resulting space use patterns, stated before. The building behaves in two different manners: one (in the north wing), where movement reflects the spatial configuration and not the programme distribution; another (in the south wing), where spatial configuration plays a secondary role and where the programme distribution dictate space use patterns. The south wing, albeit considerably segregated, happens to have the highest occupancy rates, because it houses the main function in the building: architecture classes. Thus, in spite of being an architectural reference of indisputable relevance, FAUP's building has this central contradiction; it compels its users' to be distant from the whole system, i.e. to be spatially segregated, when using the building main function. So the question is still standing, as it has always been: should

the programme and its relations determine the buildings' form or should architectural form be thought as a programme organizer?

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Permanence and evolution in the hidden city: Reasons for the deceptive interventions towards the 'ilhas' in Porto from 1899 until 1939

Luís Guimarães

Departamento de Urbanistica y Ordenación del Território, Escuela Técnica Superior de Arquitectura de Madrid

lguimaraes@arquitectura.uminho.pt

Phone/fax numbers: 00 351 253 617 482

This paper aims to clarify the reasons for the deceptive interventions towards the 'ilhas' in Porto until 1939 – a specific type of nucleus of proletarian houses placed at the back of the plots, in the inner city, without dignifying conditions to its inhabitants, which was the main housing solution for the working class in Porto in a period going from 1899 until 1939. The long lasting permanence of the ''ilhas', results from the continuous lack of effective alternatives, along with the inertia derived from the legal frame and the state laissez-faire attitude. Without alternatives under private promotion, the public housing initiatives mostly missed either the place or the beneficiaries, if not both, and the few positive solutions to the residents' interests become soon discontinued. We characterize them all while referring to their origins, models of intervention, application in Porto reality and causes of the later discontinuity. An initial brief description of Porto urban evolution clarifies the origin and success of the 'ilhas' model in the city based in its adjustment to the physical support and social stratification.

Keywords: housing; working-class; socio-spatial segregation; tenure; downgrade.

Introduction

The most peculiar working class neighbourhoods of Porto – the 'ilhas' – have their origin in the industrialization breakthrough of Porto, in the second half of the nineteenth century[53] and suppose a remarkable permanence in the city, with a significant contribution to its identity, despite all the interventions and transformation processes they have felt.

The 'ilhas' (See figure 1), in its basic form, are nucleus located, in general, among the expansion areas of the nineteenth century's city, in the typical gothic plot of Porto with twenty five palms (5,5m) large and till 100m long. Normally they are occupied by eight to ten working class houses, of sixteen square meters each and with a single facade. Initially erected in the backyard of the bourgeois houses, or later occupying the whole plot, they were served by a single access and had at most a collective toilette[54].

The city's eighteenth century expansion plan implementation would later allow the arising and proliferation of the 'ilhas' type at the physical support level. Under an extensive lay-out, the subsequent urbanisation with a gothic plot type, privileged a street/plan-of-facade relation favouring the public space composition rather than expressing the house individuality, allowing by absence any construction inside the plot.

Economically, they provided a source of rent to the low bourgeoisie whilst responded to the enormous demand of housing produced by the massive flux of immigrants to the city, along with the low wages policies, during the second industrial revolution. This housing solution expressed, at the

[53] Phenomenon derived from the effects of the second industrial revolution in Porto.
[54] For a deep analysis on the subject consult Teixeira (2001).

urban level, the first clear configuration of social spatial segregation in Porto, continuously reaffirmed in the following decades.

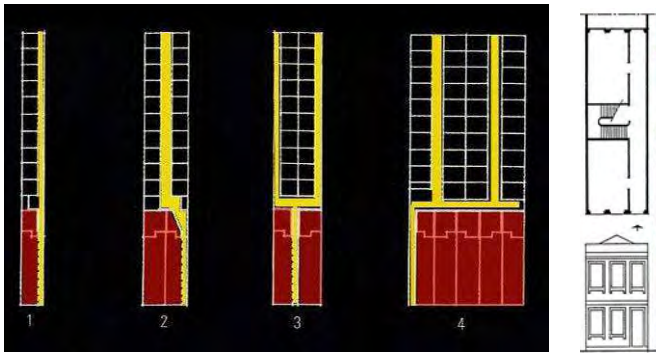


Figure 1. Most common types of 'ilhas' and example of bourgeois house facade and ground floor plan with passage way. Adapted by the author from Teixeira, 1996 (in yellow circulation areas; in red bourgeois houses).

Until the beginning of the twentieth century the 'ilhas' had a continuous, at times exponential, growth (See table 1). According to the existing available data, in the period of analysis[55], the absolute number of 'ilhas' in Porto remained steadily above one thousand[56]. Until the thirties, despite the legal procedures developed in the meanwhile, the promotion of 'ilhas' continued side to side with the low wages policies, and the extensive development of the city, avoiding the arise of tenement buildings or other improved models of working class housing solutions directed to these same layers of the population.

The implemented housing solutions during the first half of the twentieth century, more than actually attempting to solve the problem, represented the possible experimentation and adaptation of international models to Porto reality under the initiative of single figures, public institutions or even the Municipal Administration pressed by the public alarm related with moral and sanitary conditions.

After a bubonic epidemic in 1899, The Commercio do Porto Newspaper held a public subscription out of which would result the first three neighbourhoods under philanthropic initiative, directed for the improvement of the working class living conditions on public soil, and in 1915, already under a republican regime[57], the first four working class colonies were erected via municipal administration initiative. Several municipal regulations, considering the safety, sanitary and legal procedures also took place in the following years.

[55] And through the following period till present day, considering the ultimate purpose of our research.
[56] The inquiry of 1899 by Ricardo Jorge referred 1048 'ilhas' with over 50 000 inhabitants, the inquiry to the 'ilhas' in 1939 referred the existence of 1.152 'ilhas' with a total of 45 243 inhabitants and the 2001 inquiry by the town hall (Câmara Municipal do Porto) identified 1030 'ilhas' with almost 20 000 inhabitants.
[57] The Republic was implemented in Portugal in 1910.

Table 1. Comparative evolution of Porto and ilhas population until 1940

	ILHAS	HOUSES IN 'ILHAS'	ILHAS INHABITANTS	PORTO INHABITANTS
1864	-	-	-	89 349
1885 1890	531	-	19 460	146 739
1899 1900	1048	11 129	50 000	167 955
1909 1911	1200	12 000	50 000	191 890
1920	-	-	-	202 310
1929 1930	1301	-	50 000	232 280
1939 1940	1153	13 000	45 243	258 548

Elaboration by the author over CMP inquiries and INE data

The 'Programa de Casas Económicas', following garden city principles and promoted by central government initiative in 1933[58], arose as the only action applied with reasonable extent, in the period of analysis, though clearly directed to privileged layers of the population pursuing political and speculative interests, that the authoritarian fascist government upheld[59].

Until the beginning of World War Two, a single experiment of collective housing was built, the Duque de Saldanha bloc, in 1939, referring to central Europe' social democrat models, despite the fascist government opposition to such solutions. It contemplates several singularities, such as the right to the place of its residents. The supposed failure of this experiment would later be used to reaffirm the state position and the promotion of a Housing Plan in the suburbs by the municipal administration under a distorted application of the Athens Charts principles. Still, the qualities of the Duque de Saldanha bloc, which remained till present day, allow us to refer to it as a case study amongst other posterior interventions[60].

[58] Law-decree 23035 of 1935. Single family houses by resoluble property.
[59] The Portuguese fascist government was implemented in 1929 following the military dictatorship 1926-1929 and remained till the military *coup d'Etat* of 25th of April of 1974, known as '*the cloves revolution'*.
[60] Such as the SAAL program. For a deeper analysis over it, see Bandeirinha J. A., *O processo SAAL e a arquitectura no 25 de Abril de 74*. Imprensa da Universidade. Coimbra. 2007



Figure 2. São Vítor area, one of the first and most dense nucleuses of 'ilhas'**.**

1 - Conventional urban fabric of 'ilhas'; 2 – 'ilhas' adapted to extremely steep area; 3 – Bairro Herculano – 'ilha' promoted by 'capitalist', almost occupying the whole interior of block; 4 – Bloco Duque de Saldanha

Elaboration by the author

In face of such facts and without alternatives under private promotion this work aims to demonstrate that, in the period of analysis:

- the developed housing initiatives mostly missed either the place or the beneficiaries, if not both, and the few positive solutions to the residents' interests were soon discontinued.

In order to accomplish this aim, we will analyse the urban development of Porto and the evolution of its spatial structure and social change process, under the singularity of the Portuguese political evolution. This particular care lays over the 'ilhas' crucial relations with its physical support, clearly determined by Porto's urban evolution, in our judgement, decisive to a full comprehension of its origin and permanence. Throughout this analysis, we will expose the evidences that support the continuous veracity of our referred arguments.

The structure of this paper develops under chronological order, following the urban evolution of Porto, focusing on the elements related to the residential patterns, and the 'ilhas', particularly after the city's expansion plan during the enlightenment, in the second half of the eighteenth century, until Porto situation at the beginning of World War II. Simultaneously we carry out a national and international contextualization of the diverse main factors of reference to these same residential spatial patterns, and particularly the housing solutions for the lower classes, such as: the existing legal frame, the social-economical outline, the political situation and the most relevant public and private initiatives.

What we are interested in bringing to evidence is how a particular context and socio-political situation continuously denied the possibility to develop alternative models of housing, even those which, at a certain moment, presented specific opportunities for the evolution of this context, as to the

city in general. This promoted, in the end, the permanence of the 'ilhas' as the almost single alternative to the exclusion.

1. Porto's urban evolution background.

Porto territory is located at the end of the river Douro standing at its right margin while facing the Atlantic Ocean, in the Northwest of the Iberian Peninsula. The topography of this territory gently descends to the sea in its west side, while faces an abrupt irregular profile, steadily carved on the *granite of Porto* soil by the Douro River, at its south side, producing a highly dramatic landscape.

During the Late Middle Ages and over the sixteenth century the spatial pattern of Porto expressed a concentrated city without significant spatial segregation[61]. Out of walls, specific activities with fluvial or maritime character such as fishing and naval construction also promoted the development of riverside settlements. Without water contact, small settlements, eventually developing some suburban activities[62], would arise, linked to the pre-existing rural pathways that structured the territory and can still be perceived in significant extent at present day. Among them in the immediate surroundings of Porto, four roadways, had particular importance fixing these suburbs agglomerations:

- The road to Valongo and Penafiel, extending to east, through Santo Ildefonso;
- The road to Guimarães, extending to north-east through the Bonjardim area;
- The road to Braga, pulling off from Porta dos Olivais, with North direction;
- The road to Póvoa, pulling off from the same Door in northwest direction through the present street of Cedofeita; both these two streets began in Campo do Oival;

The bourgeoisie house type would have a fundamental contribution to the urban fabric of the sixteenth hundred: the narrow front house, now totally erected in stone with two, three or rarely four floors, inserted in a narrow plot with a row association along the road – as it would later happen to the 'ilhas' plots. This solution allowed a good adaptation to the hard topography, even if placed in steep ground. The façade to the street would be individually identified, having a continuous balcony with doors opening to it usually located at the laterals. The ground floor, which generally had three openings, was systematically destined to a shop or store. One of the lateral doors would give access to a stair serving the upper floors. The central staircase with a spiral stair was lightened through a skylight, and articulated with the first stair, around the staircase two alcoves, benefiting of its natural light, before the main rooms facing the front and back façade[63].

According to the geographer D. Luis Caetano de Lima quoted by Ricardo Jorge[64], the population of Porto shows by then a remarkable growth, and from the beginning of the century till 1732 almost doubles it population from 18.800 to 30.024 souls. A process related, with the arrival of new foreign people, mainly British, and immigrants from rural areas, attracted mainly by the growth of the port activities. The bourgeoisie, at that time mostly composed by traders, started to build their

[61] PEREIRA DE OLIVEIRA, O Espaço Urbano do Porto. Condições Naturais e Desenvolvimento. Coimbra. 1973;
[62] Idem, ibidem;
[63] FERRÃO, Projecto e transformação urbana do Porto na época dos Almadas, 1758-1813:. U. Porto. Porto. 1985; pp. 152,153
[64] JORGE, Demografia e Higiene na Cidade do Porto. CMP. Porto. 1899.

houses outside the wall, normally in one of the referred four main axis of connection with the surrounding territory.

The first half of the eighteenth century coincides with the main flux of gold coming from Brazil as with the signature of the Treaty of Methuen (1703) which would promote a major growth of Port wine exportation to the British islands.

2. Expansion under the enlightened despotism

In 1758, the Marquees of Pombal[65] created the Junta das Obras Públicas of Porto, a management council, successively directed by the Almadas governors from 1758 until 1804[66].. This new organ appears related with two different causes: if in one hand it represents the local consequence of a new state type of organisation, lead by Pombal; on the other hand it occurs in the sequence of the response to Lisbon's 1755 earthquake, which destroyed the Capital of the Empire and significantly affected its economy.

Under João de Almada e Melo city management a new urban conception was developed poured into the expansion plan of Porto, with a rational approach aiming 'order and property'. The city's traditional autonomy punctuated by frequent riots that the archaic medieval urban fabric favoured, were not admissible for the new state model of organization, aside with the more relevant promotion of the future commercial city. Its major transformations of the old burgh, without Lisbon's obvious justification, would have a clear ideological basis and stylistic option[67] that the progressive elite encouraged and the enlightened view of the Junta de Obras Publicas supported. The fact that the urban works tended to promote the city's future development, rather than respond to its actual needs, holds this argument.

The outsized ambition of such ideal plan, without the pragmatic requirements of the capital, would confront enormous opposition and difficulties when facing practical obstacles, such as expropriation measures and financial resources[68]. Nevertheless from 1769 on, the use of the strengthened legislation, produced to reconstruct Lisbon's downtown in 1758, became permitted to apply in Porto, giving a definitive pullout to the plan[69] (See figure 3).

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[65] Pombal by then Secretary of State as an enlightened despotic ruler (1750-1777) had previously served the country has ambassador in the United Kingdom (1738-45) and Vienna (1745-49). He looked at the first as model of progress to be followed, according to his will to modernize and bring Portugal closer to the more developed northern European countries.

[66] João de Almada was nominated by Pombal to be the head office of the Junta de Obras Públicas do Porto in 1760. His son Francisco de Almada e Mendonça later occupied the same position from 1784 untill 1804.

[67] FERRÃO, Projecto e transformação urbana do Porto na época dos Almadas, 1758-1813:. U. Porto. Porto. 1985; pp. 188

[68] Most of the land out of walls belonged to ecclesiastic proprietors that had given its exploitation rights by emphyteusis contracts, whose beneficiaries claimed extraordinary compensations for its lost. FERRÃO, 1985, p. 190

[69] FERRÃO, Projecto e transformação urbana do Porto na época dos Almadas, 1758-1813:. U. Porto. Porto. 1985, p. 191.



Figure 3. Almada's extension plan over George Balck's Plan 1803**.** Source: Ferrão, 1985.

In the first phase, launched in 1761, an extension area would be structured by an exterior radial axis, defined by the new Almada' Street running between the street to Braga and the Street to Guimarães while absorbing in its pullout a pre-existing urban assembly around Praça Nova das Hortas.

A second phase, under a plan approved two years later would demand a superior effort once it reinforced the same axis connecting, to the city's trade centre at the riverside. The opening of the new street of São João[70] through the medieval urban fabric to Largo de São Domingos, half the way up, allowed an easy connection to Largo de Lóios and Rua do Almada, through the Rua das Flores, by then the city's most flourishing commercial street.

After 1774, three new axes, with a new and the adjustment of two pre-existing streets, would definitively implement a radial type of urban structure into the plan.

Finally a fourth phase, uphold a unifying idea of the city, promoting the wall demolishing in the last twenty years of the century. Two new streets arose over its northern limit unifying the four previously referred axes as the inner city with the new extension under the same language while in the riverfront a new contact became also possible.

In opposition to the static ideal plan of Lisbon's Downtown, this pre-existence attending plan, considered both the city's peculiar topography, as its ancient and more recent urban developments, even if, according to the same enlightened policies, socio-political premises and planning and

[70] Despite the necessary effort to erect it, it was concluded in 1768, four years after the Rua do Almada. Besides these two streets with a major role in the plan, by 1775-80 most of the referred works were still undergoing or being concluded.

execution methodologies used in the Capital[71]. As Ferrão claims, we consider that its urban morphological and typological conception, based in sectorial and technical positioning expressed a clear enlightened praxis[72]. Such facts allowed the erection of a modern commercial city, under the implementation of rational ideals that would be the basis for its late 19th century development during the city industrialization breakthrough.

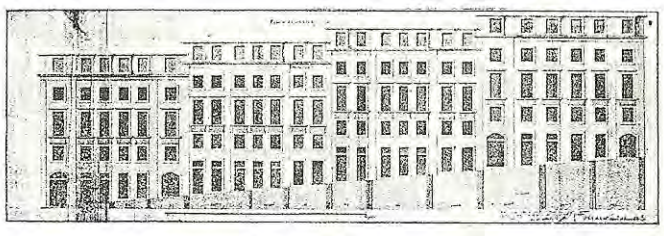


Figure 4. Façade of Rua dos Clérigos. Source: Ferrão, 1985.

The public space definition received particular attention, by erecting large, rectilinear streets with soft sloping, normally having associated carefully drawn plans of the façades (See figure 4), composed as a unifying element, rather than evidencing the isolated building. These areas have remained until present day as a paradigm of coherence and equilibrium in the relation street-erected building – while also attended aspects such as light, hygiene and sanitary conditions. That principle, ensuring a significant importance to the building façade and a minor to its plant, would remain in the municipal procedures leading to a perverse consequence in the late nineteenth century bourgeois houses, whilst contributed to the city hall's neglect of the 'ilhas'' dissemination by not surveying its construction.

The radial structure of this plan, scarcely completed with transversal crosses, except in its pullout, implied the left over of large open areas between its centripetal axes, while these had their urban vitality ensured due to their connection role with surrounding settlements or urban nuclei.

During this period, Porto still kept its trade centred in S. Nicolau, heart of a wealthy merchant city[73], based in the trade of Port wine and colonial products, namely Brazilian sugar, that had no special locative differentiation in its spatial patterns.

While in Lisbon reconstruction or Vila Real de Santo António[74] erection were developed new housing typologies, such has tenement buildings and working class houses, in Porto, as previously referred, despite the new formal language, articulating the dwelling to the public space scale and order configuration, the interior organization remained the same. The most common houses were based in the traditional types usually having commerce or services in the ground floor with the rest

[71] FERRÃO, Projecto e transformação urbana do Porto na época dos Almadas, 1758-1813:. U. Porto. Porto. 1985, p. 204, 205.
[72] This urban action under a precise socio-economic context favouring trade under enlightened principles of order and collective needs rather than individual interests, became understandably known as the Port Wine urbanism
[73] Despite the fact that Porto would be the Portuguese major industrial city in the break of the nineteenth century, its industrial development was rather weak.
[74] A new town erected in Algarve under Pombal initiative, in 1775, following the creation of the Companhia Geral das Reais Pescarias do Algarve aiming to strengthen the fishing industry.

destined to single-family housing[75]. Considering the construction elements and technologies, standardization followed Lisbon's procedure, granting a desired uniformity to the architectural elements.

Whilst the household proportionally diminished with the growth of a proprietor class living off the rents, the population continuous increase, particularly felt in the extension areas, also led to the vertical growth of the houses, in the inner walls areas, and its later over occupation.

The first signs of a suburbanization process, continuously reaffirmed in the following centuries, were now observable by the settlement of new upper class houses, mainly in the west area towards the seaside, usually fenced, with good air, water and shadow, and magnificent views over the river or the ocean. The British community headed this process followed by some wealthy Portuguese merchants or well-succeeded immigrants returning from Brazil[76].

3. Liberalism and the Industrialization outset

After an extended period of stagnation that the city faced with the French invasions (1807-1813) and the Civil war (1932-34), resulting inclusively in a lost of population, it would face during the second half of the nineteenth century a flourish era of growth and expansion.

With the "Regeneração"[77] a new arising bourgeoisie, enriched with church possessions of the extinguish religious orders, and benefiting from the city wealth, related with the Port wine trade, would assume a central role in its urban and industrial development. In this process the formation of different layers of the bourgeois class, between traders, industrial entrepreneurs, proprietors, and small commercial managers led to the lost of its traditional egalitarianism.

The period reproduces the general industrial growth process and agriculture decline of other European nations, attracting numerous rural populations to the city in search of work. From 1838 until 1864 the city's population faces a growth of 46%, reaching 86.761 inhabitants that year. Number that by the turn of the century would already been doubled up to 167.955[78].

With the inclusion of rural parishes into the urban area of Porto, for fiscal reasons, and even without them, just by the peripheral areas of the existing ones, Porto had, nevertheless, a very low density in contrast with other European cities. Fact easily understandable if one acknowledges that those cities only start demolishing their walls in the third quarter of the nineteenth century. The British cities constituted an exception, being located in an island had no need for them. Porto did so by the end of the eighteenth century with the result of the necessary available territory for an extensive expansion that the Almada's plan had previously structured.

After the old town over occupation, which laid to a medium class movement towards a urbanization ring around the centre, the 'ilhas' rapidly emerged as the general housing solution to solve the residential problem of this people (see Figure 5).

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[75] FERRÃO. Projecto e transformação urbana do Porto na época dos Almadas, 1758-1813. FAUP. Porto. 1985. p. 219

[76] PEREIRA DE OLIVEIRA, O Espaço Urbano do Porto. Condições Naturais e Desenvolvimento. IAC. Coimbra.1973

[77] Name given to the period of Constitutional Monarchy following the military insurrection of the 1st of May, 1951, which aimed to definitely institute the Liberal principles, established in the Constitutional Chart of 1826. It promoted the country's economic development and modernization having heavy fiscal measures associated.

[78] A.A.V.V. A Cidade do Porto Súmula Estatística 1864-1968. INE. Lisbon. 1971

In half a century, Porto completely changed from a concentrated spatial growth with reduced social and functional differentiation of the space to an expansion area with an extended growth with distinct levels of social and functional differentiation: The inside outside of the blocks, and the east/west distribution concerning the social distribution of the residential space. A new centre arose around the Praça Nova area, later attracting the financial district to it. The upper cross of the new bridge Luís I, and the arrival of S. Bento Train Station, reinforced this new centrality. The medium and large industries, self disposed in a second ring, around this area with better connection to the new rail connections, and lower soil prices.

As previously referred, the Almadas's intervention left vast areas to urbanize between its main axes of expansion, which were now being occupied. The industry presence in such areas produced a second downgrade process that expelled the upper classes to new urbanized areas, particularly at the west side and even at the seaside for the British community, which represented the first clear segregated community in Porto. Rich emigrants returning from Brazil and wealthy bourgeois families also participated in this centrifugal movement of the upper class. The low medium class occupied these houses, producing a secession process similar to the one described by E. Burgess in Chicago[79].



Figure 5. Main areas of 'ilhas' over the plan of 1892. Source: Adapted from Teixeira, 1996.

The success of the 'ilhas' model[80] results, first of all, from an extreme economy of means, applied by its promoters, the low medium class, to develop a minimum house solution with a reduced investment. The adjustment to a particular type of allotment[81] that in the first phase would usually be

[79] Of course in Porto it consisted in half circles, undulating according with the extension plan's axes
[80] That was described in the introduction of this work.
[81] The typical gothic plot, used in the Almada´s allotment processes, remained has the standard option for the nineteenth urbanizations, developed under private initiative usually occupying pre-existing rural properties.

in their own backyard, having the minimum cost on construction effort, land and taxes, permitted to offer a low cost housing solution that could easily finance its own reproduction[82].

Being such context typical of the industrial capitalist cities, one could expect to find similar solutions in other western industrialized cities. Nevertheless, a deeper analysis to its particular typology and morphology has only lead us to the most basic models of 'back-to-back' houses in England, that might even have influenced Porto promoters, due to their well known contact with the British reality, although there are not any evidences that prove it; or on the other end, the well documented direct transmission of the 'ilhas' model to the 'cortiços' in Rio de Janeiro[83] and the 'coventillos' in other Latin American cities such as Santiago de Chile.

What is singular in Porto reality is that, this became the most common and almost single housing solution in the inner city to the lower classes and has remained so, till present day. The tenement buildings, reproducing under worse conditions medium class models in most western European countries, or even in Lisbon, were completely out of the range to this population. Later, the slums of 'barracas'[84], that became a large extended phenomenon in Lisbon, did not proliferate, and as a clandestine precarious house solution, were generally extinguished during the nineties of the last century while the 'ilhas' prevailed. In areas like Lapa, S. Vitor, or Fontainhas one can still today find nuclei of 'ilhas' with densities with up to 150 houses by hectare mostly having a single ground floor with a common room, a kitchenette and an alcove on 16sqm.

The sanitary and construction regulations, which until 1899 only required a drawing of the façade, show a clear *laissez-faire* behavior by the municipal administration. The fact that the industrial and commercial bourgeoisie were commonly well represented in the municipal administration organs, safeguarding their own speculative purposes is therefore not surprising.

4. Genesis of the housing issue: from the private towards the public intervention

The problem of providing adequate housing solutions, at reduced prices, to the working classes as a mean to overcome the safety and sanitary problems of the industrialized cities, was largely discussed throughout the whole nineteenth century, but it started to receive, more consistently, concrete answers during its second half, in the most developed countries.

It was naturally in the United kingdom that this problems initially arose and so the place were the first reflection about it was developed, to which later French and Belgium participations are added, as the first countries in continental Europe to meet the industrialization process, soon followed by the surrounding central and northern European countries.

As we will see the emphasis centred at the moral and sanitary levels, issue in fact directly related with the birth of modern urbanism, and not in the right to a dignifying house solution by the workers. Alternative ideological currents to the liberalism, such as the utopian socialism would be the ones getting to that level of discussion. In France, the policy of the second Empire clearly defended the liberal interests, favouring the practice of a free market and avoiding any kind of public assistance

[82] It was common to construct a first group of houses, adding new ones later. This reduced even more the initial investment *in* Teixeira. *Habitação Popular na Cidade Oitocentista. – As ilhas do Porto*. FCG-JNICT. Lisboa. 1996

[83] TEIXEIRA, Manuel. A habitação popular no século XIX – características morfológicas, a transmissão de modelos: as ilhas do Porto e os cortiços do Rio de Janeiro. Análise Social, vol. XXIX (127), 1994 (3º), pp. 555-579.

[84] Slum housing solution, similar to the' bidonville' in France or 'chabolas' in Spain.

to citizens or workers. Therefore, besides exceptional actions that we will refer, this country resisted to such thoughts, assuming them only when they were already current practice in the surrounding neighbours.

In a first phase, resulting from individual action, companies, philanthropists of diverse origins, cooperative leaders and speculators, tried to promote low cost dignifying housing solutions to serve this population, according to their own agenda. In face of their declared incapacity to face the real dimension of the problem, in the frame of the liberal system, continuous claims arose defending the state direct intervention in the subject, through its diverse levels of action and administrative ranks.

The following legislative production, finally favouring the promotion by the state itself, opened way for a new generation of urban projects, endeavouring healthy, safe and pleasurable cities for all, mainly under garden city or collectivist models, at the outbreak of the twentieth century.

In England, as in the other industrialized countries under a capitalist model, the first laws relate with hygienic issues. They dealt mostly with the action over the public space, sewers systems implementation, streets and definition of minimum standards for the construction of new houses in terms of light, airing, dimensioning and hygiene, which by their own did not mean its fulfilment.

"There was no clearly defined housing policy c. 1850 – 1880 and piecemeal legislation aimed to supplement rather supplant the moral reform" [85]. We underline the Artisans and Labourers Dwellings Act (1868), known as Torrens Act, which was the first law actually dedicated to the clearance of slum areas and the Housing of the Working Classes Branch, London City Council (1890). The construction of hygienic houses for workers over the plots of expropriated and demolished *slums* was a practice by which the Housing of the Working Classes Branch became internationally renowned. It was created by the London County Council having in the Boundary Street Estate and Milbank Estate, its first two interventions of clearance and reconstruction. They inaugurated in practice the right to the place policy in the reallocation actions. The Boundary Street Estate (Arnold Circus) occupied the place of the famous London' 'slum' Old Nichol (Benthal Green) – it was approved in 1890 and design around 1893. The Milbank Estate, also developed under the formula of horizontal propriety is an analogous case though posterior (1900-03) located in West London[86].

As previously referred the will to assure general sanitary conditions, together with the moral disquiet, were the major stimulus to guarantee minimum housing conditions for the working class. The cholera epidemic in 1848 had a foremost effect enforcing the Public Health Act of 1848, which congregated efforts to frame the national building regulations. These became generally available by the end of the 1860's though with "definitional problems, erratic local versions, courts challenging municipal regulatory authority, and the continuing problem of enforcement, issues clarified only by a Royal Commission Report in 1871"[87].

In France, the *Loi Melun*, from April 13, 1850, referring to the provision of sanitary conditions to the insalubrious houses quickly felled in disuse leaving the problem abandoned to the private

[85] Rodger, Richard. Housing in Urban Britain 1780-1914. MacMillan. London. 1989. p.49
[86] Castrillo, Maria. Influencias Europeas sobre "La Ley de Casas Baratas" de 1911: el referente de la "Loi des Habitations à Bon Marché" de 1894. Instituto Juan de Herrera . Madrid. 2003, p.19
[87] Rodger, Richard. Housing in Urban Britain 1780-1914. MacMillan. London. 1989. p.49

initiative.[88] During decades both the ruling classes, the proprietor bourgeoisie as the lower classes symmetrically opposed to the state intervention in the housing issue. The first for the maintenance of the sacred right of propriety and free initiative, the latest because from a state in the hands of the bourgeoisie could not come anything but more exploitation and oppression[89].

It is the *Loi Siegfried*, promulgated in 1894, complemented and extended by the *Strauss* project, from April 12, 1906, that established the first main reference of this country in legislative matter, giving a legal frame to a continuous discussion without practical resolution. Siegfried predicted the *comités de patronage*, related to a superior council of the economic houses that became mandatory in 1896. This structure had incumbencies at the social assistance level (economy, mutuality, insurances, retirement, working class gardens, economic houses, baths, etc.) at the sanitary certification of the houses and in the report about the statuary corps of societies for economic houses promotion that wanted to be constituted (previously approved by the minister of Commerce) and the limitation of its profits to a maximum annual amount

The first housing solutions for the working class result from private action with speculative purposes, both in England as in the European mainland. As we have referred the Liberalism was the ruling economic policy in the two powers of that era, as all over Europe in general terms, imposing its *laissez-faire, laissez aller* principle. In face of the general unconsciousness, the slum areas expanded, initially in the British cities and soon in the European, as an unbreakable phenomenon of the industrialization process. Under this set, some promoters, tried to develop low cost housing solutions that, performing the necessary sanitary and comfort conditions, permitted a lucrative payback to the investment.

Sir Titus Salt, created Saltaire, in 1851, developing one of the first housing planning system for the working class. He introduced equipments such as a park and recreation fields at the margins of the Eire River and the channel, washrooms, and public lunchrooms for the elderly. Bournville. (1879) and Port Sunlight (1888) are other examples of similar initiatives by industrial entrepreneurs who promoted solutions that eventually had a positive influence in the houses destined to the working class.

Having an ideal vision of the city, and unable to reform the industrial city, some philantropists developed small residential communities connected with the factory units. Octavia Hill, a London philanthropist became renowned for her work related with the welfare of city workers, giving particular concern to the moral issue. The philanthropists action had a small impact thought they contributed to point out possible models of action.

In France the utopian influence of Charles Fourier, resulted in the construction of a phalanstère by Godin, in Guise[90] (1859). The phalanstère is an organized building designed to integrate urban and rural features living under an autarchic economy.

The English Building Societies, acting in the second half of the century would also become a reference for the co-operative movements.

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[88] MATTA. A habitação Popular. 1909.
[89] Flamand. Loger le peuple. Paris. 1989. p.10
[90] Lewis Mumford. Mumford, Lewis. The City in History. Its Origins, Its Transformations, and Its Prospects. Harcourt, Brace and World. New York. 1961.

"The *Cités ouvrières* of Mulhouse constituted one of the most remarkable housing standards of the French social economy. The support of Napoleon III in 1853, the compliment of Jules Simon in *L'ouvrière*, its presence in the Universal exhibitions of 1867, 1878 and 1889, and the numerous intents of emulation out of the Alsatian township are some of the testimonies of its emblematic condition"[91].

The *Système Mulhouse* consisted in the rent of the house with commitment of sell at a certain pre-determined number of years. This mechanism of household time acquisition was popularised by the Société Mulhousienne des Cités ouvrières and widespread with enthusiasm by the French reformists, which saw in it the certain possibility to convert the workman in proprietor of his house with the single competition of private initiative[92].

In architectural terms the main characteristics of the Mulhouse model settled in its cross plan, aggregating four houses in a single quadrangular volume, exteriorly resembling a larger single family house laterally attached to its neighbours in a row assembly by means of a small bathroom, placed in the exterior for common use of two or four households. Each house had kitchen and living room in the ground floor and probably two rooms in the upper floor.

Later the Garden city model, developed by Ebenezer Howard became a reference for the suburbs conquer endeavouring both the advantages of the town and country living quality without its disadvantages. Hampstead Garden Suburb (1907), by Barry Parker and Sir Raymond Unwin's design, learning from Howard's Letchworth (1903), developed a coherent scheme with large variety of architectural sets, with generous private gardens and large areas of useful public space. This suburb took forward innovations introduced by Olmsted in Riverside, Illinois and Roland Park, Maryland: the superblock, the cul-de-sac, the parkway, and the interior common block, opening way for other innovations.

5. Porto Working Class Housing Solutions in the late 19th century

The 'ilhas' model adjusted relation between offer and demand in Porto reality, became even clearer by the failure of the few speculative attempts to produce better working class neighbourhoods, such as Bairro Herculano (See figure 2) or Bairro do Vilar. Despite the offer of better conditions, such as larger areas, and the inclusion of equipments in the neighbourhood, the necessarily higher rent price associated with it led to a shorter demand of the houses, once the wages of the working class did not allow such improvements. As the small bourgeoisie did not want to be mixed with the working class people, and aimed other housing conditions, this conducted to the bankruptcy of its promoters and subsequent subdivision of the areas and transformations of the equipments to meet the required price conditions[93].

[91] Penot, 1865; Muller, 1879 quoted by Castrillo, Maria. Influencias Europeas sobre "La Ley de Casas Baratas" de 1911: el referente de la "Loi des Habitations à Bon Marché" de 1894. Instituto Juan de Herrera . Madrid. 2003
[92] Castrillo, Maria. Influencias Europeas sobre "La Ley de Casas Baratas" de 1911: el referente de la "Loi des Habitations à Bon Marché" de 1894. Instituto Juan de Herrera . Madrid. 2003
[93] Teixeira. Habitação Popular na Cidade Oitocentista. – As ilhas do Porto. FCG-JNICT. Lisboa. 1996

The solutions developed with other purposes than purely speculative consisted in two basic types, once In Porto there was not any cooperative intervention during this period[94]: firstly, the ones promoted by industrial companies, namely the textile companies, for their workers. Only a few did so, offering low rent prices[95] although they usually consisted in a slight upgrade of the 'ilhas' model, having similar areas in row houses solutions also served by a single access: the neighbourhoods related with Cia. Industrial de Salgueiros, the Fábrica Social da Fontinha, which built the neighbourhood with the same name in 1852; and the Fábrica de Fiacção e Tecidos do Jacinto that built Bairro da Torrinha in 1848[96]. Later another neighbourhood was promoted by Azevedo, Soares & Cia, built in 1921, having 42 houses nearby its factory in Areosa, at the extreme northeast side of Porto[97]. These represent the most significant attempts. As in other countries the same problem of double dependence of the worker towards the employer was felt.

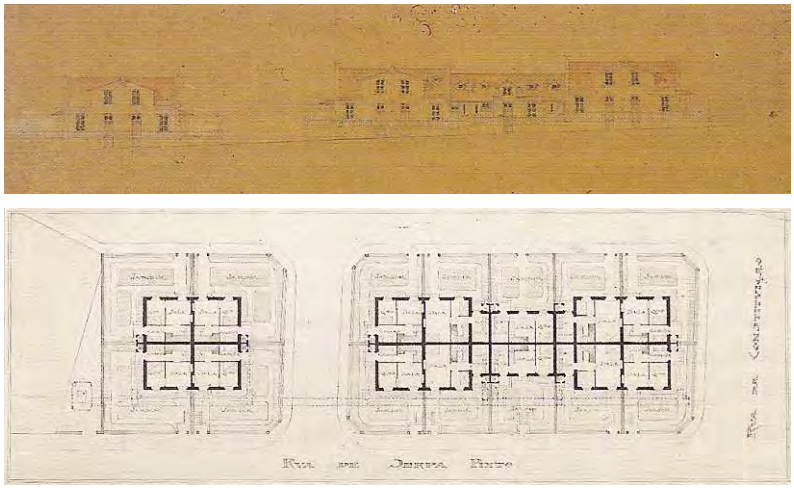
The second type consisted in the philanthropic initiatives. At the transition to the twentieth century, the urban problems were looked in Portugal, as in the main European countries, and particularly in England, mostly at the light of the sanitary and of the moral issues[98]. However, in Portugal little had been done or experimented to solve such problems.

As we have stated, referring to the English case, the epidemics promoted the best propaganda for the providences of measures against the poor living conditions of the working class. In Portugal, still living under the liberal *laissez-faire* market principles, the scarce developed housing solutions for the least privileged had no representation in Porto and the residual legislation, and most important, the surveillance over its respect was irrelevant. In 1899, the city faced a devastating strike of a bubonic epidemic that lead to a sanitary string around it. At the face of such facts and according with the continuous health reports advising towards the imperative need to act over the problem, the newspaper 'O Commercio do Porto' took the initiative, to promote the first philanthropic housing experiments. Together with its sanitary purposes, it intended to demonstrate that it was not impossible to profit with the housing solutions for the least protected and ultimately to moralize the working class and look after the social order[99]. The promoter of the initiative clarified that the neighbourhoods aimed to receive the best-qualified workers, as a prize for their merit rather than as a help for their living conditions[100].

A public subscription, together with the release of municipal soil for the effect, and its support for the construction development, allowed these three neighbourhoods construction[101].

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[94] The first cooperative created in Porto was 'A Nacional Edificadora' in 1908. MATTA. A habitação Popular. 1909. p. 141. The first known Cooperative building constructed in the city was developed by the cooperative ' O Problema da Habitação' created in 1927. From that year until 1960, it built 438 houses. Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001.
[95] Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001.
[96] Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001.
[97] Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 99
[98] As the produced legislation, without practical consequence easily shows.
[99] Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 99
[100] Quotation of several newspaper articles (1901-1903) *in* MATTA.. A habitação Popular. 1909. p. 117
[101] Idem. Ibidem. p.100



Figures 6 and 7. Plan and Façade of the first twelve houses of Monte Pedral Neighbourhood .
Author: Marques da Silva, Source: Cardoso, 1997

Monte Pedral (See figures 6 and 7) constituted the initial experiment, having the construction works of the first fourteen houses started still in 1899. They composed a small block, as a row alignment facing Rua de Serpa Pinto while its smaller front faced Rua da Constituição, a new axis, still under construction, running in the east-west direction and structuring the northern area of the consolidated city, with large areas of 'ilhas' and industrial companies around (See figure 8). Marques da Silva, the most acclaimed architect in Porto by then, drew the project and a plan predicting other 62 houses. The developed proposal is clearly inspired in the famous Mulhouse typology[102], settled in its cross plan, aggregating groups of either four or two houses in a single quadrangular volume, exteriorly resembling a larger single family house, whilst laterally attached to its neighbours in a row assembly. Each house had two storeys with kitchen, working-room and a bedroom in the ground floor, another two rooms in the upper floor with an attic under the roof and a bathroom in the basement[103]. The rent was 1$500 reis a month. A similar extension would be developed for another twelve houses[104]. In 1906, its exploitation was given to the municipality. Most of the houses still exist today with several changes to the initial design, such as the general inclusion of garage, and also has new occupants benefiting of its privileged location, for instance a café and the 'Associação de Farmácias de Portugal'[105].

[102] Marques da Silva, who had already signed several of the most representative buildings in Porto, had done his formational years in the École de Beaux Arts de Paris, keeping a regular contact with some of its main figures, being therefore familiarized with the up-to-date models of intervention.
[103] MATTA. A habitação Popular. 1909. p. 117
[104] Though the houses were developed under municipal initiative *in* Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001
[105] The National Association of Pharmacies.

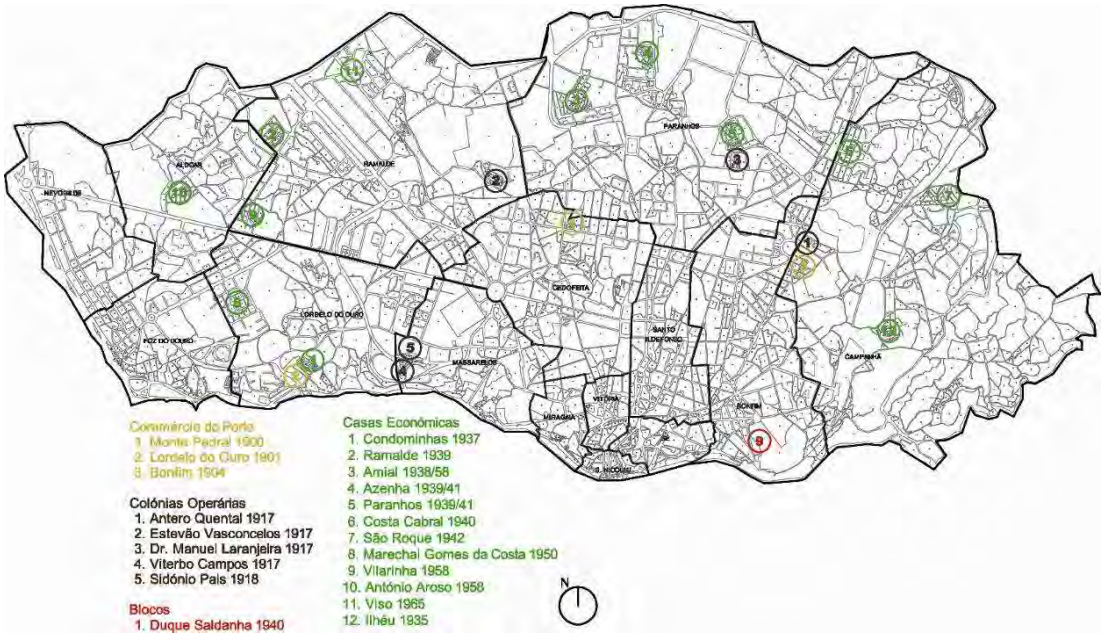


Figure 8. Location of the analysed neighbourhoods . Elaboration by the author.

The Lordelo do Ouro neighbourhood was concluded in 1901, being implanted in the district that gave the name to it. An area out of the consolidate city, aside to an ancient urban fabric, due to its proximity to the riverside, now also holding several industrial companies. If on one side, it was placed in an area without the dignity that the other new axes endorsed, on the other it was aside to a consolidated settlement of working class neighbourhoods. Besides its urban set, the architectural solution also followed a completely different typology, consisting in a single line of 29 terrace row houses, with a rather simpler internal organization and language, clearly a more modest solution despite having a front courtyard as large as the house ground floor. Designed by Manuel Fortunato de Oliveira Motta, a constructor manager, it had a single floor a living room with 10,2sqm, an alcove of 2,90sqm and a kitchen with the same dimension[106]. The rent was 1$500reis a month. The Municipality took care of its exploitation after 1936. and later sold some houses to private proprietors. The modifications and extension of several houses, under tenants or the new proprietors initiative, promoted the assemblage lost of unity. As other similar neighbourhoods it is presently under a significant demand by young couples, as a first house solution, both as proprietors and as tenants, resulting in a gentrification process at the scale of the neighbourhood. Its privileged location, close to the riverside with magnificent view over the river mouth, and low price, related with the present social level of the neighbourhood and the refurbishing cost associated with the typological solution and dimension, combine for such fact. Most of them extended to the basement and the attic.

The Bonfim neighbourhood was the third to be concluded, in 1904, placed at Monte das Antas, above an area of dense consolidated presence of 'ilhas' disposed in row assembly along Rua das Antas and Travessa das Antas. Together with Manuel Fortunato de Oliveira Motta, Joaquim Gaudêncio Rodrigues Pacheco was the engineer responsible for its design that includes 40 houses,

[106] Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 100

assembled in groups of four[107] under diverse variations around the Monte Pedral theme. With a small backyard, they had a family room, kitchen, dinning room, two bedrooms and an exterior toilet. The rent was 1$200reis a month.

These first three neighbourhoods had internal regulation also inspired in the Mulhouse model and other similar philanthropic initiatives[108]. They both previewed future property as assisted rent regimes. Worth principles according to the workers' labourer and social behaviour defined the access to its limited number of houses. The cost associated with its acquisition, or even rent, were clearly above the working class average income resulting in a selection directed to privileged functionaries with higher incomes rather than those who actually needed it the most[109]. Nonetheless, this initiative had the merit to point out: the need to act over the problem; new models of intervention related to it; and their own limitations. They were all located aside to traditional working class living areas, while clearly and proudly exposed to the city perception in opposition to the 'ilhas' condition.

Despite the economy of cost that was associated with collective housing solutions, both in the land as in the construction expenditure, the single family house with a small private garden associated to it, aiming future property of the resident, even if adapted through the explained aggregation formulas, remained as the reference for the philanthropic and later public promoters. This was justified as being the best way to assure the moral values and sanitary safety that the collective housing 'promiscuity' endangered.

A particular aspect, that is suggested in several interventions, laid in the bourgeois intention of providing a single family house to the workers with a small garden associated (that would became an extra source of rent for the promoter). That was the capacity of increasing the workers reproduction of the labour force by means of self-sufficiency production of agricultural goods (mainly vegetables and chickens). This would permit the maintenance and even reduction of the wages. The same goal the Industrial bourgeois had when promoting housing solutions close to their factories. Has the industrial inquiries revealed, the workers' choice of housing location followed other criteria, namely related with cost[110]. The common daily requirement of workforce, at the time, with a continuous change and uncertainty of the working place easily sustains this argument.

During this period, several regulations were implemented aiming sanitary purposes. The Código de Posturas Municipais of 1899 demanded for the first time the licensing of any construction distancing up to five meters to the street[111]. The Regulamento Geral de Saúde, in 1901; the Regulamento de Salubridade das Edificações Urbanas, in 1903; and in Porto, in 1905 a new Código de Posturas Municipais was implemented, which finally required a complete project for any

[107] Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001
[108] To consult the regulation of Bonfim neighbourhood see MATTA. A habitação Popular. 1909. pp. 118-126
[109] According to the opinion expressed by several working class associations in the *Boletim do trabalho industrial nº49, 1910*. Nevertheless the same publication referred the average rent of a house occupied by such workers as being around 1$400 reis and 1$800 reis. Quoted *in* Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. pp. 65-66
[110] As previously referred the 'ilhas' proximity to the industrial areas was related with the downgrade and consequent lower rent price of the houses rather than with proximity to the place of work that interested to the companies for bigger productivity.
[111] Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001

construction or reconstruction executed in the city, that should have a previous positive report by the Delegação Distrital do Conselho de Melhoramentos Sanitários[112].

After this new rules either the 'ilhas' were constructed according with them, or illegally, which ultimately happen, once as we will see no alternatives housing solutions were created for the working class in the following years[113].

6. The Republic

The Republic was implemented in 1910, and the housing issue became even more critical, after a period of strong contestation around it. With the urban medium class in the power a new rent law[114] introduced the mensal payment of the rents, the froze of the rent price, allowing a actualization up to 10% every ten years only, and the conditioning of the removal, satisfying this way the expectations of the medium and low urban classes, its social base of support[115].

Despite the maintenance of regular recommendation by technicians and even local politics to extinguish the 'ilhas' and serve the working class with dignifying housing conditions, little was done with such purpose. Finally, after 1914, the first public housing initiatives were developed in Porto. A group of four Working Class Colonies, promoted by the Municipal Administration.

The Colónia Antero de Quental followed an implantation principle, scale and relative hierarchical position in the urban structure, similar to Monte Pedral neighbourhood, while facing Avenida Fernão Magalhães, a new axis under construction, running in the south-north direction in the east part of the city. The Bonfim neighbourhood was just 100m away from it. It was built from 1914 untill 1917 and most of the houses still exist today without significant changes to the initial solution. It initially had 28 houses composed in groups of four, again under the same typology of Monte Pedral, though only with a ground floor and basement. The houses facing the Avenue have been replaced while the rest present no major changes in a relatively well maintained neighbourhood, denoting a long permanence and social upward movement of its residents.

With the same date of construction, the Colónia Estevão Vasconcelos had 90 houses distributed in several variations of the usual groups of four, also under row assembly. It is located in the north-western area of Porto, next to Carvalhido, another traditional vicinity of 'ilhas'. It was also located in an area under urbanization, adapting a grid scheme to the existing urban design.

Two other neighbourhoods would be constructed from 1916 till 1917: The Colónia Dr. Manuel Laranjeira, with 130 houses, in Salgueiros at the northern limit of the consolidated city, and the Colónia Viterbo Campos with 64 houses in the area of Campo Alegre. They both followed similar agrupation logics, and would have later part of the houses demolished due to infrastructural road works[116].

A fifth neighbourhood would also be constructed, according with the Law Decree 4137 from 24/04/1918 and 4163 from 22/06/1918. These two law-decrees express a significant attention to this

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[112] Referring to health, sanitary and municipal order regulations *in* Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001

[113] Teixeira.

[114] Decree of 12th November, 1910.

[115] Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001

[116] The access to the Arrabida bridge, constructed in 1960 a providing a support for a motorway cross in the west side of Porto, articulated with the future highway connection to Lisbon; and the VCI, an internal ring with highway profile, departing precisely from the same bridge to the northeaster side, concluded in 1995.

subject at this phase. The first predicted over 100 houses to be constructed under private initiative but only 35 were actually developed by municipal enterprise, under the authoritarian rule of the President of the Republic Sidonio Pais that gave the name to it. It is placed aside to Colónia Viterbo Campos, and is presently in a state of bad maintenance, with several abandoned houses under municipal propriety, despite its demand by the private market[117]. These two law decrees will not have a large impact in terms of a national housing policy but will lay the basis for an administrative machine regulating the housing production trigging a systematic public intervention in the housing issue[118].

Despite the over-all quality, above the average urban and architectural standards of the time, even if attending to the lack of associated equipments, of these initiatives, they naturally had a much-reduced impact in the city housing needs. In 1899 an inquiry estimated 50.000 people were living in 'ilhas', has it later happened in 1909 and in 1939 the Town Hall inquiry identifies a slight diminishing to 45 243 people.

At this time, the land proprietors, obstructing the opening of new streets and its subsequent edification, exercised a strong control over the transformation of the property[119]. A large speculative practice was created together with a social segregation in the new residential areas accentuating the housing deficit of low-cost housing solutions, which would contribute to a residential centrifugation to the peripheral municipalities[120], by then also increasing their endogenous productive activity.

In Porto the first sanitary works, constructing public water and sewer systems were started in 1907 but, in 1925 only 25 private buildings were connected to that sewer system, and still in 1933, only 2178 against 25000 not connected[121]. Only when the town hall took the process in hands imposing its costs to the proprietors, during the thirties, things improved though under a strict social and spatial segregation[122].

7. Estado Novo

In 1926 after the implementation of the Estado Novo, the housing issue received a new attention that intended to establish a clear difference with the republican practice. The Law-decree 23052 of 1933, predicts a clear intervention by the state in the construction of economic houses after the once more, failure attempt, in 1928, to promote its construction under private initiative[123].

The 'Casas Económicas' initiative predicted the government promotion with the City Hall, the administrative corporations and the Corporative organisms' collaboration, under a financing given by the same public entities, which envisaged a capital return up to 5% a year, to be amortized in a 20-year period under mensal payments to the Sate Bank[124]. This reveals the state as looking at itself as

[117] Its privileged location, aside to a central university campus, explains the fact that several of the houses transferred to private property are now occupied by offices of architects and psychologists among others.
[118] Baptista. Cidade e Habitação Social. Celta. Oeiras. 1999. pp. 25, 26.
[119] Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001
[120] Idem, Ibidem. (Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001)
[121] Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 11.
[122] Idem, Ibidem. (Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 11.)
[123] Casas Económicas. Edição do Secretariado da Propaganda Nacional, 1943 *in* Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 109, 110.
[124] Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 110.

the necessary promoter, albeit not as performing a charitable action, but a necessarily lucrative one, even if with limited extent.

By the name itself the new regime underlined the opposition it wanted to express, has having a rigorous management of the financial resources, differing to the claimed careless of the republicans[125].

This housing policy was held by three main vectors: the election of the single family house for the conservation of the social and moral order, as expressed in the 1933 Constitution (art.14) based in the British "garden city" model; the defence of the family institution allied to a nativity policy as required by the colonial objectives; and, the establishment of several categories of houses that could allow a clear social hierarchy well noticeable in the urban structure[126].

In 1933, the lowest category (A), in its simplest form (type 1), consisted in a row house solution with a common room that supported the entrance (9,28sqm), a kitchen (8sqm), a bathroom (2,63sqm) and a bedroom (10sqm)[127]. The house had 30sqm. Another two, slightly smaller, bedrooms could be added to obtain larger solutions.

In Porto twelve neighbourhoods of Casas Económicas were built from 1935 until 1965 (see table 2). They all used the resoluble rent system that conceded the access to the property of the house usually after a 25-year period.

Table 2. Casas Económicas built in Porto

Neighbourhood	District	Date attributed	Nb houses	Min. & max rent values
Ilhéu	Campanhã	1935	54	85$00 – 110$00
Condominhas	Lordelo do Ouro	1937	102	90$00 – 110$00
Amial (1st phase)	Paranhos	1938	304	71$00 – 222$00
Azenha	Paranhos	1939	114	69$00 – 246$00
Paranhos	Paranhos	1939	180	85$00 – 318$00
Ramalde	Ramalde	1939	148	85$00 – 277$00
Costa Cabral	Campanhã	1940	240	105$00 – 291$00
S. Roque da Lameira	Campanhã	1942	234	102$00 – 289$00
Gomes da Costa	Lordelo do Ouro	1950	186	390$00 – 811$00
António Aroso	Aldoar	1958	226	310$00 – 1480$00
Vilarinha	Ramalde	1958	202	310$00 – 1480$00
Amial (2nd phase)	Paranhos	1958	94	310$00 – 1330$00
Viso[128]	Ramalde	1965	294	220$0 – 1520$00
Total	_	1935-1965	2378	--

Source: adapted from Gross. *O Alojamento Social Sob O Fascismo*. pp. 163, 178-182

[125] Baptista. Cidade e Habitação Social. Celta. Oeiras. 1999. p.27.
[126] Matos. A Habitação no Grande Porto. PhD dissertation. FLUP. Porto. 2001
[127] According to figure presented *in* Baptista. Cidade e Habitação Social. Celta. Oeiras. 1999. p189.
[128] This neighbourhood was composed by collective housing blocks according to the housing policy developed in meanwhile.

Two main phases of promotion are discernible. The initial one is inscribed in our period of analysis, dating from 1933 until 1942, that laid to the construction of eight neighbourhoods with 1376 houses mostly erected in the northeast area of the city developing the lowest categories of houses. The second phase, already after the Second World War, lead to 1002 new houses, mostly in the western districts and clearly directed for upper categories of beneficiaries, as the rent values show (See Table 3). They all visibly attended to the enounced social stratification principles according to its location (See Figure 4), which was for the whole group of interventions clearly peripheral to the consolidated city, occupying rural areas of five outer peripheral districts surrounding the inner periphery districts while supporting the future urbanization around it, with the clear promotion of a social-spatial segregation process.

Another procedure, took place. Two neighbourhoods, those closer to the inner city, were positioned aside to the two existing most peripheral housing neighbourhoods. The Condominhas, aside to the Lordelo neighbourhood, and Paranhos aside to the Colónia Dr. Manuel Laranjeira. Certainly, the availability of public soil, and the economy of infrastructures contributed to it, but it helped establishing a second spatial segregation process, under development at this time and deeply explored in the next phases of social housing[129], namely through the Plano de Melhoramentos, from 1956 until 1966.

Privileged public or private functionaries coming from the regime' social base of support became the main beneficiaries of these houses. They were nevertheless, submitted to a strong surveillance system easily incurring in the full lost of right to the house use in case of delay of the mensal payment or 'improper' behaviour[130].

Table 3. Distribution of houses in 'ilhas' according to rent price by the 1939 inquiry

Percentage	Min. & max rent values
5,8%	0$00
34,7%	0$00 – 30$00
27,1%	31$00 – 50$00
19,8%	51$00 – 70$00
10,7%	71$00 – 90$00
3,1%	91$00 – 120$00
0,8%	121$00 – 201$00

Source: adapted from Gross. *O Alojamento Social Sob O Fascismo*. pp. 185

[129] Each of the twelve neighbourhoods would later anchor one or more future social housing interventions, leading to the definitive establishment of the referred segregation principles, besides suffering the same peripheral location and lack of services and equipments.
[130] Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 110.

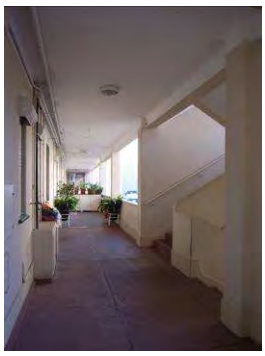
In 1939 a new inquiry to the housing conditions of the 'ilhas' was developed by municipal services. The spatial distribution of the 'ilhas' is confirmed to be mainly located in the inner-periphery of Porto, particularly in its northern and eastern sides, the traditional area of the industry location.

The inquiry also reveals that in 1939, the rent price of 85.4% of the houses in 'ilhas' was below the minimum price of a house with a single room, category A (the lowest), available that same year in Bairro da Azenha. Fact that suggests the impossibility of these layers of the population to acceded to these house solutions, which would also imply the transference to a peripheral area of the city loosing their, by then well, rooted neighbourhood relations in a central location while increasing their motion effort.

Besides the confirmation of the outrageous dimension of the problem, the inquiry confirms that little and been done to deal with it. Out of 13597 houses, only 857 were connected to the sewer system[131]. The Municipality estimated that 3700 could have sanitary improvements while the remain should be demolished. A sanitary plan was developed[132] predicting radical action with complete demolishing, or only demolish of the third, sixth and ninth house of each 'ilha', leaving the remaining as two-front houses, improving their air and light exposure, whilst diminishing the density and augmenting the open spaces[133]. The idea hardly left the paper[134] with counterproductive effects on the intervened houses due to worse thermal conditions caused by the area increase of external walls.

The plan also predicted new housing for the affected residents, which also did not proceed. Nevertheless, in 1939, a surprising new solution is developed against all the previous experiments and all principles defended by the fascist regime. For the first time a collective block is developed as social housing solution, and instead of the continuous tendency to build in peripheral areas it is erected aside to the old Town in São Vítor, considered the worst area of 'ilhas' in the city. In the beginning it was presented, as a temporary housing solution for the families of demolished 'ilhas' while expecting for the definitive reallocation, this fact might have justify its construction.





Figures 9 and 10. Bloco Duque de Saldanha**.** Photographs by the author, 2008.

The Bloco Duque de Saldanha (see figures 2, 9 and 10) followed ideas suggested in the diverse studies developed by the municipal technicians and even supported by some local politicians.

[131] Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 185.
[132] 'Plano de Salubrização das Ilhas'
[133] Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 185.
[134] The Plan predicted that the proprietors should be responsible for the demolishing but only if they agreed with then, avoiding any type of direct confront with them. Gross. O Alojamento Social Sob O Fascismo. Porto. Afrontamento. 1978. p. 186.

Its design, by an unknown author, expresses solutions tested in relatively recent international models, applied by the regime as promiscuous and dangerous for the social and moral order, namely the by then renown Red Vienna experiments[135]. Typologically and morphologically it also recalls the Spangen Block of Brinkman in Rotterdam from 1918. It has a first block maintaining the traditional 'rue corridor' formula of the street, whereas having a large central tunnelled entrance bellow that provides the entrance to an interior square defined by second block in 'U' form around it. Placed at the back of each of the blocks a gallery circulation system provides the access for the houses, added with exterior staircases projected out of the volumes. The gallery scale was larger then the necessary for merely circulation use inviting to the same communitarian type of life that the people were used in the 'ilhas'.

Table 4. Number of 'ilhas' and houses in 'ilhas' accounted in 1939

District	Nb of 'ilhas'	Nb houses
Bonfim	350	3939
Campanhã	108	1162
Cedofeita	236	2588
Foz do Douro	14	112
Lordelo do Ouro	28	325
Massarelos	32	703
Miragaia	17	236
Nevogilde	1	11
Paranhos	132	1228
Ramalde	35	299
São Nicolau	3	36
Santo Ildefonso	148	1900
Sé	45	1029
Vitória	4	26
Total	1153	13597

Source: CÂMARA MUNICIPAL DO PORTO –
Plano de Salubrização das Ilhas. Porto, 1956, p. 6.*in* Matos 2001 (No reference to Aldoar district)

The block would be pointed as a promiscuous ineffective model by the regime and any future reproduction was avoided. In 2001, the existing 117 dwellings (of diverse typologies) housed 109 families, with 263 people. It was recovered in 2006.

[135] A radical program of city reforms developed by the Social Democratic city Council of Vienna that had its core in the erection of 400 communal housing blocks the *Wiener Gemeindebauten*. "It provided Vienna with not only a large amount of living spaces – 64,000 units in which one tenth of the city's population was rehoused – but also a vast new infrastructure of social services and cultural institutions" *in* Blau, Eve. The architecture of red Vienna 1919-1934. MIT Press. Cambridge. 1998.

8. Conclusion

During a crucial period of Europe's history of housing developments, from 1899 until 1939, the city of Porto did not cope to offer clear alternatives to the 'ilhas' as the main working class housing solution or to promote its upgrade. This incapacity runs since the turn of the century, when the first philanthropic interventions were erected in Porto, still under a monarchic liberal regime, passing by the Republican experiments, until the Second World War with the fascist regime assuming a strengthen position, still convinced of its purpose to promote a stratified proprietors' society of single-family houses.

Despite the large extension and persistence of the problem, laying in extreme low living conditions, clearly identified and characterized in several reports, the state continuously denied any type of intervention that could recognize the peoples' right to a dignifying housing solution, or for that matter, any solution that could question the bourgeois proprietors' class interests.

The lack of offered alternatives were common both to the private sector, expecting further speculative opportunities, as to the public sector that continuously declared its interventions as having profit expectations, even if with limited extension, directing its efforts in practical terms to specific layers of the low medium class rather then to the least favoured. In result, a serious of evolving patterns of both the public and private interventions supported a clear social-spatial segregation principle as we have enounced.

The public subscription of 'Commercio do Porto' remained as a forerunner experiment for future housing solutions under an *avant la lettre* Public Private Partnership, having no parallel until the carnation revolution. Its architectural quality, attractive location and tenure conditions became referential solutions though strongly penalized by its excessive cost unattainable for most of the working class income.

The developed public solutions had in all circumstances a reduced quantitative impact on the overall reality due to its disproportion to the effective needs. The 'Casas Económicas' that had the largest impact in the analysed period clearly implied, by its location, a centrifugal movement for its residents. They promoted a single family house model, related with the moral virtues of the rural life, even if directed to the proletariat; working and with its main needs served in the city centre, where by now rooted relations had been established.

The exceptional solution of the Bloco Duque de Saldanha, offered effective solutions for the problem but was condemned to remain as a single example, pointed as a promiscuous ineffective model by head figures of the regime. Yet it remains as a turning point, as the first collective housing solution in the city and also as the first to apply supported rent solutions. Both models would later become a general practice, with few although relevant exceptions.

Further research on the subject shall demonstrate that these procedures persisted till present day, only exceptionally interrupted after the end of the dictatorship[136], and palliated by an overall up-grade of the Portuguese society's living conditions since then, contributing to Porto inner city overall lost of population, both to its own periphery as to the neighbour municipalities.

[136] At the 25th of April of 1974.

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Impact of urban forms in the thermal performance of the buildings according to method of the RCCTE

Luciana Silva, Vítor Leal

Autonomous Section of Social, Juridical and Political Sciences

University of Aveiro, arqludiniz@gmail.com

Phone numbers: 00 351 231504993 – 00351 961239153

Department of Mechanical Engineering

Faculty of Engineering of the University of Porto, vleal@fe.up.pt

Phone number: 00 351 22 557 4183

The purpose of the thesis comes from the interest in investigating the problematic issues of how and how much the arrangement of the buildings of the determined urban morphology intervene with the levels of thermal comfort for the habitat itself, which therefore results in the prevention of the consumption of a great amount of energy and the intention of arising awareness of how certain decisions regarding the urban design, can influence the thermal behaviour of the buildings , and coincidently the usage of energy necessary to maintain proper level of comfort within the internal environments ,as well as the release of CO2 ,related to the energy usage. To demonstrate the proposal goal, in accordance with the characteristics of each urban form, such as the dimensions and disposition of the streets and the buildings constructions characteristics - height, form, shape factor and location - will be related with its potentials of the thermal protection, ventilation and amount of sunlight allowed through the development of a series of hypothetical cases of study, on which if it applies the methodology imposed for the current legislation of thermal behavior of the buildings in Portugal, RCCTE (Regulation of the Characteristics of Thermal Behavior of the Buildings), considering the typical climate of the city of the Porto.

Keywords: Urban forms; sustainable urbanism; urban climate; thermal behaviour of buildings; energy efficiency

1 Introduction

Among the problems caused by rapid urban development is the changing climate of cities. Many studies show the emergence of a specific climate in these areas, called "urban climate" which is characterised by a temperature rise in urban centres as compared to adjacent rural areas.

These changes in the temperature vary, not only because of local climate and topography, but also with the different urban morphologies of the cities, where the potential for ventilation and solar exposition is related to the conjunction between buildings and open spaces, the dimensions and layout of streets, the location of the squares and the design of buildings, such as height, shape and volume.

According to Assis (2003, p. 146). *"The urbanized area, by modifying certain characteristics of the natural landscape, such as material composition, soil permeability to water, vegetation ratio, surface roughness (permeability to wind) and surfaces exposed to solar radiation, changes the local energy balance, causing a change in the climate variables behaviour."*

However, in general, the main studies on the subject of urban climate are related to air pollution and the human thermal comfort. Scientific research on urban climate, according to Assis (2000, p. 26), began in the nineteenth century in Europe, with the work of Luke Howard, published in 1818, on the climate of the city of London, where showed that air temperatures are often higher in the city than in adjacent rural area.

In the second half of that century, in France and Germany, several studies about this phenomenon, emerged mainly because of the expansion of weather observation networks most

significant, the work on climate changes in Paris, published in 1855 by Emilien Renou, which portrayed the problem of air temperature and the issue of air flow in the city.

After the 2nd World War, studies on this subject have proliferated, focusing in the industrialized cities of Western Europe, North America and Japan, addressing the relations between temperature, the use of urban soil, the climatic differences between rural and urban areas and effect of the size of the city on such differences.

As scholars on the subject, Landsberg, professor of Meteorology Climate of cities at the Universities of Pennsylvania and Chicago, and others, stand out among them Oke from the Department of Geography, University of British Columbia, Vancouver.

Landsberg *"allocates urbanization to the changes in energy balance directly related to characteristics of urban surface such as heat, aerodynamic and moisture radiation"* (Peregrino, 2005, p. 24), and demonstrated in his study *"that the temperature differences between urban and rural areas grows with the increase of the built areas."* (Assis, 2000, p. 70).

Oke, in turn, *"(...) showed that the city climate is a result of a phenomenon of energy transformation from the interaction between atmospheric air and the urban built environment"* (Duarte and Serra, 2003, p. 9). He advocates the process of urban climate change, to be a consequence of urban geometry and the thermal inertia of building materials produced by urban settlements.

For the study of urban areas, characterization of the urban climate behaviour and the phenomenon of urban heat islands, according to Oke (1976, quoted in Assis, 2000, p. 23) distinguishes the concept of the atmospheric boundary layer in two levels, *Urban Canopy Layer* (UCL) equivalent to the effects of urban built environment on local climate, where its size extends from the ground to approximately the average level of building tops. The other, called the *Urban Boundary Layer* (UBL) as an internal limit layer of mesoclimatic scale, effects of the urban areas on a regional climate, whose characteristics are determined, at least partially, by the presence of the urban fabric.

Other scholars on the subject refer to the need to study the climate in three levels, as established by Mascaró, (2004, p. 33), *"the climate information should be considered on three levels: macroclimate, mesoclimate and microclimate."*

It is in this latter level that urban environmental comfort studies focus, urban elements such as morphology of the city, any of its districts or even a particular street or square, for example, are investigated in relation with the local behaviour of temperature and wind.

Mascaró (2004, p. 35) stresses that it is at the scale of the microclimate that *"the effects of human actions on the environment are taken into account, as well as the influence that these changes have on the ambience of buildings."*

Gonçalves (1999, p. 29) observes that *"The urban microclimate is usually marked by elevations in temperature, compared to natural climate, and, in areas' distance from tall buildings by distinct slow winds. Buildings, open spaces, vegetation and water affect the climate because they affect the levels of solar radiation, temperature and the relative air humidity and winds."*

The study of the microclimate, there for, is valid on building's scale. *"The study of variables in this scale is crucial for the development of the project, because a number of peculiarities of the*

local climate can induce to architectural solutions better suited to human comfort and energy efficiency." (Lamberts et.al., 2004 p. 35).

Studies on the problem of urban climate changes are therefore relevant as tools to aid the work of city and urban planning, since both are directly linked. According to Assis (2000, p. 47), *"urban zoning may be affected by climatic parameters or vice versa, certain uses may end up causing problems of pollution and heat islands."*

However, *"the practice of urban design that we usually witness has often been performed without taking into account the impacts that affect environment quality, impacts that are felt not only in the environment, but also in the comfort and health of the population."* (Romero, 2001, p. 9).

For example, the restriction of direct sunlight on the buildings is a continuing environmental problem in cities, derived from the high building density found frequently in urban centre. Direct access to sunlight is a prerequisite to ensure health and thermal comfort of the habitat's interior, and its absence may affect the psychological state of its inhabitants.

In fact it is known that providing buildings with facades there accessible to a minimal daily amount of solar radiation throughout the year is the responsibility of designers, architects and planners, committed to regulating the shape of the city.

The promotion of conscious urban design, however, transcends the question of hygiene and affects, among other factors, energy expenditure in the cities. As observed by Mascaró (1996, p. 33), *"the need for energy consumption to achieve appropriate environmental comfort is not only due to a problem arising from the climate conditions, but often due to the discomfort generated by an urban and architectural spatial organization not compatible with the environment."*

Thermal discomfort, caused by a lack of concern with the organization of the urban environment and urban planning, *"it is dominated by market forces and short-term financial imperatives"* (Rogers, 2001, p.17), and requires a greater consumption of energy for a building's thermal comfort, given that buildings are responsible for a significant portion of fossil energy consumption worldwide in order to ensure comfort levels in the environment within them, the use of non-renewable energy sources is the main cause of one of the largest environmental problems currently experienced, global warming.

Currently, there are many studies that seek solutions to the design of "intelligent buildings" however, there is also a belief in the importance of the surroundings of where they are inserted. The search for comfort and energy efficiency of a building can not be done in isolation, there is a neighbourhood, a heat exchange between the interior and exterior, external obstacles that exist and must be taken into consideration.

However, it is known that much of the existing habitation in Portugal does not guarantee by itself, thermal comfort to its residents, especially during the winter season. The quality of buildings construction and the climatic reality of the country as lead to the use of active air conditioning systems, where available, by its users. Large amounts of energy, particularly fossil fuels, are therefore used, to maintain comfortable indoor temperatures.

Considering that Portugal has one of the less severe climates in Europe and has high levels of solar radiation throughout the year, therefore, not being justified, the level of discomfort presented to its residents nor the high dependency on energy resources for acclimatization of buildings.

However, a major world political priority calls for global protection of natural resources and therefore to decrease the dependence on fossil fuels, both for economic, and environmental reasons. Therefore, the building industry has a high responsibility in this sector.

However, rethinking the Portuguese standard building is essential to help meet the needs of thermal comfort for the whole population, and especially the sustainability of the country. However, recent awareness on this issue by the promoters resulted in better buildings with better thermal qualities, and better building practices. The new rules imposed by RCCTE, in force since the mid-2006, are also consolidating and promoting these achievements, the allocation of minimum requirements for construction, to ensure thermal better conditions inside the home during winter and summer seasons.

Although, the thermal comfort of the habitation is still an arduous task to be fulfilled in Portugal. Thus, it is of great importance to study and understand how, quantitatively, the different urban morphologies influence the thermal performance of the dwellings.

This approach aims to provide the knowledge to support architects and city planners, responsible for the conception of cities and their buildings with the ability to produce, ad initium, environments with high thermal standards and the capability of reducing the necessity of energy consumption for climate control of the buildings therefore contributing for a bigger sustainability of urban environments.

Thus, it is intended that in the future, habitation in Portugal, should be less dependent on active acclimatization systems, and above all, provide better levels of comfort.

2 Urban Forms

The urban form here is understood as the result of different types of continuous spatial occupation of the territory since the formation of the first urban areas, affected by various factors throughout history, such as topography, climate, culture, religion and social and political relations.

According to the definition of Lamas (2007, p. 26), *"(...) the (physical) form of space is a reality to which a set of socio-economic, political and cultural factors contribute. (...). The urban form is, or should be, the result of the voluntary production of space. Understanding by volunteer, the processes that take into account the planning of objectives (economic, social, and administrative), organized and resolved using the cultural and architectural knowledge of that same space materializing it through its SHAPE."*

The urban form can arise therefore, from a kind of continuous occupation, unordered without prior planning, likely to change, substitute and expand at different times, but it may also be the result of urban design.

Urban design, however can be understood as the practice of planning and designing of cities, and the intervention in space itself, built or not, combining technical, social and aesthetic factors, through which, urban planners are responsible both for the transformation of the urban form, and for the space resulting from this process. *"Urban design is presented as the most appropriate way to handle and direct the process of evolution and renewal of urban fragments".* (Turkienicz and Malta, 1987, p. 21). It is with the intention of aiding urban design that this work presents itself, as a working tool in the process of the urban intervention of our cities.

However, in order to understand the most common existing urban forms, we must regress to the emergence of the first cities. From the earliest known urban civilizations, there have been different types of land occupation during several historical periods. Throughout this time period, from the early civilisations to the present day there were vast changes in the physical inhabited environment, influenced by all factors from civil life of civilizations, mixed by different cultures, through invasions to wars and battles occurred over time. All these factors have left their marks in land occupation.

Thus, it is considered that the study of urban forms, from its origins to the present day, is an arduous, complex and specified work, and that the quantification and definition of urban form varies among scholars of this subject.

In this study, however, the definition of urban form is as given by Carvalho (2003, p. 11) divided by a number of five classes, named:

"- Organic - lines of buildings along irregular streets;

- Classical - lines of buildings along regular streets;

- Garden - loose single use buildings', surrounded by green open space;

- Modernist - a loose collective of buildings, surrounded by public space;

- Urban-rural - the suburban dispersion, mixing country and city."

These five urban forms, will focus on the analysis of thermal behaviour of a fraction housing inserted in each of these urban contexts, will focus.

3. Factors Influencing the Thermal Behaviour of Buildings

Thermal comfort can be defined according ASRHAE[137] cited by Lamberts et.al. (2004, p. 40), as *"a mood that reflect the satisfaction with the thermal environment surround the person. If the balance of all the heat exchange that the body is subject is null and skin temperature and sweat are within certain limits, one can say that man feels thermal comfort."*

The thermal comfort in homes is a key factor in ensuring the well being of its occupants. This condition must be taken into account from the design of the building, and when possible, from the scale of urban planning.

As observed by Assis (2000, p. 69) *"the development of procedures for the integration of climate factors in urban planning can be done in a similar way as the approach on the scale of the building, and to do so, we must examine the inter-relations between urban form and local climate, and the type of thermal comfort indexes in an available urban scale as a reference to the performance of the urban environment and the results of experiments in urban planning considering the climate."*

As for the scale of the building, thermal comfort is directly related to the local conditions (climatic factors and existing vegetation), the architectural characteristics (sun exposure, mass and volume ratio; exterior glazing protections, and shading elements) and characteristics of the building (types of materials used for thermal insulation, type of glass and frames, thermal mass of the construction materials, and resistance of finishes).

[137]ASHRAE – Handbook of fundamentals. American Society of Heating Refrigerating and Air Conditioning Engineers. New York,1993.

Therefore the *"knowledge of the climate, coupled with the mechanisms of heat transfer and thermal behaviour of materials, enables a conscious intervention in architecture, incorporating data on the external environment in order to take advantage of the positive features of the climate and mitigate its negative aspects".* (Frota and Schiffer, 2007, p. 18).

It is pointed that the implementation of adequate constructive solutions and correct use of appropriate materials, as well as the provision of passive air conditioning systems in homes, proper solar orientation and the consideration of urban landscape represent essential design guidelines to the design of comfortable living spaces decreasing, however, the need for active systems for heating and cooling. Also included in these guidelines are aspects of shape, solar orientation, and the characteristics of constructive and architectural elements that might intervene in achieving a comfortable shelter.

An energy-efficient housing unit should be designed for passive air conditioning principles, thereby reducing the need for fossil fuels to achieve comfort.

It is then, to designers, both architects and urban planners, to foster a solid foundation for the urban quality and construction of buildings in terms of thermal behaviour and comfort. The architectural form of a building has a large influence on its thermal behaviour inside and hence in its energy consumption to achieve comfort.

The shape of a building determines the amount of area in contact with external space (walls, roofs or floors) reducing the border area between, inside, and outside, heat losses can be limited. The architectural form also has implications in the behaviour of immediate wind changes, via height and width ratio, type of roofing and volume of urban composition.

The form also influences the intensity of solar radiation captured by the building, because it is often possible to manage the solar orientation of the volume and control the intensity of solar radiation received by the shape of the building. As an example, provide to that part of the body of the buildings cast shade to certain compartments of the building.

Added to this, Form, an urban context, is also responsible for ensuring the right to access to "sun hours" between the neighbouring buildings.

As for the importance of solar orientation, from the analysis of the apparent path of the sun, for the Northern Hemisphere, one can say that the southern exposure is the best for larger solar gains in buildings. Which results in better thermal comfort inside in the winter period, however, it is best in this southern orientation, to provide for appropriate protection, during the summer, combining solar protection to glazing to ensure adequate comfort levels throughout the year.

In a climate such as that of Portugal, the East and West orientations are characterized by relevant solar gains throughout the year, although with greater intensity during the summer, therefore, in these orientations is also essential to provide shading systems to control or eliminate the penetration of direct radiation on the glazing, especially in the western elevation, most prone to interior overheat during the summer months. Considering that, the direct sunlight in a building always results in heat gains.

The intensity of radiation transmitted to the interior of the housing units depends on the thermal characteristics of each set of buildings. These can be classified as opaque and transparent or translucent (fenestration) when exposed to direct or diffuse solar rays.

When transparent or translucent facades, *"the portion of radiation transmitted to the interior will act, in terms of comfort, instantaneously being the main portion of the gains in thermal environments".* (Lamberts et.al., 2004, p. 56). This fact highlights the importance of a correct orientation of the shape of the building to obtain an adequate exposure. It is considered that, in most cases, this decision can be conceived at scale of urban planning.

The type of construction materials used in any building is also expressed with high importance in achieving thermal comfort of the space within the building as well as in the exterior open spaces.

Each type of material used has a characteristic thermal conductivity λ (W/(m. ℃), which, together with the resistance of the interior and exterior finishes - CSR and Rsi, respectively, given in (m².ºC)/W - applied to each element of the construction (surrounding walls, floors, roofs and glazing), produces the overall heat transfer coefficient, U (W/m².ºC) for each adopted solution.

This coefficient reflects the ability to exchange heat by convection, radiation, and conduction, given by the differences in temperature between the construction element and the medium that surrounds it such as, the smaller its value, the greater the insulating capacity of the material.

Thus, by knowing the thermal properties of each material used and the mechanisms of heat exchange one can predict what the reactions of the building will be to changes in the external climate. It is also important to consider two distinct parts of the building envelope, the opaque surfaces and the glazed surfaces, by the distinct ability of such elements to transmit solar radiation to the interior environment.

On the other way, results in material's specification, a class of thermal inertia, when elevated, acquired by the use of heavy and massive materials, reveals especially important for the stability of thermal comfort inside buildings located in climates subjected to large temperature variations in a short time period. This is one of the characteristics of the climate in Portugal.

Another important factor to be considered in the construction of a building is the nullification of thermal bridges, because they can cause surface[138] and linear[139] heat losses, produced in heterogeneous areas of the environment that are not properly insulated, therefore, representing a discontinuity in the thermal resistance of the envelope causing heat losses and problems in the building through the phenomenon of surface condensation.

In that case, the thermal insulation, applied in a proper manner, is a component key to ensure thermal comfort of buildings in a climate such as that of Portugal, and its use is mandatory since the implementation of the first RCCTE (Regulation of the Characteristics of Thermal Behavior of the Buildings), in 1991.

According to Tirone (2008, p. 166) the thermal insulation applied continuously and on the exterior of the building envelope is the most effective, and hence resulting in an improved energy performance.

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[138] Surface thermal bridges, also called "flat", represent the heat exchange by conduction between heterogeneous elements in the same area of envelope, eg: contact between masonry and structural elements - beams and pillars - and through openings, in particular the shutter boxes.

[139] The linear thermal bridges represent the heat loss between the connection zone of the vertical envelope with other building elements, such as floors, roofs, visors, balconies and bays, and links between two panels of vertical envelope to form a distinct apex exposed the external environment.

However, the use of double walls is a common practice in the national building industry, it appeared before the obligation to apply insulation materials, as a response of the necessity to insulate the buildings against external moisture and improve its thermal behaviour.

However, this method, added with the use of adequate insulation at the space with air between the double walls has also presents a satisfactory thermal performance of the building, if well implemented, with the elimination of thermal bridges and with the guarantee of high thermal inertia, as this system takes advantage in only part of the capacity of heat storing of the walls.

4. Experimental Part

The Urban forms considered in this study are therefore five, according to the classification of Carvalho (2003, p. 11) named: organic, classical, modernist, urban garden and urban-rural forms.

The influence of these different urban forms on the thermal performance of buildings is examined through several case studies representing the primary energy consumption required to achieve comfort conditions in housing fractions of its characteristic buildings.

For the analysis of the trials, constant factors in the RCCTE methodology were selected, whose definitions have a potential, which varies according to the particularities of each urban form, capable of exerting a significant impact on the analysis of thermal performance of buildings.

The factors selected as variables, thus responsible for the differentiation of the research results, and their potential influence exerted on each urban form are enumerated below.

- Exterior envelope

The external envelope is composed by the elements of the fractions in direct contact with the exterior environment, composed of opaque components (walls, floors and roofs) and transparent or translucent (glazing).

The particularities of each urban form, in principle, lead to a pattern of development of its buildings, which consequently influence the configuration of their exterior surroundings and respective thermal bridges.

The roof, for example, as a component of the external envelope has a significant role in thermal performance of buildings; it represents a significant area subjected to direct heat exchange with the exterior.

In the analysis of the thermal performance of the building as a whole, the heat losses or gains through the roof and the fraction immediately below are dissipated by the number of floors, depending on the urban form to be studied. Exception given to the garden and urban-rural forms, where these thermal exchanges are all allocated to the building unit.

Heat losses through the external floors are in that way observed in the modern form, frequently when its buildings on *pilotis,* subsequently with the first floor housing envelope in direct contact with the exterior.

- Interior envelope

The contact areas (walls and floors) between the living areas and areas considered *"useless spaces"*[140] by the regulation are in some ways related to the particularities of each urban form.

High buildings, typical of organic, classical and modernist forms have, necessarily, a common area of interior envelope. This area is characterized by vertical communication spaces between the common areas of the building and the individual fractions. When a building is of mixed use, the floor area between housing spaces and other occupational uses is also considered as internal envelope.

These different uses often characterized by stores and or offices that even when acclimated, have significant heat exchanges by direct and frequent access, if not permanent (open door) with the outside environment. This affects the thermal performance of housing fraction located immediately above these compartments, thus originating heat exchange thru surface contact (ceiling/floor), added to the resulting thermal bridges.

- Form Factor

The form factor is determined by the volume of the fraction, by the area of external envelope, by the area of interior envelope and their indicative coefficients of thermal balance of useless spaces.

The form of a housing unit is directly related to its thermal behaviour; therefore, the greater the area of contact with the exterior environment, and with less influence with the interior envelope, the worse the thermal performance of buildings tends to be in a climate such as that of Portugal.

- Shadowing the horizon Factor

The factor of shadowing the horizon represents the incidence capability of sunlight on buildings in accordance with the existing obstructions in a given location. However, the methodology of RCCTE limits this analysis, evaluating only the effects of obstructions on the gains achieved by the solar glazing. The factor of shading of the horizon is, therefore, directly related to the particular morphology of the site, because, solar obstructions are derived from distances between buildings and their heights.

- Air Renewal - wind exposure class

Each urban form induces a class of exposure to wind to the housing fraction, or unit, depending on morphological characteristics of the site - the roughness and the distance from the fraction to the ground - which intervenes in the air renewal ratio of the fraction or building.

Less urbanized areas, where there are no major barriers to the wind, tend to be, therefore, more susceptible to its effects, and considered analogous to the urban-country form in the study.

Examining the opposite forms, the urban fabric of the Classical and Organic Forms are identified as the most protected against the effects of wind.

However, according to the RCCTE methodology, the evaluation of the effects of wind on the facades of buildings is restricted to morphological characteristics, classified according to three urban contexts, each assigned with a specific level of roughness. It also relates the class of wind exposure of the facades to the distance of the fraction under analysis to the ground and to its geographic location.

- The need of solar water heating for AQS (Domestic Hot Water)

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[140] Non-living spaces are defined as "all the enclosed, heavily ventilated or not, which are not encompassed in the definition of useful floor area and not intended for human occupancy on a permanent basis and therefore generally are not air conditioned. This would include warehouses, attics and uninhabited basements, common circulations to other units of the same building, etc. Also considered as non-Living spaces are non air conditioned open door stores. "Source: RCCTE, point z) of Annex II, p. 2476.

The Introduction of this item, in this work, aims to establish whether the buildings, characteristic of each urban form, have enough roof area available for the installation of solar water heating capable of meeting the needs of AQS of all the housing fractions, according to the considered number of floors in the building.

The intention is thus to analyze these six parameters through a series of combinations of tests to be deemed acceptable and representative, from various assignment hypotheses of the reference fraction within the characteristic building unit of each urban form.

It is assumed in this study, that all fractions are composed of identical construction elements and that its interior dimensions are 8x15 m, totalling 120 m² of floor area, except for the garden and urban-rural forms, whose fractions are composed by two storey housing, resulting in 240 m² of floor area.

Thus, the case studies begin with the selection of reference buildings, located in metropolitan area of Porto, capable of characterizing the thermal behaviour of the urban forms to be analyzed.



Figures 1, 2, 3, 4 and 5. Areas selected from the metropolitan Porto (left to the right) - organic, classical, modernist, urban garden and urban-rural forms.



Figures 6, 7, 8, 9 and 10. Buildings of reference (left to the right) - organic, classical, modernist, urban garden and urban-rural forms.

The reference building for the Organic Form is located in the historic medieval city (Figures 1 and 6), allocated in a north-south orientation and consists in two storey housing above a store.

For the classical form was selected, within the urban expansion area of the Almadas, a block oriented in a North-South direction, between the streets of Santa Catarina and Sá da Bandeira (Figures 2 and 7). To characterize the thermal behaviour of the block ,two buildings were selected, one with North-South and another with East West orientation, composed by 4 and 2 storey houses, respectively, both with a commercial occupation on the ground floor.

The Form Garden was represented by a two-storey house, situated in the urbanization of the Campo Alegre, allocated directly on ground, surrounded by houses and green open spaces (Figures 3 and 8).

The site chosen for the study of the modern form was the urbanization of Prelada, consisting in 13 residential floor building, built over underground garages (Figures 4 and 9). To evaluate the thermal behaviour of the building, the fractions of the 1st residential floor above the garage, the middle floor (7th floor) and the fraction under the roof were analysed.

For the study of the urban-rural form was selected a house, situated in Custóias, in outskirts of the city of Porto, consisting of two floors and built on ground (Figures 5 and 10).

However, from the preparation of these case studies, the need for further research must be stressed, since the characteristics of urban forms are not limited to the solutions found in the reference buildings.

Thus, the second stage comprises a series of combinations of hypothetical case studies that transcend even the subject of the this study, because of how the study was developed, it becomes possible to assess the degree of influence caused by the variable factors analyzed, especially including variations in the allocation of the fraction in the buildings, the distances between buildings - accessing solar obstruction, variations in solar orientation, analysis of the floor where the fraction is located in the building, according to the fraction's distance to the ground and the consequent impact in relation to wind exposure and, in multi-use buildings, the impact on the 1st floor housing, because of different uses on the ground floor.

All these variations are, in general, in accordance with the characteristics of the study of urban forms. Thus, from the results obtained, it becomes possible to investigate and compare the impact that each urban form has on the thermal performance of buildings and therefore in their energy consumption. It is considered that such information may prove useful to planners and architects.

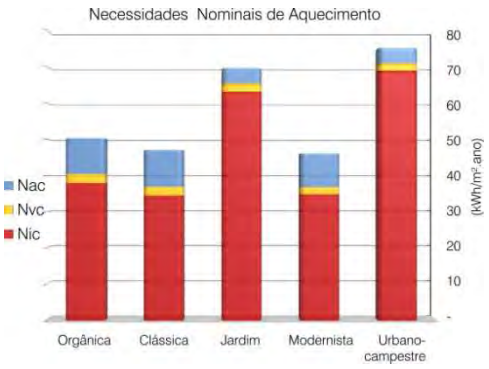


Figure 11. Graphic representation of the influence of urban form on the needs of nominal heating (Nic), cooling (Nvc) and hot water (Nac).

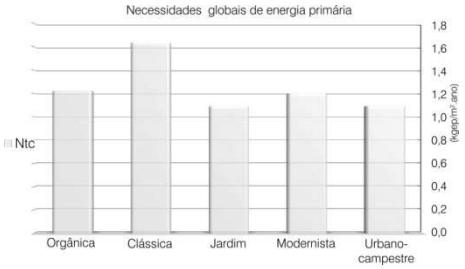


Figure 12. Graphic representation of Ntc results in each urban form.

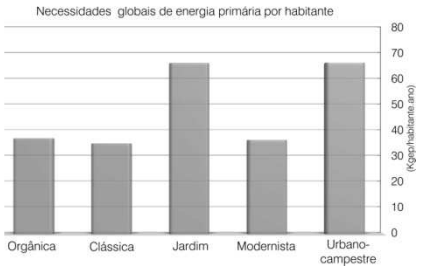


Figure 13. Graphic representation of Ntc' 'results for each urban form.

5. Results

Through the results of the case studies (Figure 11), the need for greater use of energy in the heating season – winter, (30 to 40 times greater than the need for cooling) is evident in all urban forms.

The difference in efficiency of the nominal heating needs between urban forms (Figure 11), in decreasing and consecutive order is:

- 9% of the garden form over the urban- country;
- 66% of the organic form over the garden form;
- 9% of the modernist form over organic form;
- 1% of the classic form over the modern form.

That results in a difference of almost double between the nominal heating needs of the extremes cases, ex. between the urban-rural form and classical and / or modernist forms.

This work, also showed the incongruence in the results of the global annual nominal needs for primary energy (Ntc), favouring the garden and urban-rural forms (figure 12). The distortion of results is due to the fact that the two urban forms present twice the area of floors, which translates in the distribution of nominal needs in kgep/m2, according to the method of calculation RCCTE.

For this reason, a new parameter is presented in this study: the global needs of primary energy per capita - "Ntc'" (kgep/habitante.ano), which according to the graphic (Figure 13) displays more consistent and expected values than the standard “Ntc” (kgep/m².ano).

Regarding to the influence on solar orientation on the thermal behaviour of a building, it was found that the best thermal performances are located in the South quadrant, followed the E-W orientations and that the worst results appear within the Northern quadrant.

Examining the influence of solar orientation, without interference from other constraints, an optimization of up to 30% in the thermal performance of an isolated house is demonstrated when exposing its main facade to the South (Figure 14).

The variation of solar orientation in the classic form, however, shows no significant differences in the thermal performance of buildings (north / south orientation more efficient in heating needs by 1.6%).

The variation in distances between buildings, however, showed no significant influence on the thermal performance of the buildings (Figure 15). In general, there is an average growth of 4.5% in heating requirements, between the highest and lowest variations of distances proposed for each urban form. The need for cooling, however, is not affected by the variation in the distances between

the buildings, according to the RCCTE method. The floor where the fraction is located in a building, the last parameter analyzed, as a significant influence on its thermal behaviour (Figure 16), as follows: the intermediate floors have twice the thermal efficiency in the heating season when compared with the ground floor; about 75% more efficient than the floors under the roof and 1st floor over the exterior areas and, about 50% more effective than the 1st floor over commercial activities floors and basements. In relation to the distance of the fraction to the ground, it is shown that the consecutive increase of the class of wind exposure of the facades of the building represents an average decrease of 5.5% in nominal heating needs.

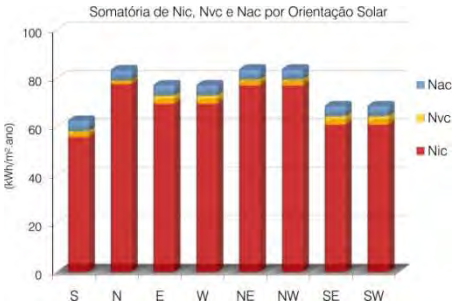


Figure 14. Influence of solar orientation in the thermal performance of a building.

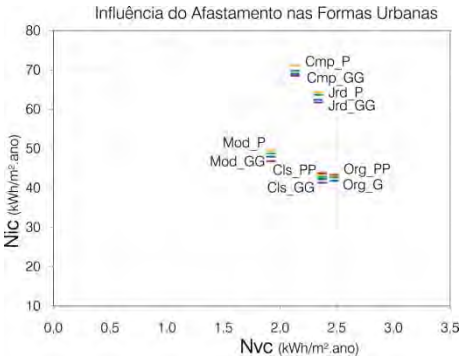


Figure 15. Influence of the distance between buildings in the thermal performance of a building.

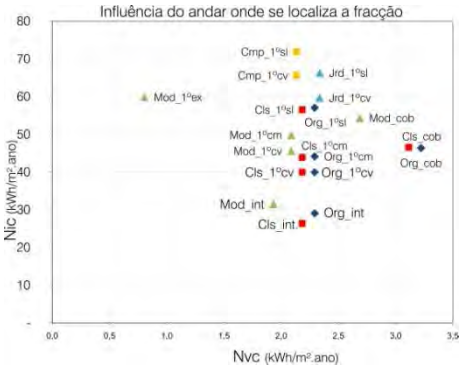


Figure 16. Influence of the floor the fraction is located in a building in the thermal performance of a building.

5. Discussion

Thus, regarding to all the exposed issues, it is considered that the purpose of this study have been achieved by the analysis of the influence of urban form, taking into consideration the energy efficiency of buildings, being able to present an overview of the thermal behaviour of the households covered by the five considered urban morphologies.

These results suggest, according to the method of evaluation, and with the local climate and the construction materials used, that urban forms have significant differences in thermal performance of their buildings in the heating season (winter), unless the analysis focuses on the classical and modernist forms, because both have similar thermal performance. However, in the cooling season, (summer) the energy performance of buildings between the urban forms as no significant difference. Classic and modern forms, present, therefore, the best results among the urban forms, followed by the organic form. Thus, a conclusion can be made that urban forms consisting of multifamily buildings have better thermal performance. Due, primarily, to the thermal performance of intermediate floors, which are less susceptible to heating loose .It also shows that urban forms consisting mainly by single homes require almost twice as much energy to reach the same levels of thermal comfort compared to urban fabrics formed by urban buildings in height.

As for the worst performance of the garden and urban-rural forms, it is due to the increased surface area in contact with the exterior environment (walls, roofs and ground floors). It can also be verified with this study that, according to the building elements used, the urban-rural and garden forms experience some difficulties in meeting the limitations imposed by RCCTE for the heating season (Ni), when set in the ground.

Related to the other parameters, it was found that the solar orientation has a significant impact on the thermal behaviour of buildings. However, the variation of sun exposure is directly related to the urban form, and that, modern, garden and Urban-country forms demonstrate greater flexibility of the location within the urban fabric and therefore, subject to more appropriate architectural solutions.

However, the variation of distances between buildings has a limited influence on their thermal performance, a variation of 6% the most. It is suspected that this relatively low value, is in part the result of the RCCTE calculation method, a thesis to be proven, or not, in future studies.

The study also shows that the thermal behaviour of a fraction or building is directly related to the composition of its exterior and interior envelopes. Thus, in a vertical building construction, there is a wide variation in the thermal behaviour of the fractions according to the analyzed floor.

The roof, as a component of the external envelope has a significant role in thermal performance of buildings; as it represents a significant area subjected to direct heat exchanges with the exterior.

Analyzing the thermal performance of a building as a whole, thermal losses or gains through the roof and by the fraction immediately below it are dispersed by the number of floors, depending on the urban form to be investigated. With the exception of the garden and urban-rural forms, where these thermal exchanges are all charged to the building unit, which results in a worse thermal performance in terms of the building, when compared to those in other urban forms.

Heat losses through the exterior floors are verified in modern form, when its buildings are built on *pilotis*, with the first housing floor in direct contact with the external envelope.

Regarding the evaluation of the method imposed by RCCTE, when applied to the garden and urban-rural forms, it was concluded that its methodology in relation to the assessment of global primary energy needs, is less than appropriate, because the division of energy needs for AQS (domestic hot water) by the living area of the houses underestimates the amount of primary energy needed, when in fact the reverse is true, the larger the living area of the building, the greater the energy consumption required for acclimatization.

It is, however, considered that the imposition by the RCCTE regulation of solar water heating installations for domestic hot water will bring an essential contribution to the reduction of fossil fuel consumption by the habitations.

Although it is considered that the objectives of this work have been reached, it also had certain restrictions, this research was, admittedly, performed with a comprehensive but simplified database, in the aspect of urban design and their built components, linked only to one theoretical method for thermal performance evaluating of buildings and one weather condition.

Therefore, new, more realistic, assessments, developed through computer models for sunlight and wind action could be valuable to investigate such impacts.

Taking into consideration that this study alerts for the necessity to protect the buildings from the effects of wind, this factor demonstrated a considerable influence on the thermal behaviour of the studied fractions, It also reveals to the necessity for more detailed future studies to ascertain that fact, not the least, by the peculiarities, alone, of the aforementioned method RCCTE regarding building shading.

It is still recommended, that, in future studies, the building constructive components should be separated, and combined with the factors presently investigated for assessing such impacts.

In this study area, most of the work still to be developed both in the research area, and in the production and performance of buildings. This approach aims, therefore, at providing additional and support knowledge to architects and planners responsible for the design of cities and its buildings, so that these professionals can produce environments with high thermal performance that can reduce the need for energy consumption for building acclimatization.

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Daily practices and mobility in residential areas – the cases of Telheiras and Quinta do Conde

Ana Mendes, Eduarda Costa, Jorge Rocha, Michael Rodrigues, Nuno Costa

Centro de Estudos Geográficos

IGOT - UL, anamendes@fl.ul.pt

Phone/fax numbers: 00 351 217940218 - 00 351 217938690

One of the problems of cities in the twenty-first century is related to urban sustainability, that is, the ability that a city has to balance economic growth with environmental objectives maintaining a harmonious social interaction by reducing poverty and social exclusion. The question of sustainability is discussed at different scales that reflect naturally different problematic and planning answers. "Sustainable communities" concept emphasize the question of accessibility, mobility and the level of services in residential areas and their relation with family practices, as key elements for the urban sustainability at local level. This paper[141] seeks to analyze these components and their relations in two residential areas of Lisbon Metropolitan Area (a residential area of Lisbon city, Telheiras, and a residential area in south metropolitan area, Quinta do Conde), considering that this relationship can be an indicator of urban sustainability throughout the residential area. Therefore this analysis seeks to compare a simulated situation with the practice of families in terms of travel time and modal choice to access to 3 services: local grocers and supermarkets, coffee shop/snack-bar, schools and fundamental services to everyday life[142]. This paper is structured in three parts. Firstly, is presented a synthesis of theoretical discussion. Secondly, is presented the results, and thirdly, some general considerations about the results are made.

Keywords: GIS, Sustainable Communities, Family Practices, Mobility, Services

1. Introduction

One of the problems of cities in the XXI century is related to urban sustainability, i.e. the ability of a city has to reconcile economic growth balanced with environmental objectives, while a harmonious social life by reducing poverty and social exclusion. Since urban sprawl has been associated with an increased mobility of people and goods, mainly supported by increased use of private transport, this led to significant impacts in terms of emission of greenhouse gases, waste generation and consumption resources, as well as an increase of social disparities, with particular emphasis on the fragmentation of the city.

The concept of "Sustainable Community" presented in the final report "The Egan Review - skills for Sustainable Communities (ODPM, 2004), is a reference and framework for the establishment of guidelines for the improvement of sustainability on a local scale, or a sense more applied, the scale of the neighborhood, this scale that has been gaining momentum, both within the academic reflection, both in developing new instruments of urban policy.

According to that report, the definition of "Sustainable Community" based on seven components: a good network of transport infrastructure and mobility, the existence of services, a diversified economic base, in offering diverse socio-cultural; in the provision of housing for different

[141] This paper was elaborated serving as a exploratory methodological basis for Research Project PTDC/GEO/69109/2006 - FURBS.

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segments population, a quality environment, and the existence of a good connection between the local and community participation that is related to a good governance model.

The work presented here is fundamentally related to these two components: the issue of mobility and level of services in the neighborhood, knowing that they have a strong relationship with the practices of families. Regarding the transport network and mobility, the greater the density and quality public transport network serving the neighborhood, the greater the contribution to the establishment of a sustainable community. The same applies to services, where the existence of a wide range and quality is an important attribute to ensure good levels of care to its residents, encouraging quality of life and sustainability of everyday families. The relationship with the "sustainability" is reinforced, since the existence of a good service network and presence of diverse shops, can provide enhanced consumption of goods and services in the district, which may encourage walking, contributing to develop more sustainable forms of mobility. Take as an example, some relationships evident: the existence of a good school system nearby households provides an intensification of walking to school, a greater variety of shops can boost the performance of daily shopping on foot, the presence service from the hairdresser, going through the health center, which will leverage the walking and public transport, examples which together contribute to building more sustainable communities, both in economic or social or even environmental terms.

Case studies were chosen neighborhoods of the Metropolitan Area of Lisbon (AML), with very different characteristics from the point of view of population density, in terms of geographical location in the context of AML, and in terms of socio-economic characteristics of the population. It was considered a high-density neighborhood in the city of Lisbon - Telheiras and other less populated neighborhood located in the municipality of Sesimbra - Quinta do Conde.

This analysis seeks to compare a simulated situation with the practice of families in terms of travel times and modes of travel used for 3 functions / services: local grocers and supermarkets, such as mini markets, local grocers and supermarkets, hypermarkets, etc.. ; coffee shop/snack-bar such as cafes, snack bars, restaurants, etc.., and schools, considering the public schools of all courses and private schools until the 1st cycle, fundamental to the daily lives of families in two neighborhoods of the metropolis Lisbon (Telheiras and Quinta do Conde). In a first part, we build the functional assessment of the 3 functions mentioned, as well as the identification of the network of footpaths, resorted to network analysis and determined the potential population (2001 Census data in subsection statistic) that lies at 2, 5 and 10 minutes walk from the functional units of the 3 goods and services. In the second part of this communication, this information is confronted with the results obtained by investigation, which these results allowed evaluating the actual behavior of households in terms of using the above functions, including the time they spend in travel and modes of travel, the standing in their own transport or public, they resort to.

2. Sustainable Development a complex concept

In terms of mining the concept of sustainable development we can refer to it as maintaining development over time, in terms of environmental, economical and social issues. However, Holmberg and Sandbrook (1992) suggested that there are more than seventy definitions of sustainable development currently in circulation.

The term sustainable development was first used in the World Commission on Environment and Development (WCED) in the report “Our Common Future”, in 1987, were sustainable development was describe as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.“ By the late 1990s, the term sustainable development has “gained a currency well beyond the confines of global environmental organizations” (Adams, 1990: 2) and is widely used in many political arenas and academic fields.

According to Girardet there are two reasons for the affirmation of the concept of sustainable development: “[…] populations are migrating in different ways then they used to and must faster than they used to” and ”[…] global population shifts, so shifts that are international shifts, but then also shifts because of extreme events.”

Although the simplicity of this definition the subsequent paragraphs of the report refers that "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- The concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given;
- The idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs."

In short we can think about Sustainable development as multi-dimensional concept that relates the maintenance and enhancement of environmental, social and economic resources, in order to meet the needs of current and future generations. In this sense the “Environmental sustainability requires that natural capital remains intact. Social sustainability requires that the cohesion of society and its ability to work towards common goals be maintained. Individual needs, such as those for health and well-being, nutrition, shelter, education and cultural expression should be met. Economic sustainability occurs when development, which moves towards social and environmental sustainability, is financially feasible.”
(http://www.comarchitect.org/WebHelp/9_sustainable_development_definition.htm)

Regarding to the cities was addressed the need to link the regional strategies and urban development, and the need for development of secondary centers to contain the sprawl and create a balanced urban system. The publication of Our Common Future and the work of the World Commission on Environment and Development laid the groundwork for the convening of the 1992 Earth Summit and the adoption of Agenda 21, the Rio Declaration and to the establishment of the Commission on Sustainable Development.

3. “Sustainable communities” a form of sustainable development

Planning for Sustainable cities is an increasing concept in our days. The perception of the populations and politics about environment, economic and social problems is greater than ever,

however some authors say that this concept is more a political approach than actually an a joint action of acts. “A 'weak' view of sustainable development looks to continuing economic growth on terms that favour existing financiers and corporations (while maintaining the support of the majority of voters in countries like the UK). A strong view 'represents a revised form of self-reliant community development which sustains people's livelihoods using appropriate technology'” (Huckle 1996: 4 in Smith, 2008) In this sense there is a rising movement of “communities who have a shared concern and vision along with the will and determination to enact programs and policies that make sustainable development real” (Woodrow, 2010:).

The Geographical Association and Academy for Sustainable Communities (www.geography.org.uk/projects/buildingsustainablecommunities/) defines “sustainable communities” as: “[…] the places where people want to live and work, now and in the future. They meet the diverse needs of existing and future residents, are sensitive to their environment, and contribute to a high quality of life. They safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all”. For Egan (2004:7) sustainable communities “meet the diverse needs of existing and future residents, their children and other users, contribute to a high quality of life and provide opportunity and choice. They achieve this in ways that make effective use of natural resources, enhance the environment, promote social cohesion and inclusion and strengthen economic prosperity.” Roseland (2005 in Minnesota SEDEPTF, 1996) defines it as those who “[…] seeks a better quality of life for all its residents while maintaining nature’s ability to function over time by minimizing waste, preventing pollution, promoting efficiency and developing local resources to revitalize the local economy”. The Communities Plan (Sustainable Communities: Building for the Future) embody the principles of sustainable communities, trough “balancing and integrating the social, economic and environmental components of their community, meeting the needs of existing and future generations and respecting the needs of other communities in the wider region or internationally to make their own communities sustainable”. Furthermore they say that a community to be sustainable should offer: decent homes at prices people can afford; good public transport; schools; hospitals; shops; a clean, safe environment, and people also need open public space where they can relax and interact and the ability to have a say on the way their neighborhood is run” (http://www.communities.gov.uk/archived/general-content/communities/whatis/).

As referred in Egan report (2004:19-21) there are seven components and sub-components that define sustainable communities that are:

- SOCIAL AND CULTURAL – “Vibrant, harmonious and inclusive communities”
    - A sense of community identity and belonging
    - Tolerance, respect and engagement with people from different cultures, background and beliefs
    - Friendly, co-operative and helpful behavior in neighborhoods
    - Opportunities for cultural, leisure, community, sport and other activities
    - Low levels of crime and anti-social behavior with visible, effective and community-friendly policing
    - All people are socially included and have similar life opportunities

- GOVERNANCE – “Effective and inclusive participation, representation and leadership”
    - Strategic, visionary, representative, accountable governance systems that enable inclusive, active and effective participation by individuals and organizations
    - Strong, informed and effective leadership and partnerships that lead by example (eg. government, business, community)
    - Strong, inclusive, community and voluntary sector (eg. resident’s associations, neighborhood watch)
    - A sense of civic values, responsibility and pride
    - Continuous improvement through effective delivery, monitoring and feedback at all levels
- ENVIRONMENTAL – “Providing places for people to live in an environmentally friendly way”
    - Efficient use of resources now and in the future in the built environment and service provision (eg. energy efficiency, land, water resources, flood defense, waste minimization etc)
    - Living in a way that minimizes the negative environmental impact and enhances the positive impact (eg. recycling, walking, cycling)
    - Protecting and improving natural resources and biodiversity (eg. air quality, noise, water quality)
    - Having due regard for the needs of future generations in current decisions and actions
- HOUSING AND THE BUILT ENVIRONMENT – “A quality built and natural environment”
    - Creating a sense of place (eg. a place with a positive ‘feeling’ for people, and local distinctiveness)
    - Well-maintained, local, user-friendly public and green spaces with facilities for everyone including children and older people
    - Sufficient range, diversity and affordability of housing within a balanced housing market
    - A high quality, well-designed built environment of appropriate size, scale, density, design and layout that complements the distinctive local character of the community
    - High quality, mixed-use, durable, flexible and adaptable buildings
- TRANSPORT AND CONNECTIVITY – “Good transport services and communication linking people to jobs, schools, health and other services”
    - Transport facilities, including public transport, that help people travel within and between communities
    - Facilities to encourage safe local walking and cycling
    - Accessible and appropriate local parking facilities
    - Widely available and effective telecommunications and Internet access
- ECONOMY – “A flourishing and diverse local economy”
    - A wide range of jobs and training opportunities

- Sufficient land and buildings to support economic prosperity and change
- Dynamic job and business creation
- A strong business community with links into the wider economy

- SERVICES – “A full range of appropriate, accessible public, private, community and voluntary services”
  - Well-educated people from well-performing local schools, further and higher education and training for lifelong learning
  - High quality, local health care and social services
  - Provision of range of accessible, affordable public, community, voluntary and private services (eg. retail, food, commercial, utilities)
  - Service providers who think and act long term and beyond their own immediate geographical and interest boundaries

Generally sustainable communities can be defined as communities that have a focus in environmental, economic and social sustainability. They are planned, built, and/or modified to promote sustainable living. And by Community we mean “‘a residential or mixed used area around which people can conveniently walk. Its scale is geared to pedestrian access” (Barton 2000:5)

4. Characterization Of Areas Of Study

The residential area Telheiras is part of the municipality of Lisbon, located on the north side of the Metropolitan Area of Lisbon and lies between the parishes Lumiar and Carnide, being bordered on the south by the parishes of São Domingos de Benfica and Campo Grande. The district covers an area of 196 ha and has a total population of 14 735 people (INE, 2001). The area of the sample corresponds to 43% of the total area of the district and in terms of population, corresponds to 8817 habitants, in 2001, which corresponds to 59.8% of residents. Through our empirical knowledge and observation, we can characterize Telheiras as being a residential area with a good quality of housing, well served with good public spaces, a wide range of schools, a vast number and variety of shops, a good network and variety of public transports and a clean environment. The area stands for quality planning and is known as the “Neighborhood of doctors” by the characteristics of residents, namely a vast number of graduates.

In turn, the residential area of Quinta do Conde belongs to the municipality of Sesimbra and is located on the south side of the Metropolitan Area of Lisbon located in the parish of the same name. The district has a total area of 413 ha and a total population of 14,605 people (INE, 2001). The sample area corresponds to 110 ha which represents 26% of the parish, and 6393 people lived here in 2001, 43.8% of residents. Quinta do Conde can be define as a residential area, that can be illustrate as a low density area, with a good number of school and public services, and a adequate number of shops, and a clean and safe environment.

5. Methodology

The methodological work is based on two main instruments: a Geographic Information System application that allows us to analyze the coverage of the resident population in terms of services, and

a survey to the local population in both residential areas, that allows us to verify the real behavior of population consumption.

In general terms for the work in the Geographic Information System was building a network, from where was conducted a simulation of service levels / coverage of the resident population of the district for the functional units of the 3 functions considered: local grocers and supermarkets, coffee shop/snack-bar, schools, and fundamental services to everyday life.

In this sense, we start to define areas of study: Telheiras and Quinta do Conde. We intend to verify whether it is reliable to assume that the characteristics of each area, not only with different morphologies, but with different levels of care in services and public transport can interfere with everyday practices of families. However, we must take into account that the practices of families vary widely according to socio-economic group they belong to, which may be another factor of differentiation and influence on the results reported.

The simulation in GIS environment was developed in six phases.

The first step consists in building the network. Therefore was necessary vectoring the axis of the network, of the districts. This vectorization was made based on orthophotomaps with a spatial resolution of 50cm.

In the second step, a functional survey was elaborated in order to identify all of the functional units of the functional services that were being analyzed, which were later transformed into digital information through its vectorization (figure 1).

The third step, the building process of the network, was the topological correction of the map, in order to ensure connectivity between the linear elements of the network.

The fourth step was the definition of subareas within each residential area. This division was based on criteria of homogeneity in terms of population density observed in each sub-section statistics and also in the presence of school equipment. Thus whether the district Telheiras or Quinta do Conde, were divided into 3 sub-areas.

The fifth step consisted in the calculation of isochrones for each of the sub-areas separately and for three ranges of pedestrian time movements (2, 5 and 10 minutes), having as origin the functions considered for the study. It is important to mention that the times obtained naturally are a simulation of reality, since it is only taken into account travel time assigned to each axis of the track, in which case the network established considers a constant displacement of 3.8 km/h , a speed that empirically attach after the completion of functional survey in both residential areas. Note that the variable of time depends not only on the physical characteristic of areas but also in the characteristics of the pedestrian (since it is different the speed of travel of a child, an adult, an elderly person or a person with limited mobility), the conditioning travel network (prohibition for the transit of pedestrians), the obstacles and road works, the weather conditions, among others.

The sixth step was to simulate the potential population served by the three functions considered from each of the geometric centers of both areas, in terms of time/distance. This potential population was determined with information from the Geographical Database Referencing Information of National Institute of Statistics, which appear in the quantitative population-level statistics section. This led to the quantitative population that lives in each of the sub-areas of

Telheiras and Quinta do Conde, that are the time-distance footpaths of 2 minutes, 5 minutes and 10 minutes of each of the functional units of the three functions considered.

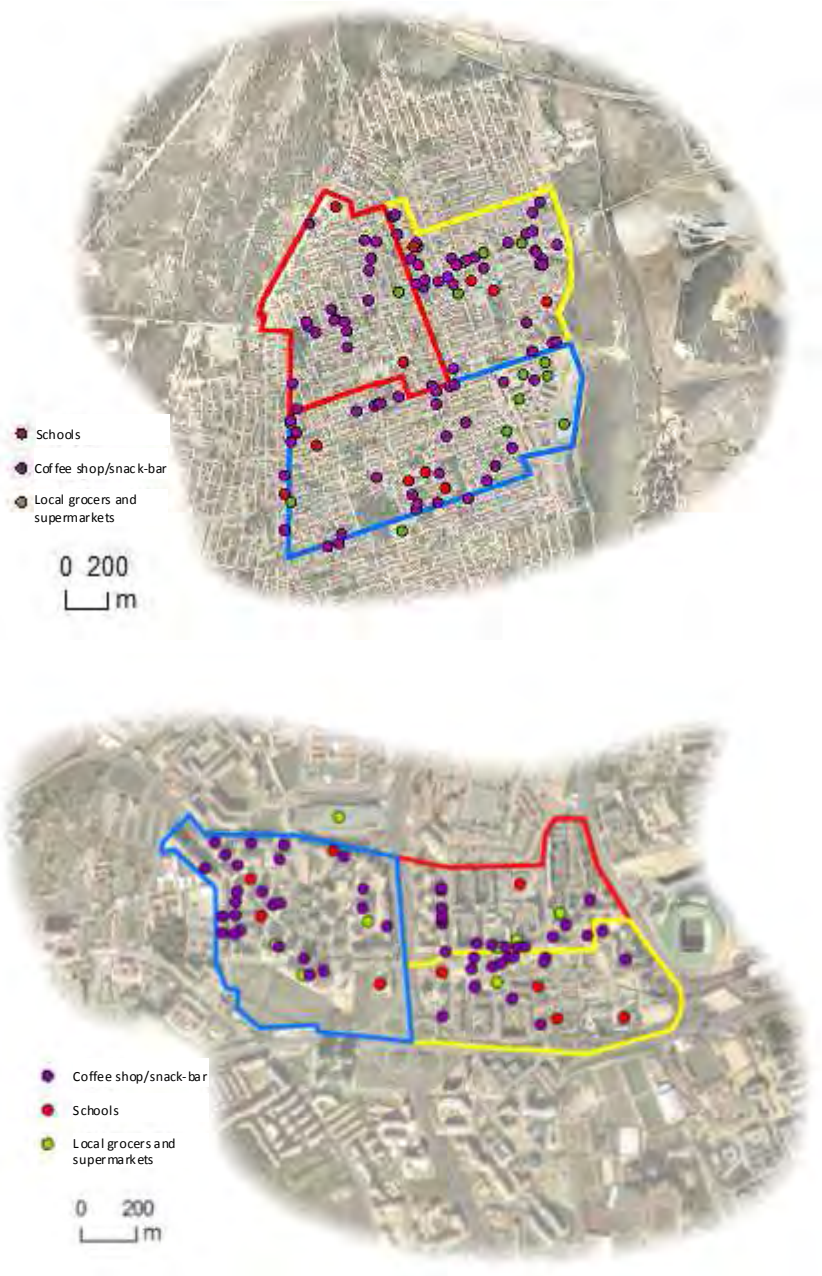


Figure 1. Location of the functions in the study areas Telheiras and Quinta do Conde.

At the same time that we were elaborating the functional survey we were also making and survey to the population that lives in both areas. This survey focus on the main characteristics of each family and individual in terms of their actual behavior of households in terms of using the functions in analysis, that is, local grocers and supermarkets, coffee shop/snack-bar and schools, including the time they spend in travel and modes of travel (on foot, in their own transport or public), they resort to. With the results of the survey was possible to make a confrontation between the "simulated" values and the values obtained by the survey, corresponding to actual practices of the habitants of the areas in study.

6. Potential Population Served By Three Functions - An Analysis Of Isochronous

From the analysis we obtained the potential population in two areas of study, the values are represented in tables presented below (table 1 and 2). The values of the tables are expressed as a percentage to allow comparison between areas. In relation to the maps each represents the output for each of the functions under review in each residential area. As we said previously, each area is divided in three areas related to schools location.

In Telheiras it appears that the catering establishments are those that exist in greater number. The study area is characterized for having coffee shops and snack-bars that cover more than 98% of the population of each area at a distance of less than 5 minutes walk. When we analyze the distance of 10 minutes' walk there is the population are served throughout the entire area of study.

For local grocers and supermarkets the vast majority of the population of Telheiras is located at a distance less than 5 minutes walk of this service. Even, when distance enlarges to 10 minutes walk almost the entire population is at this distance from these sites.

Schools, are more rare then the other two services. Neverthess, a little more than half the population has to walk about 5 minutes until such a service. If we consider 10 minutes pedestrian distance, 100% is covered.

The same analysis was made for the area of Quinta do Conde and we found different results. Compared to Telheiras, Quinta do Conde is not as well served.

Thus, more than half the population is at a distance of 5 minutes walk from a coffee shop or snack-bar and almost the entire population has access to this service in a pedestrian 5 minutes. However there are still some people who need to walk more than 10 minutes to get them.

The local grocers and supermarkets are concentrated in the study area, however, almost the entire population is served by a service of this nature, with a distance of 10 minutes on foot the entire population is covered by this service.

For schools, these are better distributed so as to allow the vast majority of the population has access to a school pedestrian at a distance of 5 minutes. If we look at the figures, on a distance of walk 10 minutes almost the entire population is covered by this service.

The analysis of the isochrones map (representing the pedestrian travel time from one type of service) shows that in the case of local coffee shop/snack-bar, the whole population is served by this function in a pedestrian distance that doesn’t exceeds 10 minutes, while the simulations on the functions of local grocers and supermarkets and schools is likely to find areas where the population needs to walk more than 10 minutes to reach these services (figure 2, 3,4,5,6 and 7).

Table 1. Potential population percentage covered by the functions considered in the study in the area of Telheiras

Study area	Telheiras											
	Area A				Area B				Area C			
Time in minutes	2 min.	5 min.	10 min.	>10 min.	2 min.	5 min.	10 min.	>10 min.	2 min.	5 min.	10 min.	>10 min.
Local grocers and supermarkets	99.8	99.8	99.8	0.2	100.0	100.0	100.0	0.0	100.0	100.0	100.0	0.0
Schools	99.8	99.8	99.8	0.2	100.0	100.0	100.0	0.0	100.0	100.0	100.0	0.0
Coffee shop/snack-bar	98.6	98.6	98.6	1.4	100.0	100.0	100.0	0.0	100.0	100.0	100.0	0.0

Table 2. Potential population percentage covered by the functions considered in the study in the area of Quinta do Conde

Study area	Quinta do Conde											
	Area A				Area B				Area C			
Time in minutes	2 min.	5 min.	10 min.	>10 min.	2 min.	5 min.	10 min.	>10 min.	2 min.	5 min.	10 min.	>10 min.
Local grocers and supermarkets	26.6	100.0	100.0	0.0	100.0	100.0	100.0	0.0	22.1	95.5	100.0	0.0
Schools	100.0	100.0	100.0	0.0	8.1	100.0	100.0	0.0	10.0	54.7	97.1	2.9
Coffee shop/snack-bar	0.0	85.6	85.6	14.1	100.0	100.0	100.0	0.0	1.3	28.2	66.1	33.9

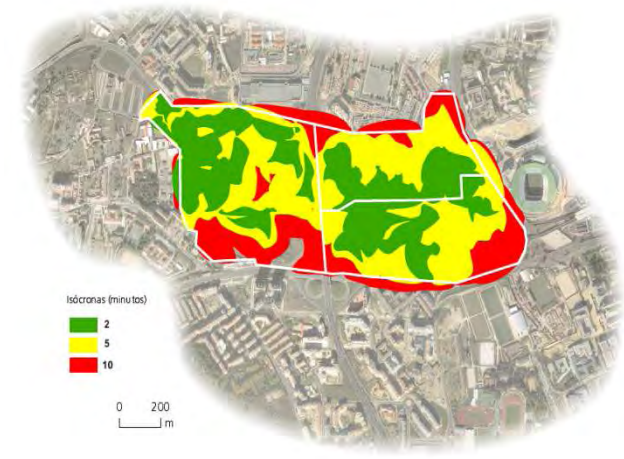




Figure 2. Isochronous simulating pedestrian travel time from coffee shop/snack-bar establishments in Telheiras.

Figure 3. Isochronous simulating pedestrian travel time from coffee shop/snack-bar establishments in Quinta do Conde.

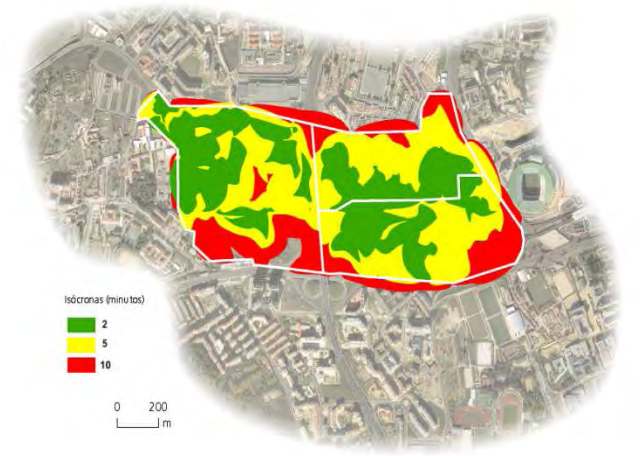




Figure 4. Isochronous simulating pedestrian travel time from local grocers and supermarkets establishments in Telheiras.

Figure 5. Isochronous simulating pedestrian travel time from local grocers and supermarkets establishments at Quinta do Conde.

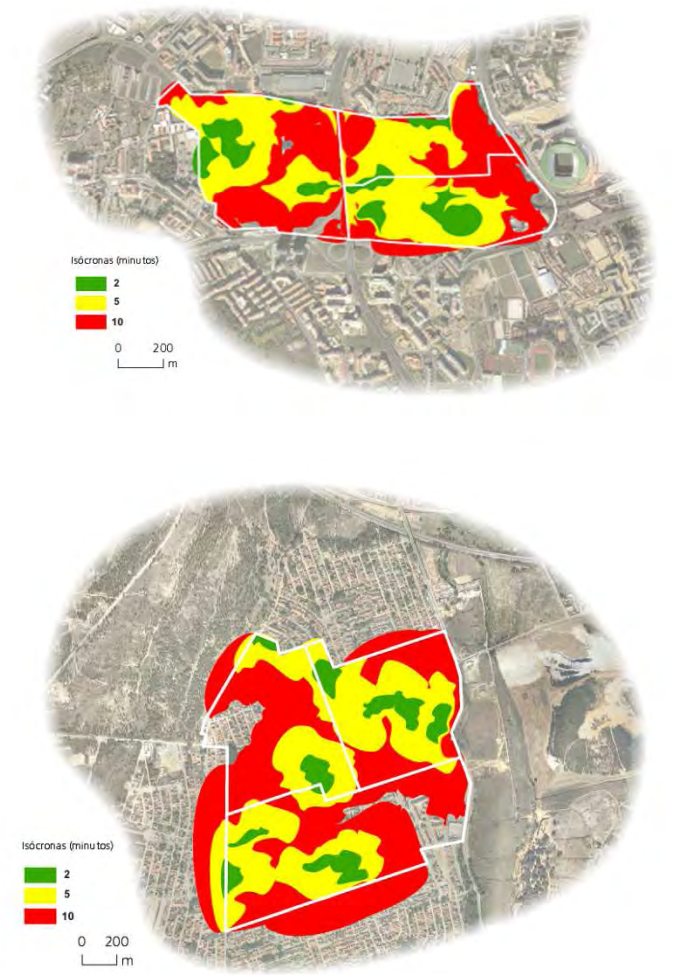


Figure 6. Isochronous simulating pedestrian travel time from the schools (public at all levels, only private education) in Telheiras.

Figure 7. Isochronous simulating pedestrian travel time from the schools (public at all levels, only private education), Quinta do Conde.

7. The Confrontation with Families Practices

In this section we set out to cross the information on the potential of residents in the neighborhood served by the three services under study with the population surveyed about their habits and travel times.

From the comparison of results for the residential area of Telheiras it appears that the majority of the inquired people takes over 5 minutes to reach a coffee shop/snack-bar, although the simulation indicated that only 5.6% of residents in the residential area of Telheiras had the need to move more than 5 minutes walk to reach a coffee shop or a snack-bar. However, for the surveys analysis it appears that the families practices in the residential area of Telheiras, in terms of the coffee shop/snack-bar establishments can be considered "sustainable" since 88% of the people polled take more than 5 minutes to walk to a service like this.

Concerning to the service schools the simulation indicates that 66.5% of the population is served by this service at a distance less than 5 minutes of pedestrian movement, while the survey results indicate that only 14.3% of the people polled takes less than 5 minutes to move to a service school, and here the people polled didn't make any preference between the mode of transport. In relation to walking more than 5 minutes, the simulation indicates that about 33.5% of the population is located more than 5 minutes walk of the schools. The surveys indicate that over 85% of the people polled takes more than 5 minutes walk to move to a service school. What could be related to school choices of residents and the adaptability to different level and field specialization.

However, as noted in the analysis of coffee shop/snack-bar services, the population has a sustained performance in the sense that only 52% travel on foot and, 33.3% moves by motor vehicle of their parents. This corresponds to youngest members of family that are dependent of their mothers and fathers to go to school in the neighborhood or near the labor place of their parents.

The simulation made for local grocers and supermarkets establishments shows that 70.6% of the population is 5 minutes walking of one service of this nature, but the information collected through the surveys indicates that only 5.9% population takes less than 5 minutes to reach a local grocer and of the people polled only 2% travel to the local grocer by foot, the vast majority uses the car. About 29% of the population needs to move more than 5 minutes on foot to go to a point of local grocers and supermarkets, however 94.1% of the population surveyed stated that they take more than 5 minutes to move a service for local grocers and supermarkets, and more than 50% of those uses their private vehicle. In this case it appears that the family practices are not in fact considered the most "sustainable". However, we realize that according to current living standards the personal vehicle allows an easier transport of purchases, which can be voluminous or heavy.

Finally, for the district Telheiras it appears that the use of public transport by the respondents is very low, in general, is only used for journeys to school services for young people.

In relation to Quinta do Conde we can verify in the simulation, that in relation to coffee shop/snack-bar for almost the whole population of this residential area, about 96%, they can reach this service in less than 5 minutes walk. When confronted this values with the results of the survey to the resident population we perceive that only 14% of the population takes less than 5 minutes to reach a service of this kind, although of these 14%, 11.6% choose to travel on foot, which is very favorable in the context of the sustainable communities. Regarding the simulation to a displacement of more than 5 minutes it appears that only 3.2% of the population takes more than 5 minutes to travel on foot, while the information collected through the surveys indicates that 86% of the people polled takes on average more than 5 minutes to go to a coffee shop/snack-bar, and of these, what is relevant is that 32.6% use their personal motor vehicle. It appears that walking is the preferred mean of locomotion of people polled, considering the service coffee shops/snack-bar but the percentage of population that uses the car is still considerable, which can be explained by the choices of families, probably because sometimes the act of going to the coffee shop/snack-bar by car is related to multi-travel of families.

Table 3. Levels of use of goods and services in the district Telheiras - confrontation between the potential population served less and more than 5 minutes away from second-time pedestrian mode (simulation) and actual values for the use of goods and services in the manner travel

Telheiras	Simulation by foot (%)	Survey Sample				Simulation by foot (%)	Survey Sample			
		Total	Way of deslocation				Total	Way of deslocation		
			Walk	Private Car	Public Transport			Walk	Private Car	Public Transport
	Time < 5 minutes					Time > 5 minutes				
Coffee shop/snack-bar	94.6	12.2	10.2	2.0	0.0	5.4	87.7	77.5	10.2	0.0
Schools	66.5	14.3	4.8	4.8	4.8	33.5	85.7	52.4	33.3	0.0
Local grocers and supermarkets	70.6	5.9	2.0	3.9	0.0	29.4	94.1	29.4	64.7	0.0

As for school equipment it appears that this service has a close relationship between the values obtained in the simulation and the values obtained by means of the survey. Thus, the simulation showed that about 44% of the population is less than 5 minutes walk from a school, and 36% of people polled report that they are 5 minutes walk from a teaching service. Regarding the preferred mode of transportation used the personal motor vehicle is the preferred mean, but the pedestrian movement is used in almost 45% of cases. The simulation of moving more than 5 minutes walk indicates that 56.5% of the population is situated at this level of time. 64% of the people polled report that they took more than 5 minutes to move to a school, and preferably by foot. But the use of the personal motor vehicle has a weight of 27,8% and only 5.6% uses the transport public to go to an education service.

Regarding the local grocers and supermarkets, the simulation of more than 5 minutes of pedestrian movement shows that only 38.8% of the population in the study area needs to move more than 5 minutes walk to reach a local grocer. The results obtained in surveys, 86% of the people polled stated that it takes more than 5 minutes to reach such a service, and of those 85% use their own motor vehicle to move, only 15% travel by foot. It is noticed that in the case of local grocers and supermarkets the use of the car is the personal preference of the majority of people polled for the comfort and convenience it offers, especially the habit of performing a higher volume of purchases, but more spaced in time. However it is necessary to implement daily practices more sustainable.

Table 4. Levels of use of goods and services in the district Quinta do Conde - confrontation between the potential population served less and more than 5 minutes away from second-time pedestrian mode (simulation) and actual values for the use of goods and services in the manner travel

Quinta do Conde	Simulation by foot (%)	Survey Sample				Simulation by foot (%)	Survey Sample			
		Total	Way of deslocation				Total	Way of deslocation		
			Walk	Private Car	Public Transport			Walk	Private Car	Public Transport
	Time < 5 minutes					Time > 5 minutes				
Coffee shop/snack-bar	96.8	14.0	11.6	2.3	0.0	3.2	86.0	53.5	32.6	0.0
Schools	43.5	36.1	16.7	19.4	0	56.5	63.9	30.6	27.8	5.6
Local grocers and supermarkets	61.2	14.0	5.3	8.8	0.0	38.8	86.0	12.3	73.7	0.0

8. Conclusions

The present article intends to create a network in a GIS environment to simulate the movement and definition of the population covered by the coffee schops/snack-bars, by schools and local grocers and supermarkets. Note that any analysis will always be based on a model developed for this purpose, hence the creation of a model of a network that has as its objective the simulation of reality, as regards the movement of people, will always be an element greatly simplified of the reality, that worked as a referential for the population distribution and their relation to 3 different services, that corresponds to 3 different levels of demand. This simulation only gave us an theoretical idea of population coverage services.

In our work we must considered some methodological limitations. Thus, from the methodological point of view should be careful in defining the sub-areas of study which became the basis for defining the potential of population and the logic of residential areas units adjusted to the school equipment, equipment use a key to families and has a formative character of the neighbourhoods in the organization.

From the empirical point of view, concerning the relationship between urbanization, urban form and sustainability emerges the importance of density as a differentiator of the everyday practices of families.

Still emerges as a factor explaining the location of the district under the Metropolitan Area of Lisbon, the difference between the consolidated city and a suburban location, which has different practices. This raises the issue of mobility in private transport as a predominant feature in the consolidated city and outskirts. This generalizes to everyday practices, such as going for coffee shop/snack-bar, local grocers and supermarkets and school equipments.

As pointed in our analysis, the demand of the 3 services depends on family composition (age, families with children under 15 years old, more dependents of their parents for mobility, children with autonomous mobility linked to public transport and others) the density of the public transport network, as well of place of work of the active members of the family. Another relevant aspect is linked to private car mobility and multi-travel behaviour. The travel days between Home and work, includes shopping, kids to schools, sports, and other activities, which justifies the high percentage of families that go by car to access the 3 exercised services, in stead of do it by pedestrian way. A better

understanding of these family practices should be taken in account in order to develop a sustainable local planning.

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Spatial Segregation and Urban Accessibility in Brazilian Cities

Ana Barros *, Valério Medeiros *, Maria Morais **

* Department of Architecture, University of Brasilia

** Department of Regional and Urban Studies, Institute of Applied Economic Research (IPEA)

anapaulabgb@yahoo.com.br, medeiros.valerio@uol.com.br, piedade@ipea.gov.br

Phone/fax numbers: 00 5561 33155033/5412

The article shows the relation between the degree of urban mobility, place of residence, land use patterns and income level of the population, trying to identify in what way the spatial interpretation of socioeconomic segmentation can contribute to the understanding of the mobility patterns and urban accessibility in Brazilian cities. The methodological approach used in the study is the Theory of the Social Logic of Space or Space Syntax that associates the spatial configuration of cities with the subjacent social relations. The study performs the analysis of 03 main variables for several Brazilian cities, including São Paulo, Recife, Belém and Manaus, among others: (1) income level of the household head; (2) type of neighborhood (substandard sectors used as a proxy to slums; other precarious sectors not classified as slum; regular neighborhoods); and (3) integration indexes, derived from the axial maps of these cities. Our results demonstrate that there is a strong correspondence between income level and type of neighborhood, with the population living in substandard and precarious sectors presenting lower income levels than the city average. There is also a strong correlation between integration indexes, income level and type of sector, with the areas where low income population lives, usually in substandard or precarious settlements, corresponding to the less integrated neighborhoods, showing a process of involuntary segregation. The opposite is also observed: the higher the income levels, the lower the probability of living in informal settlements and the higher the levels of topological accessibility as measured through integration indexes.

Keywords: urban mobility, spatial segregation, space syntax, accessibility, integration

1 Introduction

The rapid urbanization process in Brazil, during the 20th century, is due to a series of factors such as industrialization, rural-urban migration, demographic growth and public policies, that, together, favored the great transformation of the cities in the country, with more than 81,2% of the Brazilian population now living in urban areas. This urban growth had occurred very fast, mainly between 1960 and 1980 (ROLNIK, 1998; VILLAÇA 2001; SANTOS, 2005), producing a contemporaneous scenario that presents several challenges to the improvement of the quality of life of the country´s population.

Maybe the most visible consequence of this disordered urban growth is the process of spatial segregation that had occurred in Brazilian cities, with the low income population tending to locate in illegal settlements in the periphery of the metropolitan areas or in slums in risky prone or *non aedificandi* areas, thanks to the high value of the urban land, as compared to the income level of the majority of the population. This fact progressively provokes the social and physical apartheid between the periphery, the slums, the rich neighborhoods and the active centers – understood as that part of the city to where converge, in quantity and quality, diverse uses and different flows (HILLIER AND HANSON, 1984; HILLIER, 1996; TRIGUEIRO, 2001).

The great distances, besides provoking an increase in average commuting distances, progressively produce an urban space that, fragmented, puts the different social groups apart.

Besides, it ends up causing serious negative externalities to the urban agglomerations, taking into account that they provoke an increase in the economic, social and environmental costs of urban transportation (infrastructure, maintenance, prices, urban sprawl, pollution and carbon emissions etc.) and a reduction in the citizens capacity to move/circulate. Due to promotion of gradually greater distances, the movements to and from the central areas (but also to the diverse component parts of the city) are reduced, causing, then, serious implications to the urban mobility.

The definition of urban mobility is comprehensive and relates to the dynamics and permanence of cities as well as to the patterns of social relations in the urban space. Etymologically, urban mobility refers to the movement or capacity to move what includes the notions of circulation and accessibility in the urban space. In the urban context, mobility is above all, a mean, not an end in itself, incorporating a series of implications that enable the performance and the realization of social relations that exist in the city. The analysis of the literature brings more specific meanings to the definition of urban mobility, MACÁRIO (2007) defines urban mobility as “the aggregated result of the multiple decisions (and factors conditioning those decisions) taken by individuals and economic agents as an answer to their requirements of displacement of people and goods”. According to the author, urban mobility is conditioned by the location of economic and social activities in the city, the pattern of working hours, the opportunities for social interaction as well as other cultural aspects.

THE MINISTRY OF CITIES OF BRAZIL (2005), defines urban mobility as “an attribute of the cities that refers to the facility of movements of people and goods in the urban space. Such movements are made through vehicles, routes and all related infrastructure such as pavements, etc.” According to this vision, the facility of movement seems to be exclusively a product of the infrastructure that serves as support to circulation, revealing a strong content of space geometry, taking urban mobility as a dependent variable of the organization, function and performance of routes and pavements, etc. This concept is restricted to the transport arena and does not incorporate other characteristics that are important to the evaluation of the capacity to move. According to VASCONCELLOS (2001), the interpretation of urban mobility needs to go beyond the questions that deal only with spatial geometry and space project and should incorporate variables such as land use, income, employment, age, gender, schooling, household size, etc.., expanding the items that influence the performance of such movements.

This paper presents precisely an effort in such sense, by incorporating in the study of urban mobility and accessibility, questions related to spatial segregation by census tract, neighborhood, and household income strata. To this set of variables that are important either by (1) questions of traffic engineering or (2) insertion of the socioeconomic aspects of the people involved, still lacks a view that incorporates the spatial structure of the city, in its complex network of interactions, as a variable of significant importance to urban mobility – what implies, then, the insertion of the configurational variable in the analysis. Figure 1, below, shows that different spatial structures generate distinct patterns of movements and degrees of integration, where the colors represent the potential movements: red colours meaning higher integration while blue colours mean lower integration.

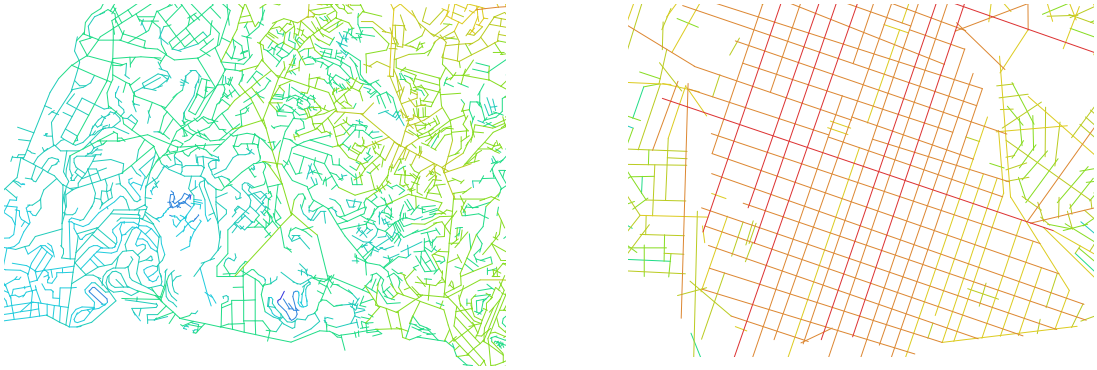


Figure 1. Axial Maps - On the left Salvador (Bahia) and the significant irregularity of its streets ; on the right Pelotas (Rio Grande do Sul) and its regular grid in a chess table format.

This article investigates the use of the configurational variable to study spatial segregation and urban mobility in 4 Brazilian cities (Belém-PA, Manaus-AM, Recife-PE and São Paulo-SP), with a focus in precarious settlements and in the location of social classes in the urban space and their relative degree of accessibility/integration to the city as a whole.

The study is part of a bigger project of the Institute of Applied Economic Research (IPEA) called “Characterization and Typology of Precarious Settlements in Brazil” and searches to verify in what extent such settlements are more segregated/isolated in the urban fabric comparing to the other areas of the city. For this purpose, we have used the classification of census tracts elaborated by the Centro de Estudos da Metrópole-CEM (MARQUES ET AL., 2007), based upon microdata from the demographic census of the Brazilian Census Bureau (IBGE), as well as axial maps of these cities, according to the methodological tools of the Theory of the Social Logic of Space (HILLIER AND HANSON, 1984).

Our objective is to understand how the investigation of the different degrees of road accessibility distributed over the urban system, originated in the ways of articulation between the component elements of the city (spatial configuration), are able to reveal significant findings over the process of spatial segregation, what can contribute to the formulation, monitoring and evaluation of actions, projects and urban policies. In this sense we intend to insert the discussion of how the structure of the road network (design/layout of the roads), understood in its relational aspects, i.e., the interdependence between the diverse component parts, is able to interfere in the circulation aspects (action of circulate), accessibility (capacity to reach a certain place) and spatial segregation (distribution of individuals by income, social class, race or any other factor related to the physical separation of the distinct social groups in space, according to their local of residence/housing conditions).

The confrontation of these information, organized on a Geographical Informational System (GIS), allowed a series of interpretations over the existing process of “voluntary” and “involuntary” segregation in such cities, highlighting the importance of the configurational variable to explain residential segregation in Brazilian urban areas.

The article is divided in 3 more sections, besides this introduction. Section 2 describes the methodological considerations relative to the space syntax and the procedures adopted in the study.

Section 3 presents the preliminary results of the research for the municipalities of Belém, Manaus, Recife and São Paulo municipalities, also showing with detail the integration values among the different neighborhoods of São Paulo. Finally, section 4 presents the main conclusions of the article.

2 Methodology

The Social Logic of Space

As a theoretical and methodological tool to discuss spatial segregation and urban form, we have adopted the Theory of the Social Logic of Space, more well-known as space syntax, that investigates the space from the social logic incorporated in it. It means to say that in the conception of urban space there are implicit (or explicit) social attributes that belong to the society that builds it, according to a series of expectations, including the ones of circulation.

The objective of the Space Syntax is to study the relations between the architectonic space – also understood as the urban space – and society – seen as a system of the possibilities of meetings (HOLANDA, 2002). The creation of this theory, supported by systemic and structural thoughts (HILLIER et al., 1993; LEFEBRE, 1999), derives from the worry that according to HILLIER and HANSON (1997), "(…) the (space) theories had been extremely normative and less analytic". According to Hillier (1999) the main research question addressed by space syntax is: "what, if any, is the effect of the built environment *in itself* on what happens in cities"? For the author the method can be used as a general tool for studying the interactions between the physical structure and the functions of cities.

To the authors of the Theory of the Social Logic of Space, the gradual development of the techniques had convinced them that there is, in the investigation of space, a very important relational property called "configuration" (HILLIER and HANSON, 1997). Configuration is, therefore, a complex of interdependency relations in space with 2 fundamental properties – the configuration is different when seem from: (a) different points within the same system; and (b) only from a part of the system. Due to changes in one of the elements of system or in one relation, the entire system can be altered in various degrees. The interpretation of the variations in the configuration can reveal attributes derived from the interaction of the space form and different processes associated to circulation, accessibility and urban mobility.

The investigation of these associations can reveal new interpretations about the urban phenomena, bringing information about the movement related questions that occur in the city. About this subject, engineers, architects and urban planners, when looking over the space, several times don't understand that their focus of action surge and is a product of a series of complex relations associating different components. Either the physical objects (buildings, neighborhoods, roads and circulation systems) or these relations are a product of the concept of space and represent properties closely related to their functioning.

In terms of tools, the Space Syntax, offers instruments to understand and represent the urban space. Of the recommended strategies, the linear representation is useful to investigate the movement and its related urban aspects and is the one that better applies to big systems and structures such as the city. The linear representation is obtained designing over the road network, from the available cartographic base, the smaller number of possible lines that represent the direct

accesses through the urban space. After the processing of such lines, we can generate a matrix of intersections, from where are calculated, by especially programmed applications, values that correspond to their axial inter-relations (HILLIER and HANSON, 1984; HILLIER, 1996; HOLANDA 2002; MEDEIROS, 2006), representing the potential of attraction of the flows and movements of a certain axis within the urban system, called the value or potential of integration, accessibility or permeability. The integration values can be represented numerically or by a chromatic scale with graduation going from red, passing through orange, green until reaching blue – where the more integrated axis tend to red and the less integrated to blue –producing the so called axial map (Figure 2) .

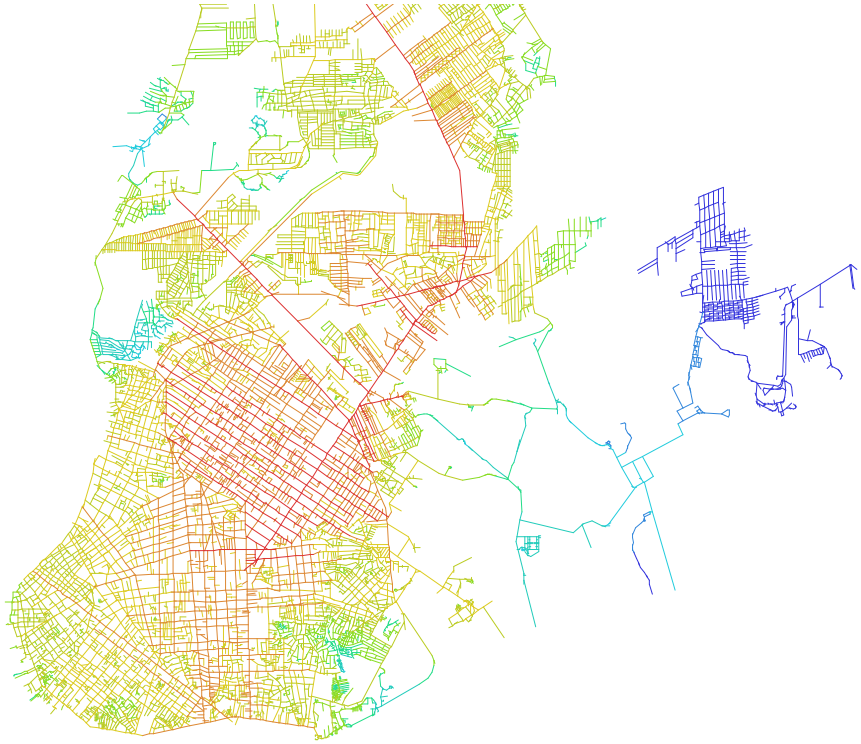


Figure 2. Axial Map of the municipality of Belém – Pará.

The more integrated axis are those more permeable and accessible to the urban space, from where it's easier to reach the others. They imply, on average, the shorter topological ways to be reached from any other axis of the system. More integrated axis tend to assume a position of control, once they can connected themselves to a higher number of axis and hierarchically present a higher potential of integration. To the set of the more integrated axis is given the name of integration core.

From this information, it can be inferred that from the procedures that investigate the configuration of the road network of a city, the simulations done by the Spatial Syntax consist of an instrument able to measure, quantify and distinguish different levels of connections between each road and the system where it is inserted, establishing in such way correlations, connections and hierarchy between the roads and the urban complex (MEDEIROS, 2006). This permits, consequently, the visualization of the road network in several gradations of the potentials of flows and movements, that is, of integration. It becomes perceptive the definition of areas with a predominance of axis with

high potential of movement in opposition to those peripheral areas with less flows. We have, in such way, a valuable tool to study urban mobility by facilitating that factors related to urban configuration can be quantified mathematically and easily visualized and therefore can be correlated with several information that involves movement and circulation.

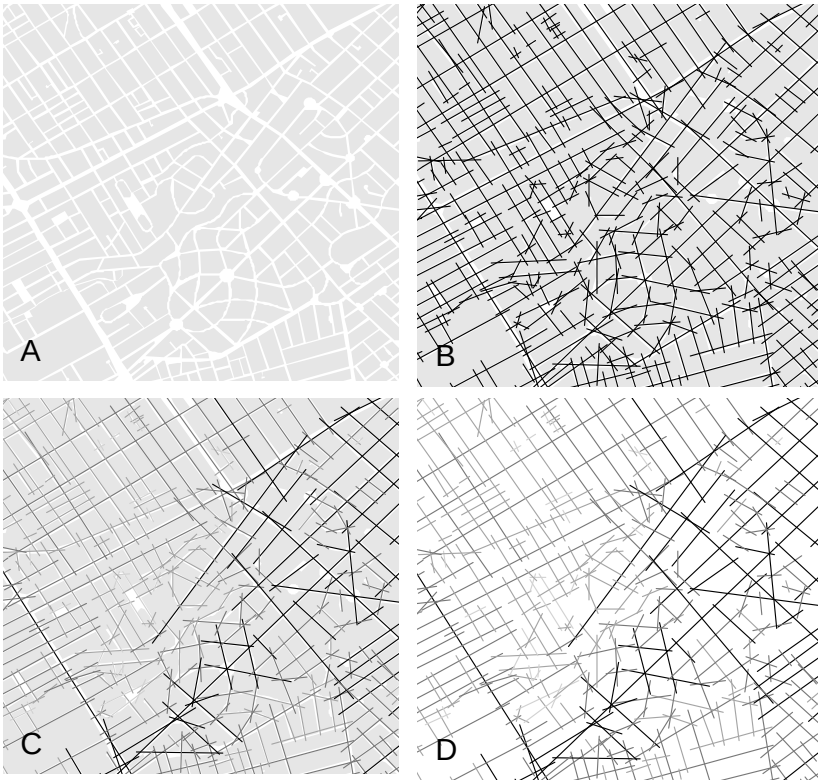


Figure 3. Process of construction of an axial map in a section of the city of São Paulo: over a cartographic base (A) are designed the axis representing the possible movement routes (B). This grid of connected axis is analyzed and one of the resulting measures is the integration value, presented graphically as an axial map (C e D). The darker the line, the more accessible: and *vice-versa.*

Other procedures

After the survey of the information on accessibility of the axial maps (derived from the study by MEDEIROS, 2006) for a) the urban systems as a whole and for b) the census tracts classified as substandard by IBGE c) the census tracts classified as precarious by CEM and d) the other urban sectors, the data was compared with information on head of household income in minimum wages, collected at CEM data base.

The results related to the different types of census tracts and household income levels in the 4 studied cities are then compared with the indicators of road accessibility (integration value). For the case of São Paulo we also calculated the integration indexes for the different neighborhoods of the city. All the information was displayed in a GIS software, in order to help the visual and statistical correlation of the variables.

Our objective was to verify what are the most common patterns of spatial segregation, according to GIST and FAVA classification (apud VILLAÇA, 2001) in voluntary segregation (when the individual or

the family opts for isolation) and involuntary segregation (when the individual or the family is forced to live in certain parts of the city). Specifically, the study tries to verify in what extent the population living in the so called precarious settlements suffers from involuntary residential segregation and are more isolated in the city than the regular neighborhoods, resulting in less urban mobility and accessibility to the city as a whole.

In this study, we understand by precarious settlements the sum of the census tracts classified by IBGE (2000) as special sectors of substandard agglomerations[143], such as an "agglomeration constituted by a minimum of 51 dwelling units (shacks, houses) occupying until recently, land belonging to others (either public or private), generally disposed in a dense and disordered manner and lacking essential infrastructure services, also designated as informal settlements, slums ("favelas"), "mocambos", "alagados", etc., together with those sectors classified by the CEM as precarious ("those sectors identified by IBGE as regular but very similar to substandard sectors, according to socioeconomic, demographic and housing characteristics; MARQUES et al. 2007)[144].

Table 1. Variables used in CEM study to classify precarious settlements

Dimension	Variable
Housing and infrastructure	% of households without garbage collection
	% of households without connection to water network
	% households without bathroom
	% households without sanitation from public network or septic tank
	% households type room
	% households –other tenure conditions
	% households – other tenure regarding land
	Bathrooms per inhabitant
Income and Schooling of the household head	% illiterate head of household
	% head of illiterate household with less than 30 years old % of household head with less than 3 minimum wages
	% of household head with less that 8 years of schooling
	Average years of schooling of the household head
	Average income of the household head
	Number of permanent private dwellings in the census tract
Demographic aspects	Number of improvised dwellings
	Number of people living in the census tract
	% of household head with less than 30 years old
	Average person per dwelling

Source: Marques et al. (2007) Assentamentos Precários no Brasil Urbano

[143] For the 2000 census, IBGE divided Brazil in 215.811 census tracts (smaller spatial disaggregation for statistical information, that corresponds roughly to 300 households), classifying them as regular sectors and special sectors of substandard agglomerations, boats, camping, prisons, asylum, indigenous camps etc. In Brazil there were 7.9891 census tracts classified as special sectors of substandard agglomerations by IBGE, 98% considered by CEM, that realized the study considering the 56 municipalities with population over 150 thousand inhabitants in 2000 (MARQUES et al. 2007).

[144] For more details over the methodology and the variables used in the CEM study see FERREIRA et al (2007).

2 Main Results

This section presents the preliminary results of IPEA study on Urban Form and residential segregation for the municipalities of Belém, Manaus, Recife and São Paulo. Table 2 shows the population living in precarious settlements, that corresponds to the sum of people living in IBGE substandard census tracts (A) and the sectors classified as precarious by CEM, whose socioeconomic characteristics are similar to substandard sectors (B), according to the set of variables listed in table 1.

Table 2. Population living in precarious settlements in urban areas (including rural areas of urban extension), by sector and municipality- 2000

Municipality	People in Substandard Sectors (A)	People in Precarious Sectors (B)	People in Precarious Settlements (A + B)	Total Population	% people living in precarious settlements
Belém	447,915	205,039	652,954	1,268,230	51.49
RM Belém	580,329	320,743	901,072	1,756,793	51.29
Manaus	166,870	193,006	359,876	1,389,892	25.89
Recife	134,317	121,990	256,307	1,413,119	18.14
RM Recife	226,833	311,379	538,212	3,223,037	16.70
São Paulo	902,490	557,158	1,459,648	10,215,800	14.29
RM São Paulo	1,652,757	963,421	2,616,178	17,476,789	14.97
Brazil*	6,365,573	6,050,258	12,415,831	88,084,143	14.09

Source: Marques et al. (2007), based on IBGE 2000 Census microdata. Elaboration: the authors.
* Refers to the 56 municipalities with population over 150 thousand inhabitants in 2000

As we can see in the above table, the highest level of precarious housing in relative terms is found in the cities of the North region, mainly in Belém municipality, where more than half of the population lives in precarious settlements (51.5%). São Paulo presents the highest absolute numbers of the problem, with almost 1.5 million people living in precarious settlements. Manaus (25.9%) and Recife (18.1%) also present a percentage of precarious housing above the national average (14.1%).The population living in precarious settlements are concentrated mainly in the core municipalities of the metropolitan regions. Belém, for instance, accounts for almost 73% of the total population living in precarious settlement in Belém Metropolitan area. The proportion of precarious settlement population concentrated in the core municipality is 47.6% for Recife and 55,8% for São Paulo.

Table 3 presents the socioeconomic characteristics by type of sector, showing the existence of high inequalities in income, schooling and access to urban services such as water, sanitation and garbage collection, among the precarious settlements and other regular neighbourhoods of the studied cities. The table also shows the similarities in quality of life between the substandard sectors and CEM precarious sectors in terms of access to services and social vulnerability, as was expected.

Table 3. Characterization of Precarious Settlements according to selected socioeconomic indicators by Metropolitan Area- 2000

Metropolitan Area	Type of Sector	Average Income of household head	Average years of Schooling of Household head	% households without access to public water network	% households without garbage collection	% % households without sewage network or septic tank
Belém	Substandard	337.43	5.74	38.17	12.51	41.97
	Precarious	378.48	5.78	45.61	16.02	40.65
	Regular	1,014.59	8.63	31.93	3.34	7.23
	Total	684.26	7.19	36.42	8.55	24.35
RM Recife	Substandard	259.62	4.54	14.03	22.23	64.24
	Precarious	312.37	4.75	18.26	24.61	64.3
	Regular	758.13	7.08	13.24	10.03	46.79
	Total	602.03	6.69	13.77	12.24	49.63
RM São Paulo	Substandard	357.92	4.53	3.89	3.79	42.65
	Precarious	450.34	5.0	5.48	4.09	43.27
	Regular	1,244.03	7.61	2.41	0.74	7.07
	Total	1,129.39	7.22	2.69	1.17	11.88
Brazil*	Substandard	326.30	4.69	12.47	9.3	38.67
	Precarious	382.49	4.97	17.10	13.71	40.60
	Regular	999.60	7.36	8.12	3.74	17.15
	Total	915.75	7.03	8.98	4.74	20.06

Source: Source: Marques et al. (2007), based on IBGE 2000 Census microdata. Elaboration: the authors. * Refers to the 56 municipalities with population over 150 thousand inhabitants in 2000.

By analyzing the variables of head of household income level and type of sector *versus* the road accessibility originated from the axial maps, we can notice that there is a positive correlation for all the studied cities, as there is a clear tendency of high income people or the residents of regular/ non-special census tracts (proxy for medium and high class neighbourhoods) to locate near the more central areas or in areas of higher degree of accessibility. Such parts of the city, as revealed by the axial maps, coincide with the so called active centers or integration core, that is, areas with a higher number of roads and potentially more accessible to the circulation system as a whole (red axis).

For the 4 studied cities, we have observed that as the income level increases there is a tendency for a progressive increase in the average integration value, what means higher accessibility/proximity to the urban active center and therefore higher facility of movement (Figure 4). On the other hand, the smaller the income level the higher the distance to the urban center, expressing how much accessibility is a good indicator of social status in Brazil, except for the cases of voluntary segregation. Finally, accessibility is a good that is positively incorporated, especially by the real estate market and that is reflected in the price of housing.

When we observe the average degree of integration for CEM precarious tracts (proxy for peripheral allotments) and IBGE substandard sectors (proxy for slums) in relation to the averages for the regular/non-special sectors (proxy for medium and high income neighbourhoods) and for the city as a whole (Figure 5), except for Recife, where the location pattern of precarious settlements is relatively more central, it is perceptive how much these spaces related to precarious settlement belonging to A and B groups are less accessible and present lower integration averages, except when located near the city center, in marginal areas with high level of inclination/slope and river and lakesides, mainly. On average, in general, the IBGE substandard sectors present more central locations when compared to CEM precarious sectors, reaffirming the results of other studies on the

subject, that argue that the population living in slums search for locations near employment centers (MORAIS et al. 2003).

In Belém, for instance, the study confirms that medium and high income classes (head of household income above 20 minimum wages) are located in the noble areas of the city (Nazaré and Batista Campos neighborhoods), located near the integration core (Figures 6 and 7). Even in smaller scale, there are also sectors of closed condominiums, with high household income level, located in peripheral areas such as Parque Verde neighborhood, what represents the scenery of voluntary segregation in the so called fortified enclaves or gated communities, as CALDEIRA (2000) defines.

Our results agree with Lima (2001), who argues that mobility in the peripheral areas of Belém is restricted by the internal layout and by the distance of social housing and informal settlements from the main arterial road and bus stops, forcing the population to walk long distances to get access to public transportation. This author also found that the high income classes tend to locate in central areas and in luxurious gated communities in the periphery, while the poor are located in informal settlements in central areas (“baixadas”) or in the urban fringe.

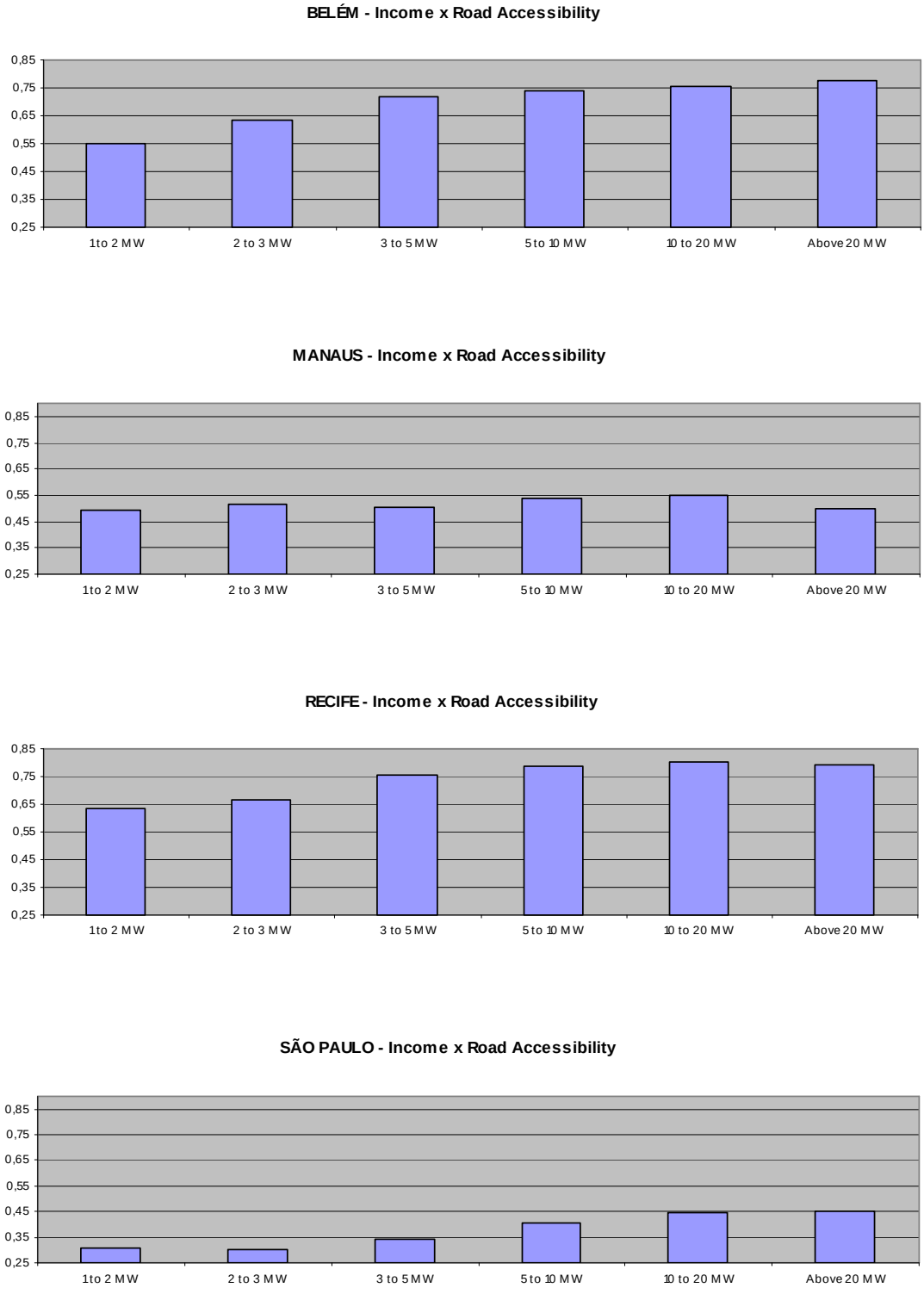


Figure 4. Correlation between average head of household income, in minimum wages, (x) and road accessibility (y).

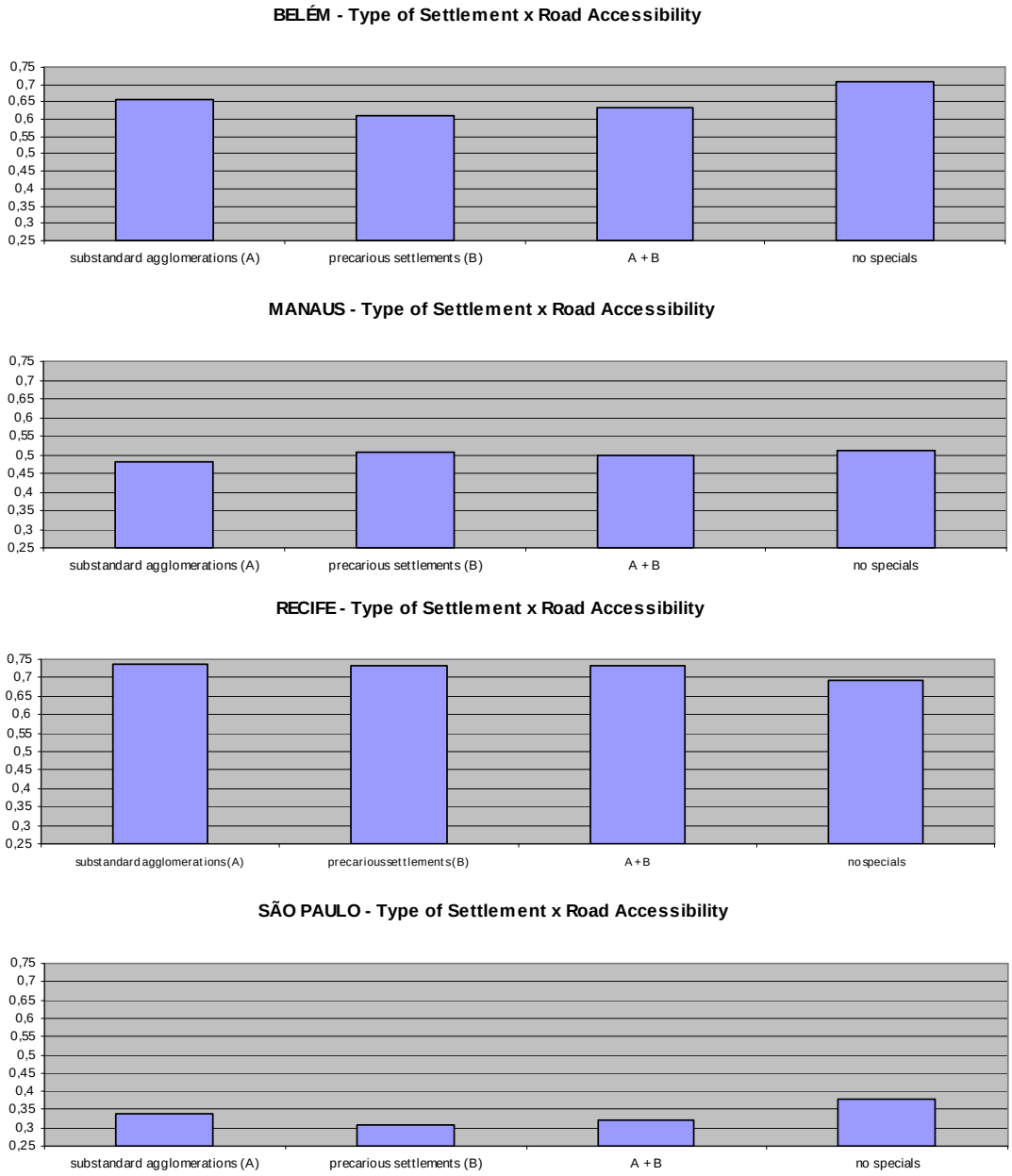


Figure 5. Correlation between type of settlement (x) and road accessibility (y).

It is important to clarify, however, that such scenery of voluntary segregation is relative, because despite the higher distance, such areas tend to be accessible from express roads that reduce distance, like the BR 316, that acts as the continuation of Almirante Barroso Avenue and penetrates Belém, in the format of one of the higher accessible road of the system. On the opposite side, cases of involuntary segregation are located in the neighborhoods of Terra Firme and Guamá, with low accessibility in relation to the entire urban system, that present average household income around 1 to 3 minimum wages, conforming patterns of precarious settlements (Figure 8).

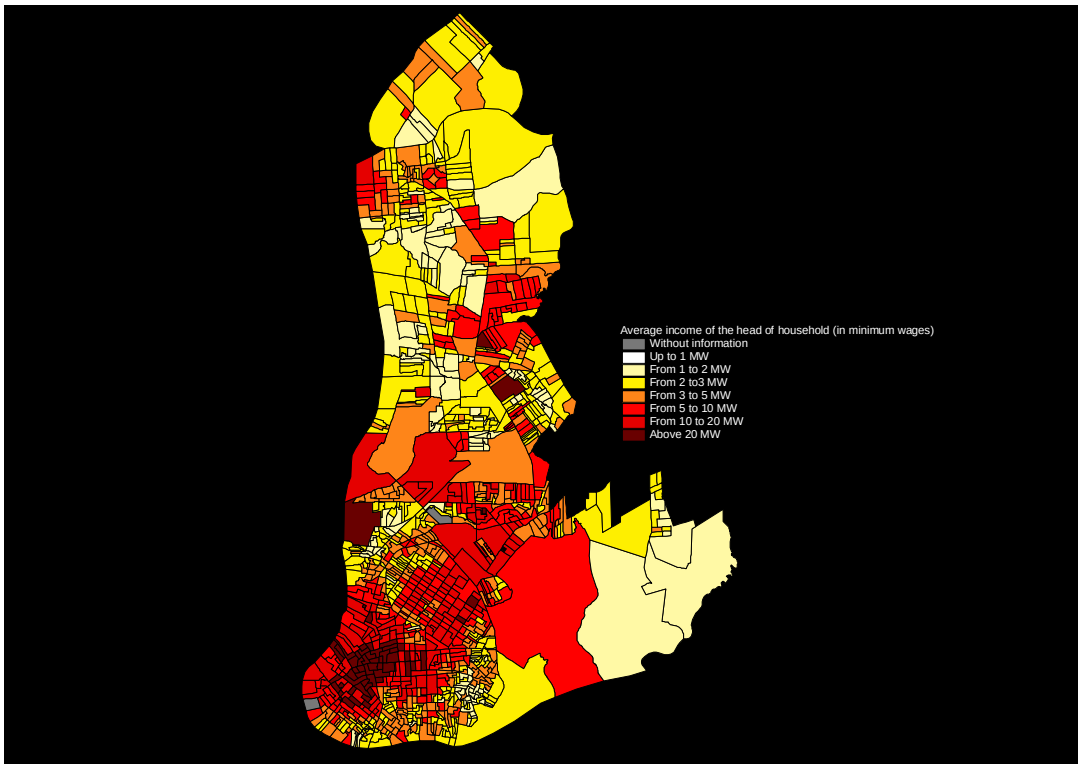


Figure 6. Belém: average income of the head of household (in minimum wages).

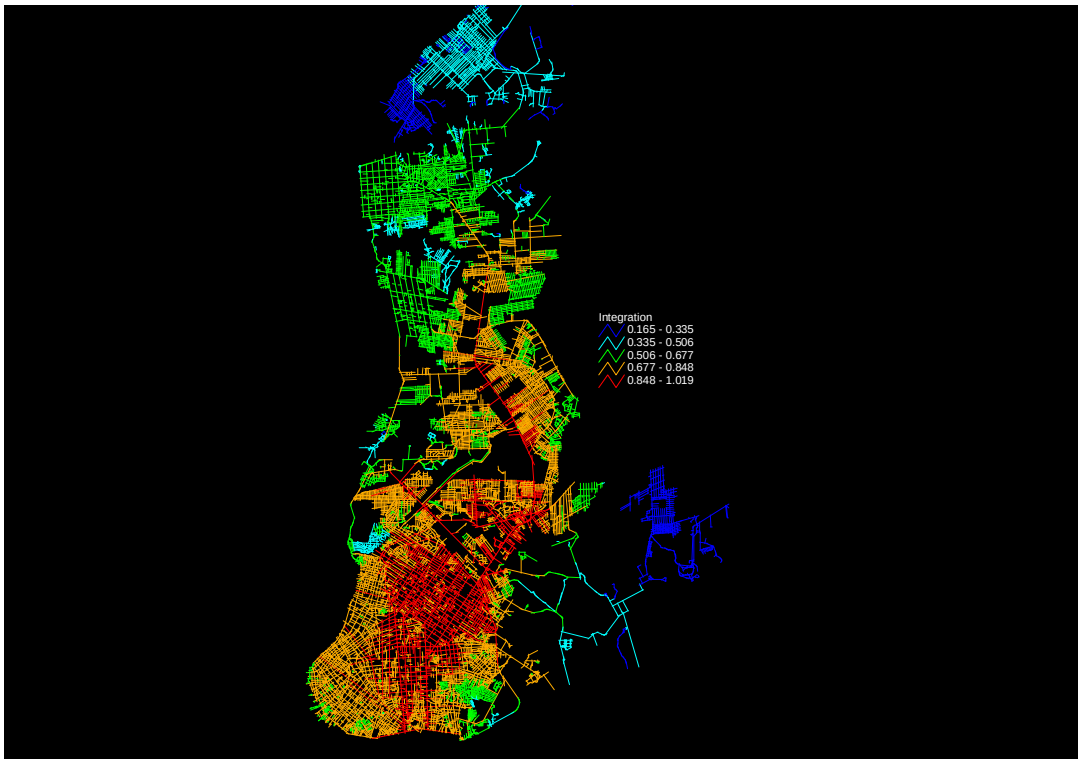


Figure 7. Belém: axial map.

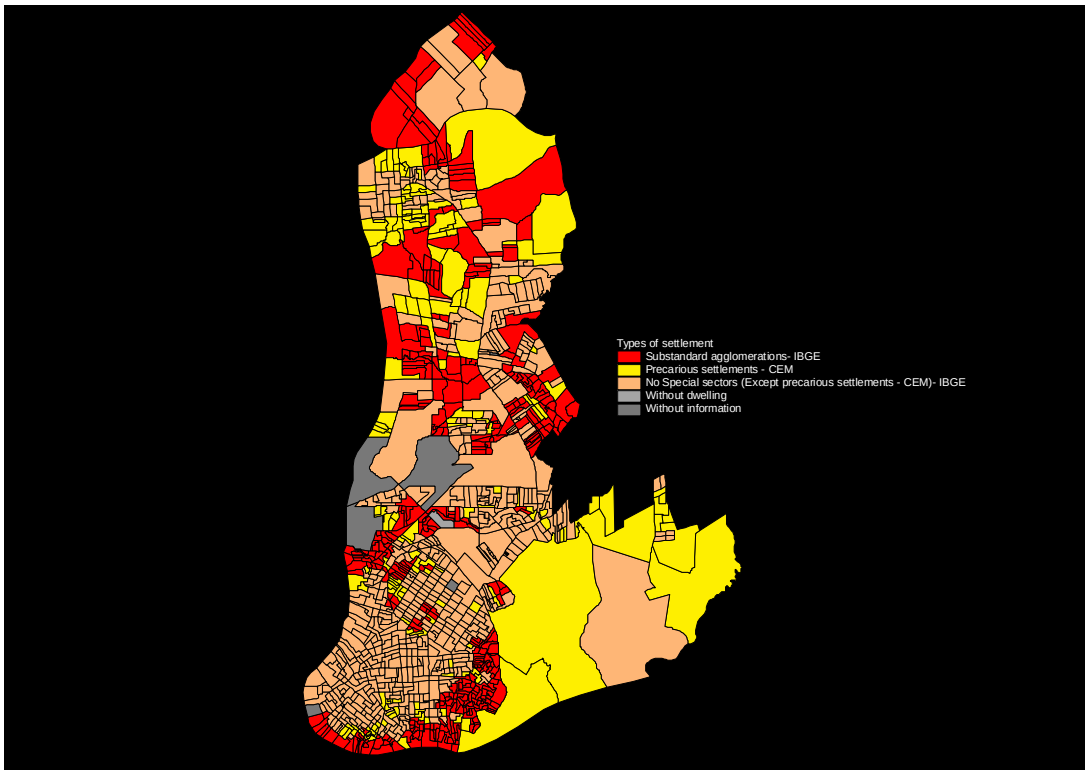


Figure 8. Belém: type of settlement.

In Manaus, the medium income and medium-high income classes are located near the urban center, accompanying its active center or integration core (Figures 9 and 10), and its distribution can be considered in dispersed when comparing to Belém. In Manaus volunteer segregation also occurs, especially in the Ponta Negra neighborhood in the west part of the city, that concentrates a good parcel of the population whose the head of household average income level is above 20 minimum wages. The lower income classes are located near the center to the south, occupying marginal areas derived from land filled water streams, or more distant areas to the north and the east, what can be noticed by the strong presence of precarious and substandard sectors in those areas (Figure 10).

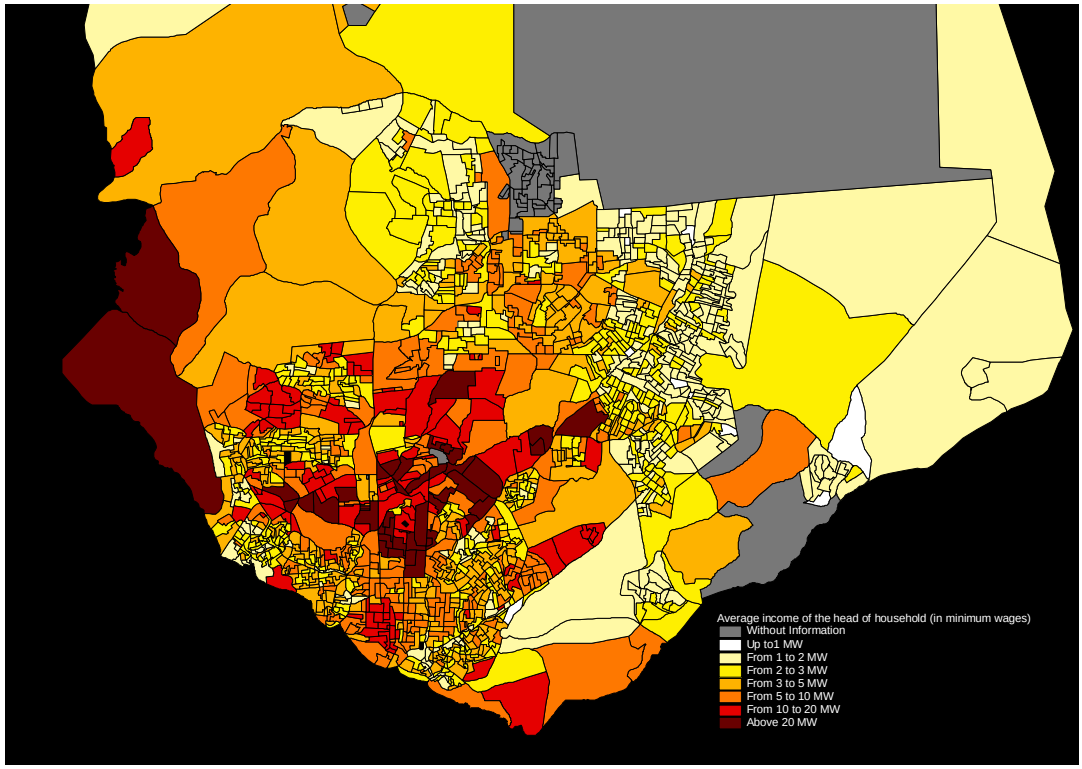


Figure 9. Manaus: average income of the head of household (in minimum wages).

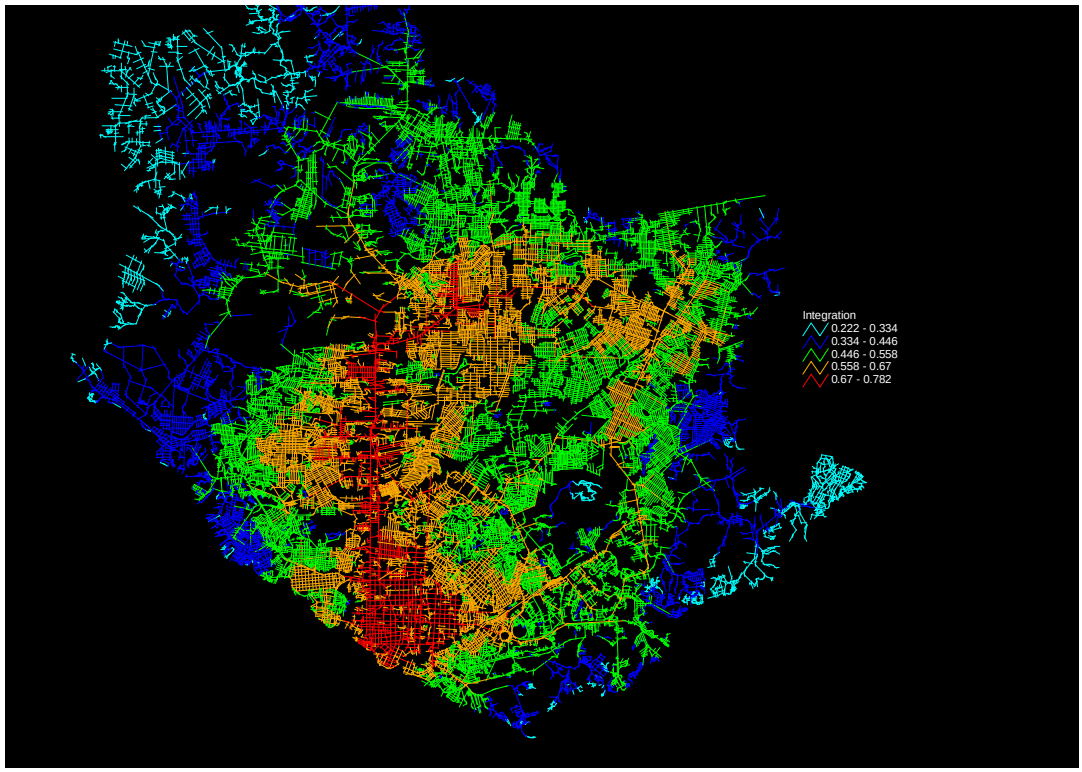


Figure 10. Manaus: axial map.

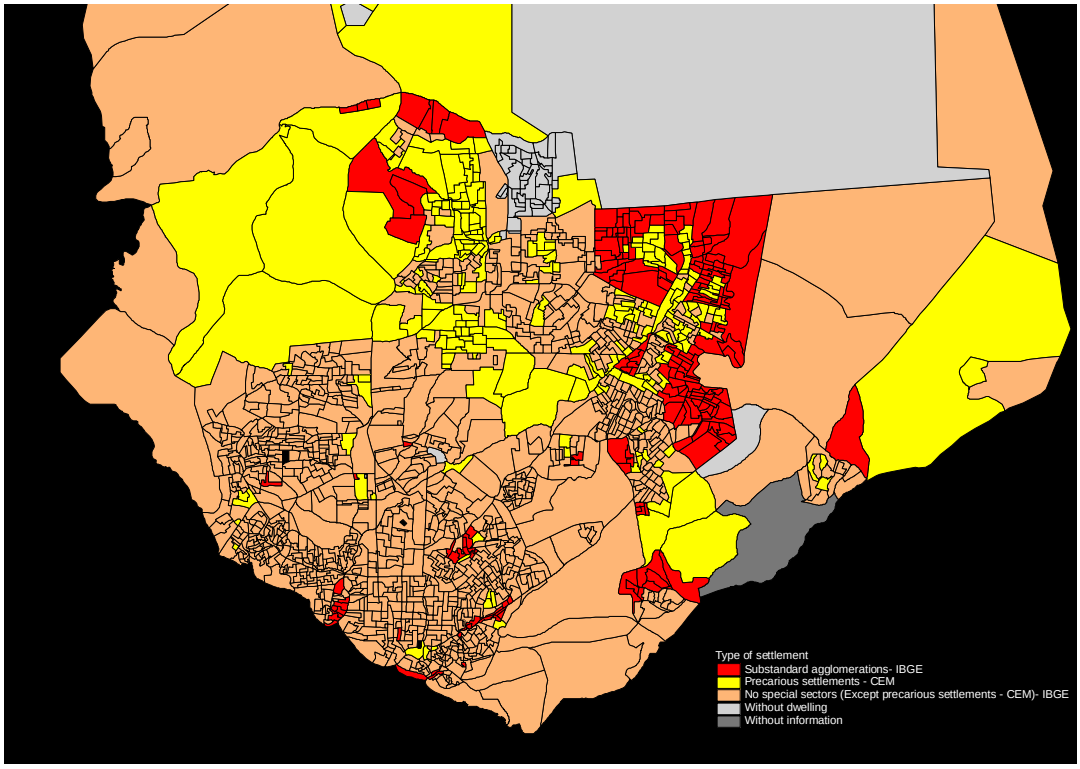


Figure 11. Manaus: type of settlement.

In Recife, the active urban center (Figure 13) is located in the center north part of the city, coinciding with Graça neighborhood, that concentrates the high income households (above 20 minimum wages – see Figure 12). The Boa Viagem neighborhood corresponds to a hotspot of voluntary spatial segregation, as the income levels are similar to the ones in Graça, the same happening in the south expansion, still going trough the municipality of Jaboatão dos Guararapes (Figure 14).

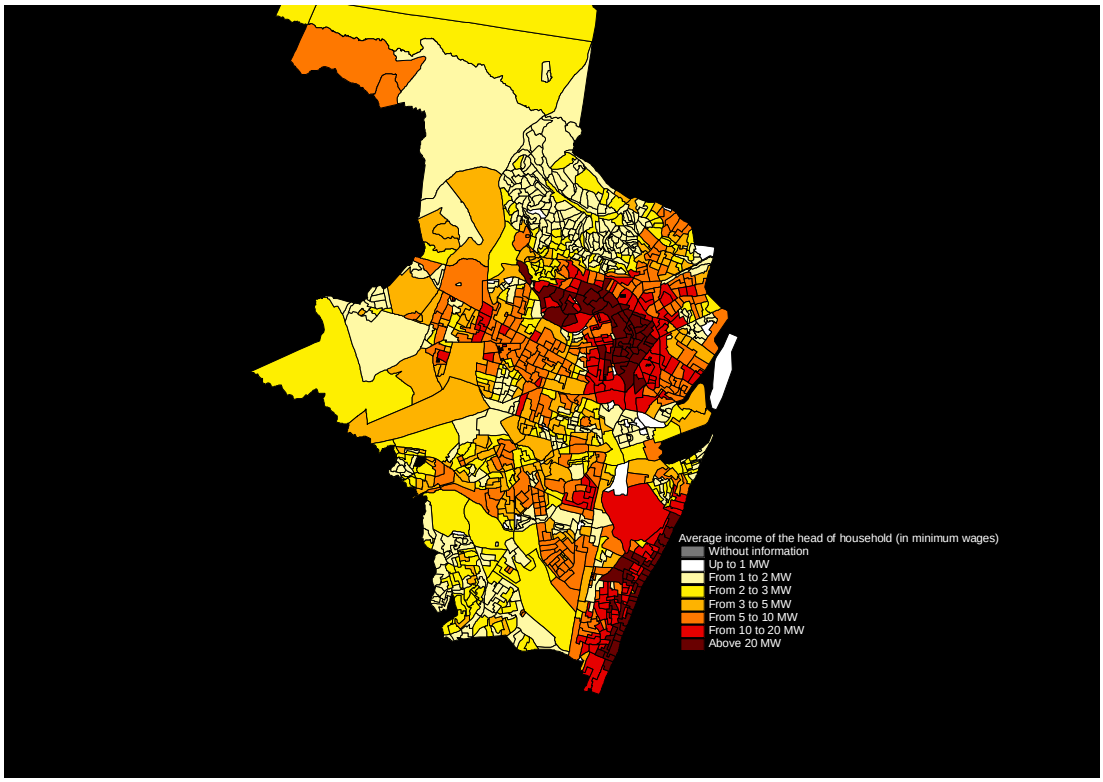


Figure 12. Recife: average income of the head of household (in minimum wages).

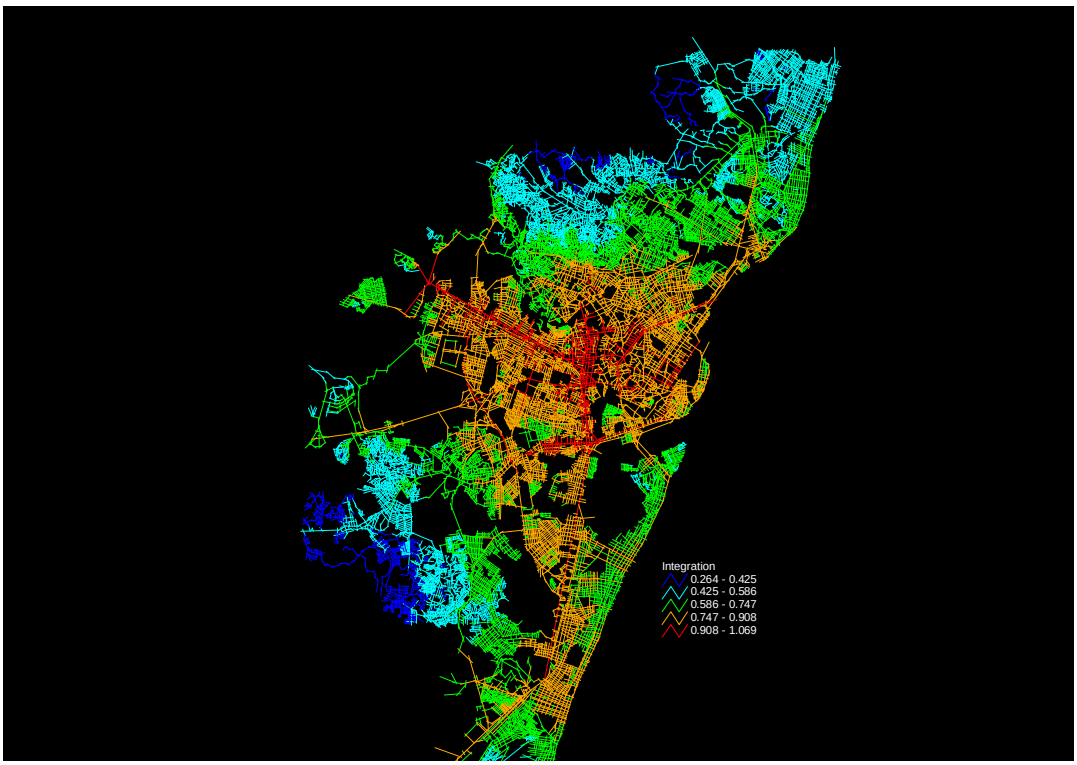


Figure 13. Recife: axial map.

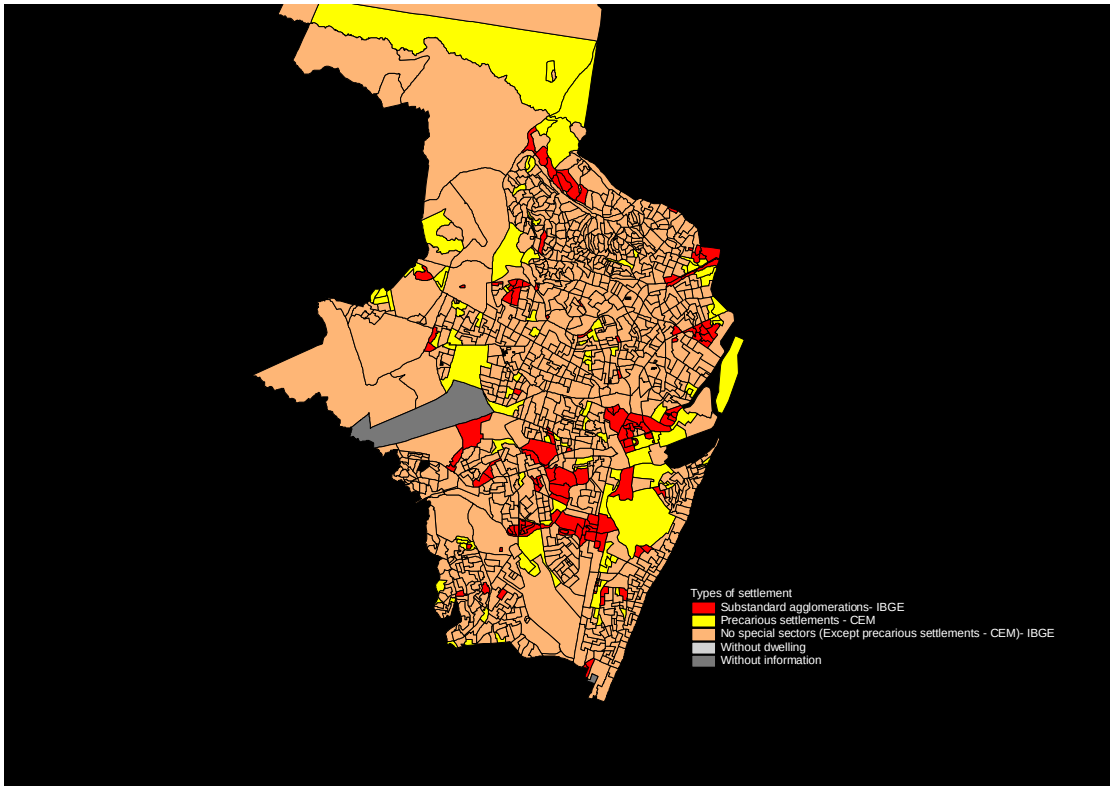


Figure 14. Recife: type of settlement.

Finally, in the case of São Paulo, the higher income bracket (above 20 minimum wages - Figure 15) is localized in the middle east of the city, in the neighborhoods of Morumbi, Jardim Paulista, Alto de Pinheiros, Pinheiros, Santo Amaro, Vila Andrade, Moema, all with high road accessibility (Figure 16). In these neighborhoods there are almost no census tracts classified as substandard or precarious, that are common in peripheral areas such as the neighborhoods of Capão Redondo, Pedreira, Jardim Angela, Grajaú, São Rafael, Jardim Helena, Itaim Paulista, Lajeado, Cidade Tirandentes, Jaraguá, Brasilândia, among others, characterizing a situation of involuntary segregation (Figure 17).

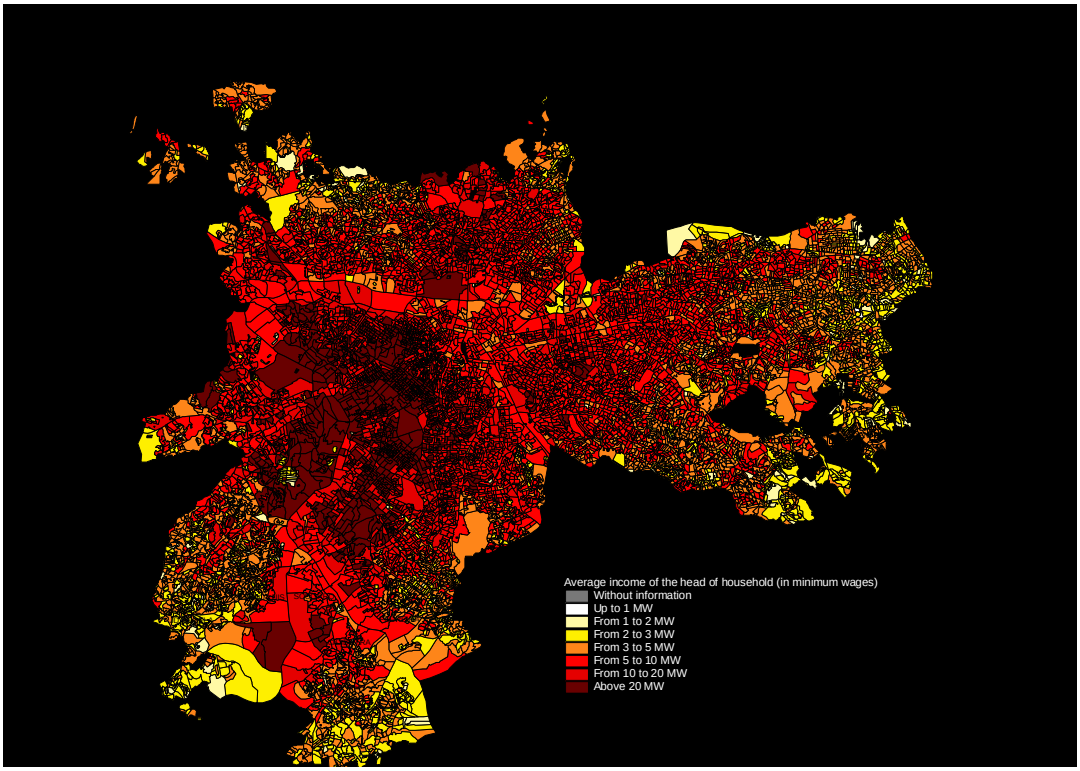


Figure 15. São Paulo: average income of the head of household (in minimum wages).

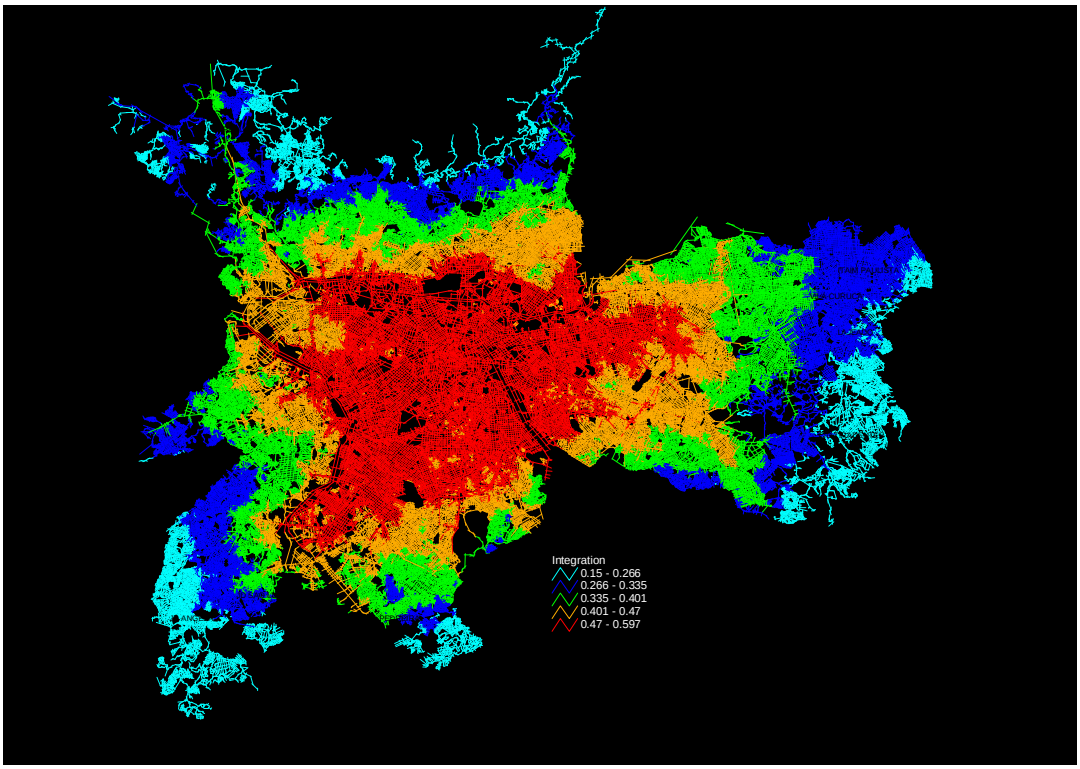


Figure 16. São Paulo: axial map.

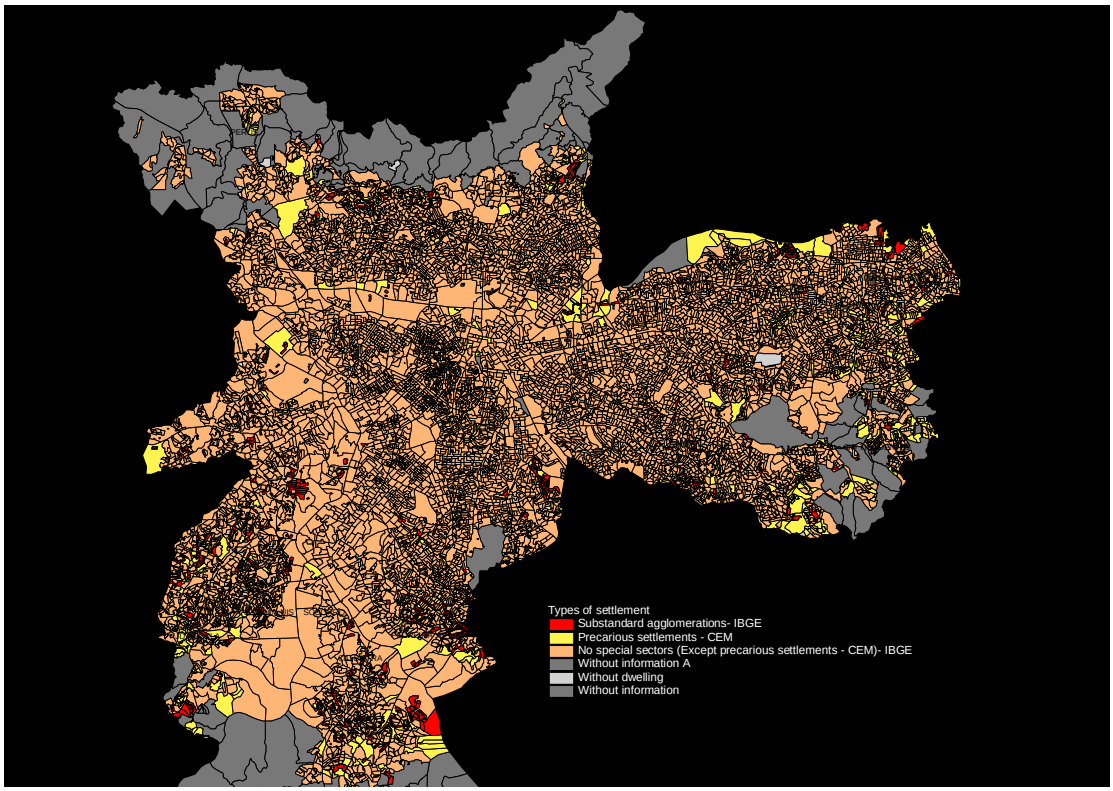


Figure 17. São Paulo: type of settlements.

In São Paulo, if we analyze the values of integration by districts, we find that those with higher purchasing power correspond to the more accessible areas, like what happens in Pinheiros (0.500) and Vila Mariana (0.504). The opposite situation is also true: Cidade Tiradentes presents the lowest integration value in the city, with only 0.213 (Figure 18).

An experiment to compare the performance of some neighborhoods located at the same distance from the Se/República region (8.5 km) reveals the continuity of such trend (Figures 19 and 20): the highest the purchasing power, the higher the integration value (Mandaqui: 0.338; Tucuruvi: 0.404; Freguesia do O: 0.410; Butantã: 0.432; Morumbi: 0.438; Alto de Pinheiros: 0.466; Itaimbibi; 0.509). From what we can see, the accessibility to the urban space, resulting from its configuration, tends to be a good indicator of income concentration, once accessibility is also converted in an economic good: more permeable areas, in thesis, are those with greater mobility, and, usually, with the highest market value.

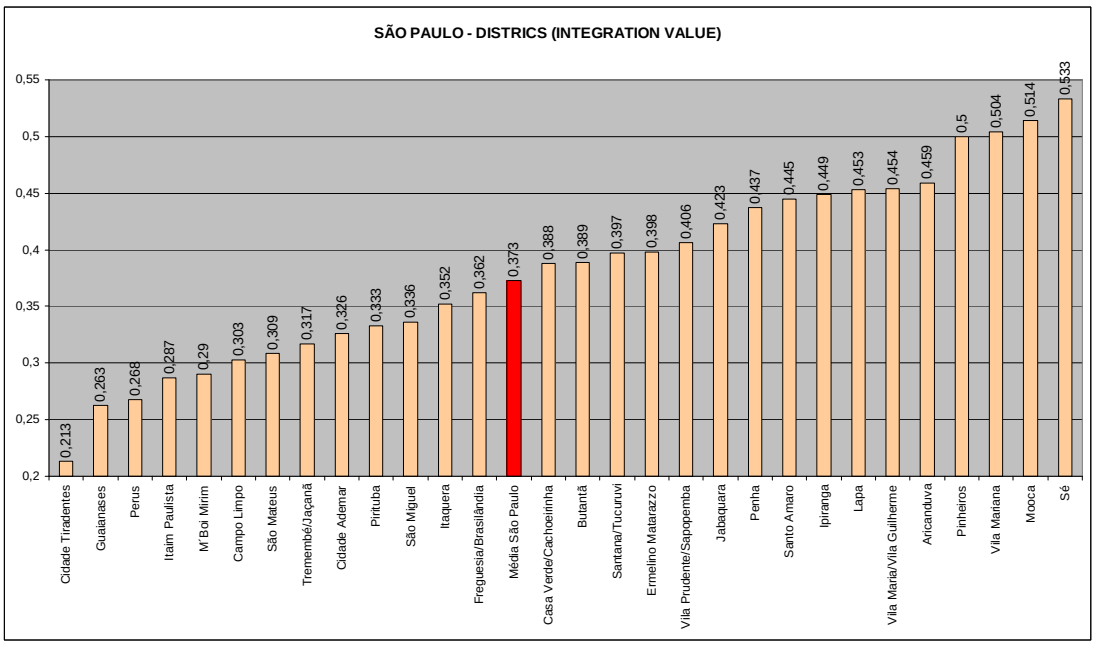


Figure 18. São Paulo: road accessibility value of integration by district.

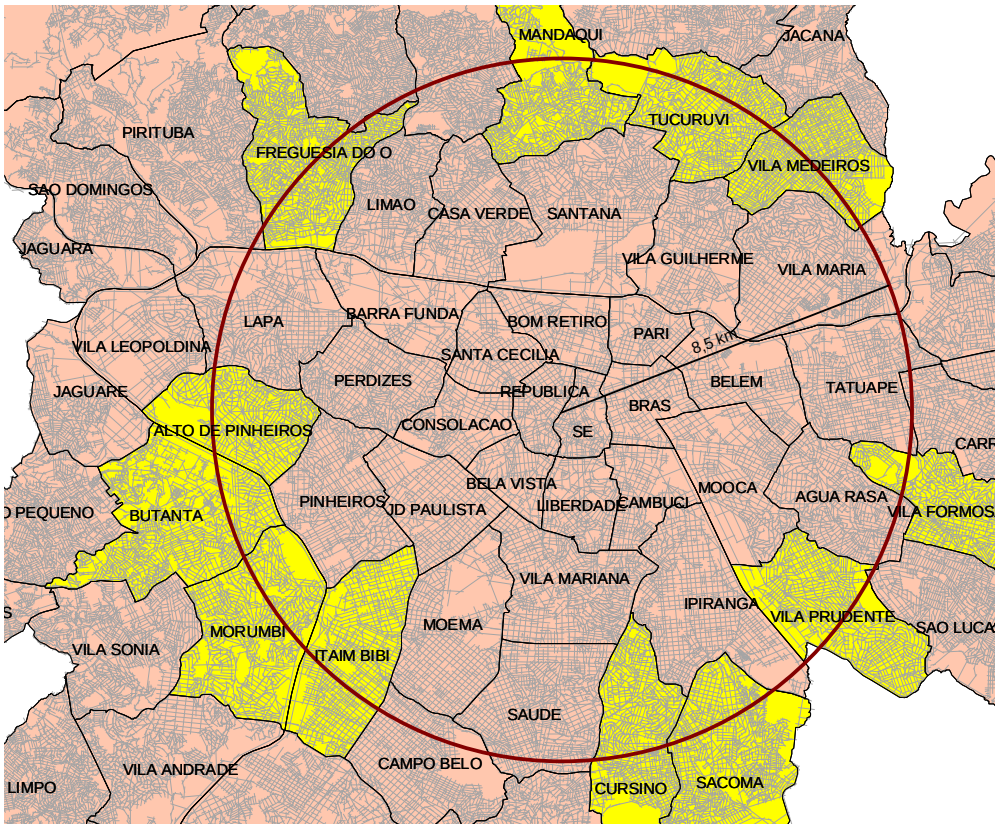


Figure 19. São Paulo: selected neighborhoods for analysis.

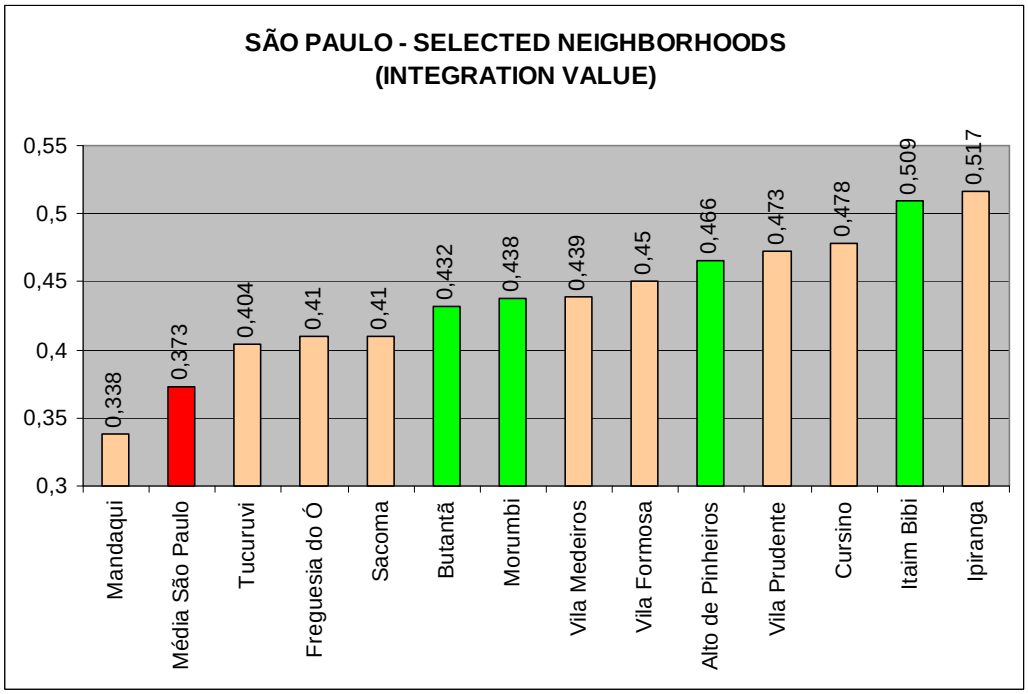


Figure 20. São Paulo: average integration by selected neighbourhoods.

Finally, for the last variable - average road accessibility or integration - we have verified that, among the studied cities, São Paulo is the one that possesses an urban grid with less road accessibility (0.373 - Figure 21). According to MEDEIROS (2006), this value results from a labyrinthine urban form, with strong irregularity and discontinuity of its road axis (Figure 16). Belém, on the other hand, presents the highest road accessibility index (0.651), resulting from an urban grid where roads are more straight and there is a strong continuity among the axis, producing a less labyrinthine pattern and therefore, more permeable system (Figure 6). Recife has an accessibility index very close to Belém (0.650), showing a good integration of the system with the entire city, what is the result of a more continuous and regular road network (Figure 13). Manaus, on its turn, presents a medium integration value, among the 4 cities, indicating the existence of a road network sometimes continuous sometimes fragmented, a product of a physical space with high incidence of small watercourses called “igarapés” (Figure 10).

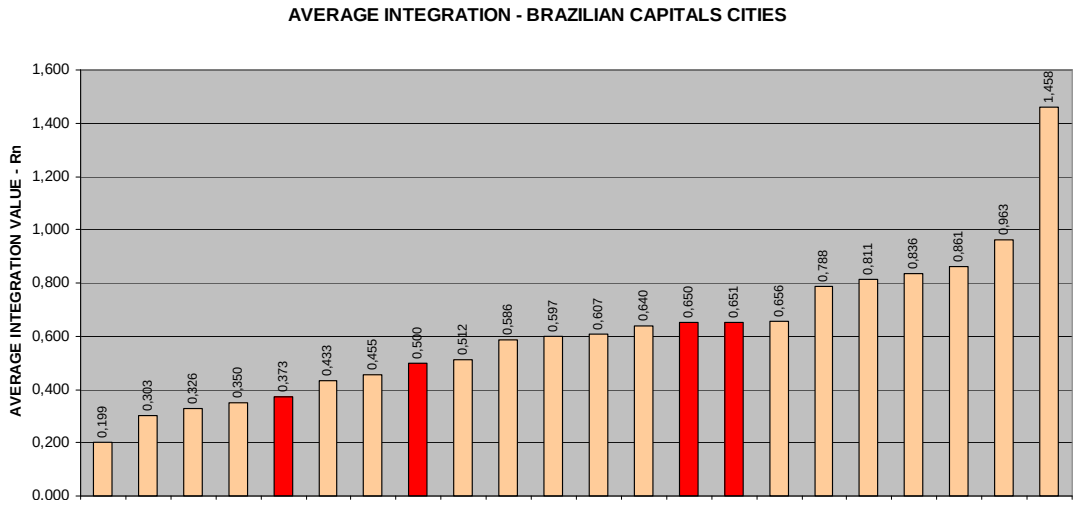


Figure 21. Average integration values of the studied cities, comparing to other Brazilian state capitals. Source: Medeiros, 2006.
List of cities: Florianopolis, Rio de Janeiro, Salvador, Porto Alegre, São Paulo, Vitória, Belo Horizonte, Manaus, Aracaju, São Luis, João Pessoa, Goaiania (e entorno), Natal (e entorno), Recife (e entorno), Belém, Brasilia (e entorno), Maceio, Fortaleza, Cuiabá, Teresina, Palmas, Porto Velho

4 Conclusions

From our results, we can observe that the spatial urban structure, revealed in its configurational aspects, seems to contribute for a clearer understanding of the phenomena of spatial segregation in the Brazilian cities.

Historically the cities have been treated in the literature according to the distinct degrees of geometry in its road network (KOSTOF, 1992, 2001; TEIXEIRA, 2000; MORRIS, 2001; REIS FILHO, 2001), usually classified between the extremes of irregularity (organic patterns, with design of complex geometry) or regularity (planned patterns, whose resulting structure is based mainly in grids, linear models or radial schemes).

Apart from the discussion of the layout of the cities and of the social expectations that have promoted the consolidation of one of the 2 patterns of road network, it is interesting to understand in what way such patterns - taking from a relational point of view, that is, in the relation of interdependence between all the component parts of the system - affect the urban accessibility in cities, according to the distinct composition of its spatial structure. It means to observe how the layout of the components of the circulation system (patterns of the circulation structures related to road design, forms of connections, existence of nodes, the size of the links, the high or low density of the roads, etc.) interferes in mobility, resulting in restrictions or enabling conditions for road accessibility. It has a direct impact on the aspects of the spatial segregation of social classes in space, as confirmed by our results, where the low income populations or the residents of precarious settlements have lower levels of urban mobility and, therefore, less access to the entire urban system, what represents a deny in their human right to the city.

We conclude, then, that the configurational approach verified by the use of axial maps, contributed to the study of spatial segregation and urban mobility in the 4 studied cities, showing that the configuration of the road network is a relevant aspect to explain some of the urban problems related to social apartheid/inclusion and physical segregation /accessibility in the Brazilian cities. It

happens that the spatial hierarchy depends directly on the modes of relationship among the different components of the circulation system, in their various degrees of regularity or irregularity in what regards to its spatial structure, what tends to be one of the most robust expressions of the distribution of social classes in the city.

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Maputo: between density, fragmentation and formless?

David Viana

CICRA – Centro de Investigação de Construções Rurais e Ambiente

Escola Superior Gallaecia, david.leite.viana@gmail.com

Phone: 00 351 961305207

Maputo reveals [sub]contour lines stamped by individual self-forms. Express themselves on a very intricate territorial reality (marked by non definition – between formal and the informal), in which take root (and/or gravitate) particular microstructures (dwelling and productive-commercial) of urban [sub]forms between the infrastructure (fluxes, public/collective spaces and urban services) and the superstructure (of Nature, as major urban connection). Exist the atrophy of the structural relation between project and city form, aggravating the fragility of the net of nexus established between types and programs, set on fluidity, fragmentation and on non calculated hazard, but with high creative potential – induced by imagination and spontaneity inherent to subjectivity, which conform renewal city forms, tested in different planning options (colonial and post colonial) such as image-plans, management-plans and structure-plans. Reticular urban form allows linear and sequential lectures of structural morphological elements. On the other hand, today's prolific complex forms overlaps without precise limits as the ones of the colonial grid. The actual urban mosaic set the platform of uncertainty and the unforeseen. The city became so extensive and plural that it's no longer possible to look at Maputo as a polish structure. The good city shape melts itself on a hybrid and solving composition in which its contour lines, as legible artefact (with unique identity and clear limits), were replace by the non determination of the urban space. Can one say that Maputo's city form is, simultaneously: compact city (density); sprawl city (fragmentation); city without form (formless)? The article will focus this question.

Keywords: Maputo city form, urban structure, compact city, fragmented city, city without form.

1. Planning: between the predictability of formal drawing and the unpredictability of informality

Many African cities have suffered an accentuated physical deterioration caused by the population pressure. The majority of the descriptions on these urban spaces portray scenarios usually nominated as "chaotic", sharpened by the economic scarcity and the increase of social violence - both tends to aggravate poverty. However, a more careful analysis of the citizens' daily discloses a capacity of action of great dynamism and a vigorous resistance towards survival: they pull out the plasticity and the capacity to auto-redefine the urban form.

Problems such as clandestine, informal, spontaneous or not planned housing occupation, in reserved central spaces or in areas of expansion of the city in the periphery, modify what was formally drawn and fixed for the territorial development, compromising the articulation of the spatial structure of the city . This situation is due, among other factors, to a certain rigidity and operative insufficiency (the rhythm capacity of answer to an urban reality in continuous transformation) of the planning instruments practiced in cities such as Maputo. The mutation felt in this type of cities affect the urban morphology and its forms of management and reveals a co-relation between typological and technological order (formal or informal, of colonial or local root) interacting with morphologic determination.

The integral urban planning [legacy of the culture and modern thinking of industrial societies (turned to production)] looks for to express the logic of a territorial homogeneity , a system to be created and resulting from the convergence of different disciplines and decisions that would express, in a global sense, unity (the whole) - controlling the expansion of the urban form and assuring the balance and development of its standards.

Another type of planning fomented ideas and theories on the urban process considering the expression of the cities misadjusted to the complexity of their own cultural values. This way of thinking rejects the functional and historical determinism of integrated planning and its swaggerer for a "new" social order and its own linear social evolution. So, the urban process bound with the notion of "structure" exceeds the limitations imposed by the different chains of the modern thought (mostly the functionalist ideas and the strict and undifferentiated unity, intrinsic to the extreme and reducing formalism of the respective urban drawing). Moreover, it recognizes the existing complexity and the implied difficulties to solve emergent problems. However, it remains hostage of the form and the binary logic (and its formal-conceptual directory) and of the dynamics, articulations and connections of structural composition elements, encapsulated in a closed system.

Post-modernity[145] knocked down the myth of the absolute and dogmatic urban action: *"la regularización-formalización debe formar parte de una estratégia conjunta que debe partir de la propria ciudad. Que la ciudad descansa sobre unos engranajes que son los valedores"* (Piñón, 2001:38). Yielding to the evidences of the global reality, recognizing the "ordinary", the everyday life and its inherent limitations and instabilities, contemporary urban thinking ceases as isolated, hermetic and unambiguous speech of the City.

Some urban recent proposals, in a globalized and highly competitive world, adopt other presuppositions to plan cities: despoiled of social utopias they are assuming, according to Magnavita (2006), the "marketing" connotation of a production of consumption goods, not only material but also symbolic, which accent is to compete and to gauge profits of the rented investments - estimate the creation of prompt, seductive, singular urban images, of simulacrum, promoting different levels of enjoyment and promoting processes of individual and collective subjectification.

Different, continuing quoting Magnavita (2006), is the thought that adopts the "Logic of the Multiplicity", one of the sources of the Post-Structuralism. Appealing to conceptual instruments that privilege premises as multiplicity, difference, repetition, segmented totality, heterogeneity, discontinuity (a-significant rupture), a-parallel evolution (not linear), body without organs, rhizome, "chaos", event, hypertext, it looks for to remove the hegemony of concepts that the modern thinking still exerts in the formulated speeches about urban form, namely: unit; identity; totality; homogeneity; continuity; organism; evolution - Order.

Portas (2007) refers that planning should be an action of constant and patient [re]ordering, looking for compatible territorial models within the trends of social and economic development and the least consensuses of citizenship. Planning must moderate more than to propose anticipatory answer of social and cultural practices. It equates subjective morphologies resulting from subjective, informal and plural urban processes. It approaches the urban process and the urban expression

[145] According to E. Lourenço, the state of our world is distinguished from those who preceded us, "*não tanto pelo grau de caoticidade histórica, política, ética, religiosa, cultural e social que o caracterizam como pelo facto de que esse «caos» é o anverso do sucesso no limite do ainda inimaginável de uma manipulação hiper-racionalizante de todos os conteúdos da experiência humana ou dos dados sobre que se afunda*" (Jornal de Letras, Artes e Ideias, 19, June 2007, p.13). Trough this words we can understand that «undefined» – condition of contemporaneity – requires principles capable of responding to complex challenges, among which are those related to planning and urban form.

surpassing the binary relation subject/object of the classic | modern | structuralist reductive phenomenology.

The city in mutation is abandoning clear images (compact) of its urban form, becoming out of focus - with overlapped configurations and reflexes, conferring a complex and polymorphic expression to it. The urban transformation has been consolidating apparently confused and difficult to recognize (formless) morphologies in superficial approaches, noticeable for symptoms of periphery and dispersion (fragmentation). The construction of the urban form, through the planning of the urban space, implies the understanding and the reinterpretation of the elements that constitute it.

2. Urban form: from Order to morphological-type disorder (while order)

Hillier and Hanson (2003) refer to the necessity of establishing a method of analysis of the social standards, emphasizing the connection between local morphologic relations and global standards. It can be accomplished through the establishment of a descriptive theory of standard-type and consequently a method of analysis intending to survey and to quantify the presence of local and global morphologic *performances*. They allude to the establishment of a relative and descriptive theory of the form, as spatial standards can themselves carry information and contents from social nature: spatial vision of the citizens - “spatial logic of society” (capture the formal dimension of the real spatial systems in terms of the social logics behind them).

The morphologic analysis has co-related concepts: the physical and spatial form of the city is the central object of theoretical concerns of urban drawing and urban design (and not the social, economic and political processes that had led to the accomplishment of the urban object). It implies that this central object possesses a certain autonomy while subject matter of search, of critic and of experimentation. Analytical disciplines must pre-exist to any attempt of establishing a normative order to the urban architecture: the urban morphology aims the reunification of architecture and urban design in an only discipline [morphology-type (understand spatial organization through architectonic form) - relation between society and spatial form | the effects of social life in the spatial organization (Hillier and Hanson, 2003)].

The object of the morphology is not the study of the city taken as a whole, since it represents a dynamic deed. Hillier and Hanson (2003) refer that the biggest achievement of architecture is at the level of the space and that architecture structures the spatial system, in which the social relations are promoted, exceeding the meagre static and formal dimensions, more immediate and directly distinguishable and consolidating, at the same time, the relation between space and social life: *“real time solutions”* for *“real time problems”* (Koolhaas, 2003).

According to Pereira (1998), urban morphology studies the physical form of the city, analyzing structure [transportation and mobility infrastructures, free spaces, green areas (not constructed)], texture [patterns, building typologies, architecture, volumes, forms (the constructed)], densities (population, for example), types of spatial and social appropriation, among other aspects of the urban space. The morphologic analysis makes perceptible the physical transformation of city form (referencing its social, economic and functional expressions, etc.). Through morphology it is understandable how physical form produce, or reproduce, social form. With this kind of logic, it is possible to disclose underlying [micro]structures that [sub]organize settlements generally referred as

"chaotic" or "organic". They are seen, by this way of morphologic analysis, as the result of "an unconscious" production that is emerging and consolidating with time and with the contribution of diverse generations. Still according to this same author (1998), urban morphology enables the perception of the chances and constraints that concur between themselves in the configuration of the urban space or in the construction of the city.

The strict interpretation of "Order" subjugated "formal" perspectives to architecture and urban design. The morphologic approach to the urban space will have to be based on broad agreements of the notion of "Order": a conception that allows "disorder" and the idiosyncrasy to associate themselves with "order", without committing themselves to it in exclusive terms. Through this type of methodologies, urban form is analyzed and supported by processes that operate case by case. To articulate spatial relations it is necessary to determine degrees of impregnation in different types of spatial configuration, leading to methods of relational and syntactic analysis of urban forms. These are considered within themselves and in relation to others.

The urban forms in African cities are interpenetrating themselves: urban centres gain land to suburbs - but they allow themselves to be absorbed by those. They lack of articulation of the disordered urban in the field of the planned city. It matters to state Rossi (1982) that values the typology of the city in the architecture and refers that, though it is not preeminent, it is also important. It is from the typology speech that the classificatory aspect of knowledge of architecture and the concept of typological form unbend and enhances the role of the city in the architecture: taking urban house as reference, and considering it as an element in the construction of the city - Lage (2001), in Maputo, developed his doctorate thesis with this positioning of A. Rossi, articulating the relation between the evolution of the housing form and its effect on the form and urban space (the research is directed to the field of architecture and analyzes the existing relations between constructive typology and urban morphology considering the meanings that they assume).

3. Maputo: between density, fragmentation and formless!



Figure 1. Overall perspective of Maputo's city forms between density, fragmentation and formless.

The main-city of Mozambique saw in itself distinct urban options (colonial and after-colonials) being experienced, translated in image-plans, management-plans or structure-plans, for example. Nevertheless, the planning and ordering of its territory were many times exceeded for the informal urban production, disintegrated and not regulated, not foreseen and spontaneous. The urban fabric enlarged, occupying free spaces or agricultural zones in the outlying areas.

In its tense and misty morphology, in its urban form, multiple realities and meanings coexist: and according to O'Connor (1983:200), "[...]*most African cities are neither wholly indigenous nor wholly colonial creations, and in many the balance between introduced and local ingredients is now such that they are best considered as either dual or hybrid cities*[...]". The city grew rapidly, mainly through internal migrations, that is, people who placed themselves in areas near the city and went towards it searching for new chances of life. These migrations consolidated urban forms increasingly complex, hybrid or transgenic, between the compact, fragmentation and the formless, that has been consolidating an urban organism which form presents (in parts) proper characteristics close to a rhizome structure.

In Maputo prevails, at the form and dwelling type levels, mix and syncretic compositions which result from the interaction between African traditional and agricultural practical, and modern, urban occidental references. It is a structure with diverse conformations, of ramified extension in multiple purposes. While multiplicity, it urban form grow according to the dynamics of the connections: the city dwellers redefine the spatial matrix, from which they develop themselves, invent and add other functionalities, new ways of economic acting and housing formulas - they rearrange organization projects and residential aggregation [where exist juxtapositions, coexistences and overlapping processes of substitutions of strategies, forms or types that do not ignore the emergency of new visible urban forms and its centralities, infrastructure and equipment nets and types of housing park (Raposo and Salvador, 2008)].

This city suffered (and is still suffering) the effects of a vigorous process of hyper-urbanization, which produced multiple unfolding in its urban fabric, transforming its form and limits. It assumes multiple levels of different readings, diverse experiences and complex stratifications that are not inserted in urban models absolutely formatted or sectarian. Its urban condition, in transition and indefinite, is shown in fragmented and apparently disordered representations: it constitutes a complex body that goes beyond the geographic and urban limits – and in its urban space multiple forms of life and ways of acting are proposed. These surpass any predefined, imposed and/or foreseen structure and city form.

According to Rivas (2005, 2006), the urban discipline has been conscientious of the diversity of urban situations: : "[…]*el desarrollo sostenible recupera ideas que permanecen en el inconsciente de la disciplina, sin embargo permanece el peligro simplificador. El modelo urbano radioconcéntrico es el característico de la ciudad capital europea, centro de servicios, así lo vieron Howard o Le Corbusier. La ciudad industrial tiende al modelo lineal, soportado en la dependencia de infraestructuras lineales -canales, ferrocarril o autopistas- así lo afirma Le Corbusier en sus 'Tres Formas de Habitar', pero también lo reconoce F. Wright en su Broadacre o el urbanismo planificado soviético. La cuadrícula responde al modelo colonial, desde Grecia a América, pasando por la Europa medieval. Pero, como ha destacado R. Sennet, la cuadrícula sin centro y sin límites definidos*

es característica del modelo capitalista, de su disposición a la hegemonía del mercado en la toma de decisiones[…]". The urban space of Maputo incarnates parts, sometimes fragments, of these models of urban forms.

The one million inhabitants of Maputo is, in the current conjuncture, sufficiently problematic. And if the average of annual growth around 3.5% is kept, it will lead to the duplication of the population in twenty years. It started lodging (in less than a century) a population around twenty-five thousand inhabitants and went up to another one that already exceeds the million. The expansion of the urban space did not correspond, in the two last decades of the last century, to an employment expansion. To this growing urbanization it did not correspond an integrated society. The number of degraded areas grew. The periurban space became more fragile due to absence of instruments for planning the use of the ground, its implementation and control. The majority of the city dwellers started to inhabit zones without the appropriate access to basic infrastructures and social equipment, in precarious housing units, with no warranty of ownership.

Attempting to improve the dwelling conditions in the suburbs ordering actions were assayed. The suburb was seen as an abnormality of temporary character by the Portuguese colonial authorities, which correction was only a question of time. The suburb was a dormitory for the cheap workmanship, necessary to increase the colonial economy. The difficulties to eradicate the increasing phenomenon of the suburbs early led the colonial authorities to regain conscience that the suburb was a challenge to the capacity of absorption and integration of these areas in the urban fabric of Mozambique's capital. These rules happen mainly on the housing typology, which would have to assume a provisory character, in order to turn less onerous the demolition, since it was time for the already expected urbanization and expansion of the colonial city. It was not allowed any construction in long-lasting material in the suburban zones, giving place to the proliferation of reed houses or wooden and zinc houses.

In the post-independence period the structuring of the urban space in Maputo [profoundly marked by the dichotomy "*cidade de cimento*" (cement city) versus "*cidade de caniço*" (reed city)], as well as public infrastructures, did not suffer relevant modifications. The part considered as "cement" remained. Its outlying areas, where the majority of the local population was, were the only ones that had been extended. The urbanization in the post-independence period came across three main stages, as stated by some authors (Oppenheimer and Raposo, 2002):

a) 1975-1977: stage of the city occupation - this stage begins with the National Independence, when the city was partly abandoned by the Portuguese population that returned to their country or migrated to South Africa. The abandoned houses were nationalized and administered by the *Administração do Parque Imobiliário do Estado* (APIE), which were directly rented to Mozambicans or leased the state-owned and private companies for their own distribution and their workers;

b) 1977-1987: stage of urban and environmental deterioration of the city - the organization of the population to keep the urban space and to become aware of life in the capital was getting debilitated. Slowly, in the city, especially in the assigned "cement" (formal part of the urban space), the buildings and the rented houses, jointly with urban avenues, streets, parks and services lost their quality (the deterioration of the conditions had diverse and conjugated factors: difficulties to consolidate the new economic and social politics of socialist ideology; a war that led to financial and economical crisis; low

incomes that had not allowed the fiscal contribution for the maintenance of the buildings and services and weak urban tradition of the majority of the population). One of the deterioration indicators of the urban environment was the reduction of offers and the quality of the services, mainly the garbage collecting, the water supply, and later, the difficulties in transports.

c) From 1987 on: stage of deterioration and beginning of recovery - the economical and social crisis that fell down on Mozambique had its reflexes on the urban space. The central authority initiates a radical change, officialised in 1987, with the introduction of the *Programa de Reabilitação Económica* (PRE). Economical and social processes began and led first to an intensification of the city deterioration and later to the beginning of a slow recovery. The increment of the population in urban zones due to the war, allowed the creation of new settlement areas, which majority included marshy areas, slopes and barren among others, also degraded.

As for the interventions of improvement of the urban space in the post-independence period, some projects to endow *habitat* of the urban periphery with infrastructures and services (transports, primary urbanization, social and sanitary services) appeared first at the end of the year 1976. In a second moment it was intended to define a regulating plan coherent with the development. The projects of intervention in degraded areas and on spontaneous housing had roused in this period, at an international level, an large debate about “provisory urbanization” or “poor architecture”. But, in the late 1970’s, the conditions of instability in Mozambique turned it difficult to make a balance of this different way of making city form and planning. According to the document *“Moçambique, Melhoramento dos Assentamentos Informais, Análise da Situação & Proposta de Estratégias de Intervenção”*[146], the informal settlements are urban zones in continuous growth, that do not offer acceptable life conditions to their residents, although there are sufficiently attractive aspects in them, particularly its favourable localization towards the employment and services centres.

According to Maria dos Anjos Rosário (1999), “[...]*the question of managing the urban environment in Mozambique’s cities is particularly difficult because of the parallel existence of two socio-economic systems with sometimes contradictory needs and interests. Every Mozambican urban centre has clearly differentiated zones. There is a formal modern zone where people of different classes and economic and cultural levels live, and where individual isolation is the dominant feature. And there is a suburban and periurban zone where settlement is spontaneous and anarchic. The traditional, informal, rural world meets the modern, formal urban world in all the zones in Mozambican urban centres*[...]” (op. cit. Ferraz and Munslow, 1999:190).

Economical, popular and informal practices are enlarged at the same time that vacant lands for familiar "*machambas*" (farms) are more and more distant from the city. With the privatization of the real estate park, the social services, and with the emergency of an informal and illegal urban ground market, the process of socio-spatial differentiation is sped up [according to Oppenheimer and Raposo (2002)]. The population without resources that had occupied the centre in the first years of independence is led back to the periphery. It is also there that the majority of the poor of the capital inhabit.

With the gradual regeneration of port, touristic and industrial activities in the metropolitan area and according to the same authors (2002), from the mid 1990’s on, one assisted to an economic

[146] http://www.unhabitat.org/downloads/docs/4399_50963_CWS%20in%20portuguese.pdf | consult 2008.

growth. However, this growth, once again, in the context of the followed economical politics and the privatizations associated to them, has not led to an increase of employment in the city. The number of the effects in the formal sector diminished, though the urban space continued to grow in population and extension, which explains the strong growth of the known “informal” sector.

It is understandable in the morphology of Maputo some fragility in the articulation of its different parts (in the environmental, social, productive, economic and morphologic dimensions), consolidated in the weak connection between the planned city (pointed out as ordered, predictable, controlled and structured in expansion alternatives) and the real city (said doubtful, degraded, disintegrated, disordered). This condition degenerated in the atrophy of the structural relation between project [planning (at first instance)] and urban design (as consequence), aggravating the weakness of nexuses established between morphologies-type, programs and social ways shaped in the fluidity, in the fragmentation and in the not calculated hazard - basis for new social forms to use and to create space with highly creative potential, induced through imagination [productive necessity (to survive)] and artlessness of subjectivity.

Maputo is more than a diptych: the sum of the urban colonial process and the post-colonial reaches multiple parts that fit an urban mosaic of complex geometry -between the compact, the fragment and the unformed- and does not reflect merely the dichotomy “cement city” versus “reed city”. These two realities tend to be vanished; crossing, overlapping and juxtaposing themselves to many others that in the meantime gained form and expression in the urban space. This (including the assigned “reed periphery”, its most populated area) transposed the coherence of the steady image (morphologically) in the built space and in the drawing of the public space.

This process escapes to any notion of simplistic planning. As it extends its structural systems and subsystems, taking constantly possession of surrounding spaces, modifying and originating a proper order that is consolidated in fragmented urban forms. The extension of the urban space, thickness, deterioration or saturation of social infrastructures, the intensity of economic activities of informal character, the preponderance of retail exchanges and small services, its diversification, precarious life conditions, the growth of social and spatial differentiation of the quarters and the periurban areas and urbanized centres, are all aspects well portrayed by Oppenheimer and Raposo (2008), that clearly justify the urgency to exceed the paradigm of the urban duality.

The extensive growth of its city form and the administrative magnifying of its limits in the post-independence period reflected the recognition of the change of life styles that its inhabitants practiced. The first step for this process was given in 1979, with the inclusion in the limits of the city in the suburban areas, involving green and touristic areas. To this great increase of population in Maputo in the last few decades corresponds also simultaneous phenomena of urban implosion and explosion*: “*one assists thus to the over occupation of the real estate park of the 'cement city' and the existing outlying areas, what determines the increase of the occupational density of the housing and urban space*”* (Oppenheimer and Raposo, 2002:22).

The urban form in reticule, linear, clear, sequential and structured that characterizes the urban narrative of colonial origin changed into an open structure of expression of multiple urban forms: the nexuses had been multiplied, the sequences and the possible unions - people situated

themselves in emergent urban territories, looking for answers that the geometrized form of the colonial city does not supply in terms of price and functionality or even of ground accessibility. Of the diversity in ways to inhabit, to produce, to distribute and to consume, and of the multiple and contradictory reasons that inform the behaviour of social actors, results the extensive urban mosaic (only apparently implausible and chaotic) that no longer can be exclusively justify by the old urban order nor by unique principles of rationality and functionality.

The majority of elements that conform the expression of Maputo city form, though small and apparently insignificant at first, have a real history and a real framing, hold a specific meaning for each inhabitant and contribute for the construction of individual and collective memories. Observing its urban form, some micron-sections and respective strategies of self-organization in its sub-morphology become visible. What is already built (the texture and respective standards) in the urban space rarely corresponds to exclusively arbitrary configurations: each city [sub]forms brings and conveys significance to the capital - difficultly is related to it in a neutral or absolutely autonomous way. Its contents and significances are in constant production and reconstruction through the action of daily life: "*las formas urbanas son un éspejo social que ayuda a constituir o transformar la realidad*" (Cortés, 2008). New ideological and social cartographies emerge at the edge of hegemonic visions, which express the way it is being created an extensive net of critical and creative resistances based on cultural, plural and multifaceted crossings of alternative experiences and urban forms.

The condition of urban mosaic is precisely that, which enables the expression of the difference, of mutant scenes of sociability, in which the complexity of the parts is understood as a dynamic resource of enrichment of the whole. The condition of urban mosaic is that to achieve micro-readings in the macro-reading, allowing living plurality and contradictory, transforming and transformed multifaceted actions. The urban morphology consolidates itself in processes structured in new logics of understanding and interpretation of the dynamic multiples that in it interact. As Rivas states (2005, 2006), "[...]*el primer esfuerzo debe seguir siendo un esfuerzo racionalizador que trabaje para reconducir el caos aparente hacia sus ordenes posibles. Un orden no autoritario que sepa enfrentarse a una realidad siempre cambiante -he aquí lo imposible, la respuesta a la incertidumbre, pero que con plan o sin él acaba ocurriendo- y que sea capaz de servir a lo más positivo de lo que permanece y de lo que cambia*[...]": the city form is structured in regular and/or irregular, ordered and/or to order elements; in which it is necessary to join planning with adequate urban forms that [re]establish a large picture of social life.

According to Rivas (2005-2006), urban design is a *"*[...]*poderoso instrumento para comprender, pero también para crear valor en una ciudad y en su entorno territorial. Si somos capaces de observar cómo la ciudad tiene lugar, los elementos y matices de su condición de acontecimiento social en sus contextos, indagando en las regiones donde lo urbano está inmerso y en los procesos que dan forma al paisaje, podemos alcanzar un conocimiento previo a cualquier condición o intervención ordenadora: las formas del habitar.* […]*Saber hacer las preguntas oportunas y desarrollar un sentido común específico es, al final, la tarea del curso que se interrelaciona la experimentación proyectual con los intereses sociales, desde la evaluación sobre el espacio-paisaje de los que los proyectos concretos realizan. Un proyecto urbano como horizonte para la transformación, una herramienta que interfiere dialógicamente en el metabolismo urbano*[...]*".*

The city mosaic configured a synthetic landscape that answered to the urban transitory character of its communities. Not to recognize the unstable balance between rationality and sensitivity, between conscientious will and unconscious expression, between desired inter-subjectivity and irreducible subjectivity, between collective intervention and individual creation (Baptista, 2007) is to contribute to deepen aspects of urban form disruption. Not understanding the transformation and artificiality operated in the morphology of the capital of Mozambique can disregard differentiated alternatives for the reading and representation of this territory (and its ordering): for example, *"*[...]*it is through the analysis of the energies and the involved capacities in the construction of the dwelling unit, place of privileged symbolic investment, that it can be identified the mutations that better express historical changes, social innovations, cultural crossings and technological adaptations*[...]*"* (Salvador, 2004). It is necessary to evaluate the effectiveness and vitality of the agents of transformation here crossed, formal or informal, legal or illegal, and the form to exceed the results precariousness obtained by them.

The city is a totality that constructs for itself and in which all the elements concur to form "*l'âme de la cite*" (op. cit. Rossi, 1982). On this same city, the author considers that this is one of the most important conclusions in the study of the city. It is a determining factor "to read" and to represent the "structure of the urban fact" - the urban form. The representation of the forms of the mosaic of Maputo turns perceivable the contours of urban facts characterized by a proper and individual architecture, shaped in an complex territorial reality, in which particular microstructures of occupation of the ground had rooted.

The urban form in reticule, and of colonial origin, yields linear and sequential readings of its structural morphologic elements, echeloned in thematic areas. On the other hand, more complex forms of occupation of the ground currently proliferate, overlapping themselves, without necessary limits as those of the colonial tracing. The urban mosaic is the tray of the unpredictability, uncertainty, of the financial and ideological problems of the State, globalization, of the liberalisation of markets, compatibility of the private interests, of the crisis of the collective values: in Maputo the urban form became so extensive and different that it is no longer possible to approach it as a linear and polishing city form.

The good city form (Lynch, 1981) dissolved itself in a hybrid and solvent composition, where the contours of the capital as legible artefact, of identity, limpid in its tracings - marking the identification of its configuration, limits and centre - were substituted for the impreciseness of the urban space: being predictable that Maputo changes into a great occupied spot of territory, assimilating involving gatherings. I share of the positioning of Gausa (2007) when he says that *"*[...]*como una mancha de tinta sobre el territorio, la forma cristalina de la ciudad primitiva tiende progresivamente a disolverse, así en un abanico heterogéneo de salpicaduras y vacíos. La música armónica de una ciudad completa, refigurada, equilibrada, cede pues ante la evidencia de una compleja partitura arrítmica con -quizás- eventuales fragmentos melódicos, pero generalmente con un 'no-ritmo' sincopado y atonal de puntos y contrapuntos que harían del espacio urbano contemporáneo un cuerpo definitivamente inacabado y mutable en el tiempo*[...]*"*.

The internal processes that occur in gradually heterogeneous realities as in Maputo transpose the limitations of the traditional planning and articulate in the most appropriate way

"[...]*organismos en constante evolución entrópica. En efecto, del mismo modo que resulta inviable seguir aceptando el 'caos fascinante' de la ciudad como alibi del abandono a un proceso definitivamente aleatorio e incontrolable destinado a ocupar el territorio de modo ilimitado, también lo es pretender circunscribir los procesos a planificaciones cerradas -endógenas- limitadas a situaciones de coyuntura, apenas justificables desde el punto de vista de la lógica administrativa. Del mismo modo que el propio sistema territorial -el organismo global- acaba remitiendo a operaciones complejas de interacción en su seno, su proceso de renovación debería remitir a procesos interrelacionales, si no del todo coherentes sí intencionados*[...]" (ibid. 2007), capable of impelling the progressive urbanization of the suburbs with the maximum quality.

This process has its origins first in the people who inhabit them: regarding the way as the constructions are developed (in an evolutional form) - which demonstrate how populations in the peripheries obtain and manage their scarce resources. The forms of construction in the informal areas are multiple. The most varied techniques of construction coexist, from the most traditional ones, passing through mixing systems that integrate and articulate local technologies with others said "more modern", finishing in those with more sophisticated resources.

The use of different technologies and the application of more "modern" materials allow a greater variation in the functional distribution of the house with the consequent surfacing of new models and typologies (Raposo and Salvador, 2003 and 2008). They represent an aspiration of modernity, a greater integration in the city and the search for statute. But so many times it is in the house's façade, the most visible one, where the search for the "difference" is manifested, appearing paintings, friezes, plat bands and whenever possible seedbeds or landscaped areas (Salvador, 2004; Raposo and Salvador, 2008). Equally ingenious, according to the authors, are the strategies of the families to have access, despite precarious, to basic infrastructures, as energy and water supply - frequently through illegal processes, sometimes depending on benefits related to the working situation. The access necessity to urban infrastructure services, practically inexistent in the peripheries, generate alternative and ingenious [sub]systems, mostly precarious and considered marginal, but that point out possible solutions, though not conventional to make the city.

Not fitting in the peripheries of the city, the slight knowledge of public/private space, being equally difficult to distinguish between occupied and free space, it is possible to verify that the space not built, or interstitial (ways; ditches; passages on viaducts; among others) is a used resource for the populations for, for example, extending the house, improvising small factories, to bury garbage, or to start a business.

There is in these spaces a use and appropriation that answers with vitality to the dysfunctional of the periphery (ibid.). In the key-interstice identification, of potential centres with proper activities (dynamic), and subsequent integration in the order action, become favoured the possibilities of consolidation in the urban space of Maputo of democratic and polycentric places, weaving communicational nexuses between them: conforming the parts of the urban mosaic in a structure in a flexible and more elastic net, at the level of micro and macrostructure - in repetitive processes of auto-similarity reduced between scales and sub-scales.

Part of the challenge for the capital of Mozambique is to find out urban forms that accommodate in their structures the dynamism of the texture standards, where "[...]*roles and*

functions can vary within short spaces of times. […]*Public spaces and buildings become multi-functional, used differently at different times. Streets become 'theatres of activity'.* […]*The emphasis will be on the importance of connectivity, choice, and a framework that encourages movement, activity and pulse.* […]*The flexible framework will therefore be key to this urban design future. It will enable development to respond to uncertainty.* […]*Such adaptability will also see the emergence of new typologies and spatial components to inhabit the framework*" (op. cit. Malcolm e Rowland, 2006:186).

This basic condition does not reject whatsoever the putting on of more standard urban forms. It implies that they need to be articulated in a more integrated process, including aspects as reduced interconnectivity, individualized action, provision of adaptable spaces that allow to receive temporary, volatile and transitory uses. I refer again Gausa (2007), to paraphrase him: "[...]*hoy se requieren nuevos dispositivos -sistemas a gran escala- capaces de abordar la propia dimensión casual y, al mismo tiempo, infraestructural de la ciudad y del territorio. El estudio científico de los sistemas dinámicos conduce* […]*al análisis de procesos complejos -caóticos- caracterizados por el denominado factor 'in': alto grado de indeterminación, de inestabilidad, de incoherencia, de infinitud, es decir de informalidad. Son sistemas que, no obstante, permiten adivinar cierta idea de orden interno, un código genético impulsor, asociable a diagramas o trayectorias más o menos complicados, que dibujan -generalmente- estructuras rizomáticas, fractales, caracterizadas por la autoorganización matricial, el entrelazamiento, la secuencialidad y discontinuidad, la evolución discontinua, la ausencia de escala, el desarrollo orgánico más que mecánico y, sobre todo, la importancia de la seriación 'vació-lleno'. Emerge, entonces, la fuerza del espacio 'en negativo', no tanto como resto – o reserva residual 'entre cosas' sino como engranaje estructural. Y, en el marco de las actuales estructuras urbanas, el paisaje -el vació- aparece entonces como un 'subsistema', tanto o más importante que el urbano - una infraestructura, a su vez*[...]"

3.1. Maputo: compact city (density)

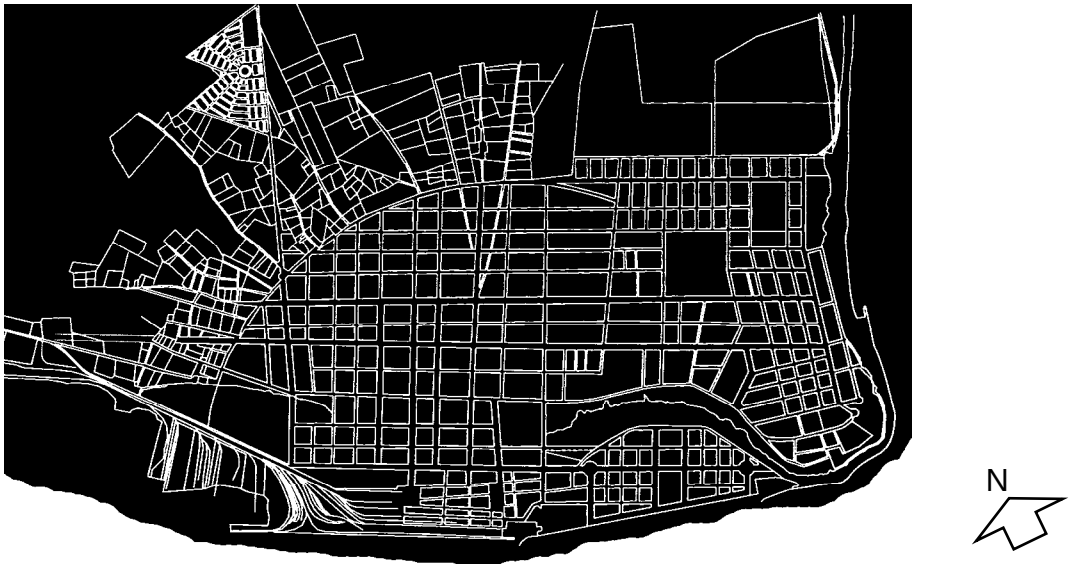


Figure 2. Maputo density: structure - compact city between regular and irregular geometries.

The Portuguese colonial city form (to the white people - "cement city") has a very definitive configuration, establishing a reticular composition with precise limits. This part of the city cohabitate with another one (to the local population - "reed city"), in the north part of the capital, that presents a more «organic» city form, with linear development. The barrier between this two realities it's a semicircular road that divide this two kinds of city forms and their communities.



Figure 3. Maputo density: texture - patterns between the formal and the informal city form.



Figure 4. Maputo: compact city - expression of the macro-density in parts of the urban mosaic.

Here we can see a huge housing area surrounding an industrial zone. The citizens due to the lack of urban mobility (private or public) need to live near the main working core. Because of this fact, many productive parts of the city were occupied with spontaneous housing self construct by the workers of the industries. Beside this, the density is concentrate in areas close to the core of the city, were the main job opportunities exist and the equipments and urban services were set up.

3.2. Maputo: sprawl city (fragmentation)



Figure 5. The urban mosaic is not only a polish composition with clear and sequential «rules» and limits: the urban mosaic is also a set of fragmented portions of different city forms, that overlaps and juxtaposes themselves in to a complex macro-pattern, were is difficult to establish the most suitable city form to be incorporated on the major planning. That's why is absolutely important to recognize the micro-strategies that reconfigure, every day, parts of the city tissue.



Figure 6. In this image we can see rhizomatous structures attached to elements of the main infrastructure system of the city. The rhizomes spread and develop on a multiplicity of paths and heterogeneous directions, promoting a kind of sub urban form that colonize the regular city form.



Figure 7. Fragmented Maputo: habitat and productive-commercial [sub]structures, with a «chameleonic» look (Viana, 2009) - emerging and combining in to the infrastructure (of fluxes, public/collective spaces and urban services) and the superstructure (from Nature, as an extended urban network) in an increasing, adaptive and flexible way. Maputo city form is defined by multiple connections, with retractions and dilatations, extensions and cuts, with open evolution and not opposing natural/rural and urban spaces. In it cohabited systems of transition, mix zones, ambiguous unions between dichotomy or accomplice realities, but also connected developments which generate places and in between-spaces (emptiness and full) in diverse scales.

3.3. Maputo: city without form (formless)

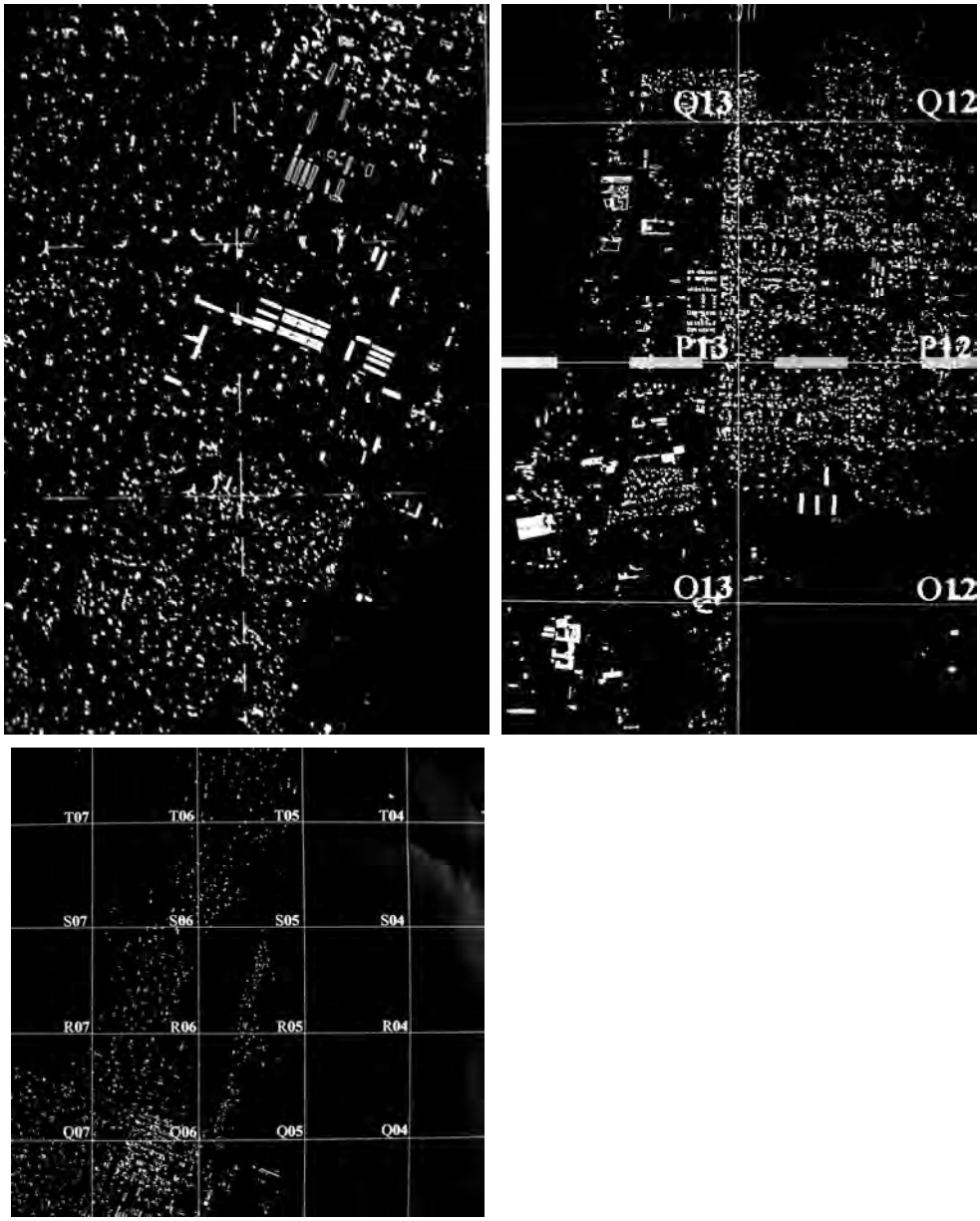


Figure 8. Maputo: parts of the urban mosaic without any recognisable form - formless city form. Through complexity and diversity, these moments entail the need to consider the change of direction into a new paradigm. Through local testing, these proposals will allow self organization of the urban space, adapting to pre-established rules and/or to rules to be defined. This will generate systems that are apparently disorganized, but where there are non established rules This interaction of rules, encompassed by different factors and behaviours is frequent in biologic processes and generate through an adaptive way, standards and [ir]regularities – typical, i.e., with «chameleonic» principles. They evolve to morphologic adaptive mutations that adapt with flexibility, predefining lessons for an incremental type of architecture, but also to the consolidation of hybrid urban forms.

4. Maputo: introducing micro-multiple city forms into macro planning

As a conclusion, it can be said that in Maputo it is perceivable juxtaposition between regular urban forms, compact and dense, and others more extensive and dispersed (in “spot”), not ordered and fragmented, beyond configurations that do not present specific form, without form - the city lives in this contradictory complex cohabitation: sometimes in an harmonized way; sometimes in conflict.

It is in the periphery that it is being consolidating a sub-morphology of informal centralities, still very deprived of followers and with no infrastructures, but that it will gradually demand another leadership as strong, or even stronger than the one affected to the formal morphology of the “cement city”. House to house renewed standards are being weaving in urban sub-forms of the periphery. The capacity to exceed adversities and uncertainties, to transform “non places” (Salvador, 2004) into spaces of great vitality, to create new models of urban forms and housing construction, adopting different technologies are all distinct answers to the question of how to design physically and to plan the transformation of the city form.

Dialog, exchange of information and analyzes, crossed and joined researches developed in an interdisciplinary system, are essential to any relative balanced and informed recommendation to the urban form of cities in crisis, as it is the case of the capital of Mozambique. They are highly dynamic urban tissues with motivated populations that reveal themselves ingenious and creative in the way they look for to exceed the difficulties they come across daily.

Planning Maputo must consolidate a widened city in an opened form, uttered in an intense and pulsating urban mosaic. Of this process it shall result a capital, which urban form is consolidated in a renewed tissue - more and more plural and solvent at its standards level. It is a way of making city through a set of norms and procedures more than a preconceived formal model. More than a model, planning Maputo demands urban guidelines opened to the interactivity in a liberated way; not tight, being able to be added or deducted. Beyond the analysis of the regularity and processes observation that are placed in the domain of the rationality, they are also necessary crossed readings on non-ordered expressions of the city form.

Complementarily to the understanding of the form and the meaning of the matter -mesh; program; method- while approaching planned urban actions it is important not to abandon the alleged “random” city, where it is difficult to find severity and apparent method. The objective is to start the verification of processes and the decoding of models that allow to interlace and to articulate the Portuguese colonial urban legacy with heterogeneous tissues -by epoch, dominant functions and social occupation- in which disaggregated or unlaced spaces are identified. In this way, planning Maputo requires a flexible city form with capacity to became a sort of “linking morphologies” between the different parts of the urban mosaic through micro-multiple urbanism.

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Arco Ribeirinho Sul: How do we design for a future that we don't know?

Ana Brandão

Instituto Superior Técnico, ana.luisa.brandao@gmail.com

Phone number: 00 351 91 507 7272

Far from a modern time marked by the conquest of space and the belief of planning the future, the contemporary world is marked by instability and change. The city of "liquid modernity" - complex, multipolar and polycentric - is difficult to understand, driven by different dynamics which make it dissolve into the territory. Its future is difficult to configure, with unstable balances and unforeseen developments. How can we design for an uncertain future; project and set up new realities in which all the possibilities are open? We present a discussion focused on the importance of time factors in the specific problems of today's urban design. We seek to understand the effects generated in the process of design by the prevalence of unsafe and unpredictable environments that contrast with a need for certainty to decision making. Can urban design incorporate strategies that facilitate change and integrate uncertainty? Or work with general rules that allow different options at various stages of development? We study the recent case of the announced project to "Arco Ribeirinho Sul", an intervention described as an urban renewal of waterfront areas on the municipalities of Almada, Barreiro and Seixal, encompassing 900 ha. The focus of the project is the conversion of obsolete industrial sites with urban and landscape potential, in a renewed urban structure, promoting new economic and social dynamics. We will analyze the models, difficulties and challenges for intervention, in search of answers to a project in the prospect of an uncertain future.

Keywords: urban design, uncertainty, future, Arco Ribeirinho Sul

1. Introduction

The global world of technology and networks, guided by flow and velocity, does not know rest - it lies in an eternal present. Bauman (2007) suggests the metaphor of "liquidity" - a society marked by a flexible space-time, constantly changing, where everything is temporary. Virilio (1999) emphasizes the idea of instantaneity.

The city is led to a necessary change of spatial organization: on one hand it is necessary to gradually project itself into the future, for reasons of survival and priority, on the other the demands of a globalization context and the proliferation of technologies impose a logic of "real time". The horizons are short term objectives, which restrain the project's creation, the necessary future projection.

If today the time factor has to be increasingly valuable in understanding the phenomenon of urban growth and change, it is also decisive in regulation and design of urban form. But trust in project as a tool for planning and designing of the future, was replaced by a constant uncertainty over the unpredictable environment of the city.

In this article we choose to address the current challenges of urban design - the need to design under uncertainty - in the attempt to find some design strategies that allow management of unpredictability. In the analysis of the case study we present a reflective approach on the so-called Arco Ribeirinho Sul - an area of the Tejo's south bank, which extends from Fonte Telha to Alcochete, (with focus to the waterfront area between Almada and Barreiro).

From the strategic document that launched the "rescue" and redevelopment project of obsolete industrial areas, we search to decode the model presented and to identify future challenges.

Based on the temporal matrix we try to theoretically structure a temporal problematic of the intervention, pointing out aspects where the relationship between the project and time are prominent; finally we seek some clues to question the act of planning on uncertainty and management of decision making in insecure contexts.[147]

1.1City and uncertainty

The context of today's city is the network city, multi-polar and polycentric, embedded in macro-regional urban systems, continental axes and global flows. If predicting a city's future wasn't troublesome enough, nowadays, the city itself becomes very difficult to understand, by its particularity, complexity and scale, exceeding the limits of human readability.

Cities are currently suffering from other forms of development and expansion: they are driven by different dynamics and processes, which make them dissolve into the territory - the result is a mix of concentrated densities, new road access and commercial accumulations. The major urban issues are both in the disproportionate suburbs outside the city, as in its heart, in the degraded historic centers. Processes of "peripheryzation" and suburbanization, "lead" the disappearance of the experience of public space and to a urban landscape monopolized by the automobile.

In the "new city" the infrastructure doesn't create by itself new centralities (or rarely does), nor places of strong identification. Rather the larger conections easily divide the territory and atomize social relations. But is this inevitable? These processes are reversible and reusable?

Many of urban theoretical persperctives, are more concerned with the multifaceted intervention on urban space, to "make the city throughout the city." Going further, and to accentuate the dichotomy "center-pherifery", many question even the city itself and its limits, and in the extreme, the very relevance of the term: from the idea of death in the cities of Jane Jacobs (1962) and Francoise Choay (1994), to the announced death of its public space in Rem Koolhaas (2001).

The city as symbolic centrality seems a formula of the past. The former centers have become increasingly decentralized, remaining with some cultural and tourist functions. The growth and dynamics of mobility within the city led to the adoption (desired or spontaneous) of other models which include a multiplication and proliferation of economic, trade, technological centers.

In this context, how can we assemble processes where risk and mutation are regarded as design data rather than disadvantages, impossibilities, or instabilities? Is it possible to ensure that a transformation can monitor the needs and desires of its players, representing a secure and recognizable process with progressive steps of definition, rather than a leap into the indefinite future? In the next chapter we'll see how in the specific case of the Arco Ribeirinho Sul is defined the model and transformation process for a horizon of about 20 years, to then search the theoretical framework of uncertainty management, with possible application.

2. Arco Ribeirinho Sul - awakening to another paradigm

The concept of Arco Ribeirinho Sul is enshrined in the 2002's Regional Plan of Territorial Planning of the Metropolitan Area of Lisbon (PROT-AML), and it comprehends the riverside areas from Alcochete

[147] On this theme José Manuel Viegas's "Perceptions Of Increasing Complexity In Planning And Avenues For Responding To The New Challenges" "presentation on CITTA's 2nd edition, presents a summary of aspects about planning strategies.

to Fonte da Telha, constituting a large urban area of the south bank. Spanning six municipalities (Almada, Seixal, Barreiro, Moita, Montijo and Alcochete), it has today a population of about 550 000 inhabitants and a moderate population growth is expected in the coming years.

Regarding the profile of territorial occupation ARS integrates several distinct units:

- Riverside historic centers relatively well preserved,
- Consolidated urban areas,
- Areas of "dormitory suburbs" corresponding to a process of suburbanization,
- Areas of poor quality construction and architectural housing, poorly equipped and infrastructured with problems of social exclusion.
- Areas currently under rehabilitation - Costa de Caparica, Seixal Bay
- And the old industrial areas as Margueira, Siderurgia Nacional and Quimiparque.



Figure 1. Arco Ribeirinho Sul.

The development of urban occupations in the axis Montijo-Cacilhas starts with more intensity in the areas of river accessibility to Lisbon and relates deeply with river Tejo and the economic activities related with it. From the early twentieth century the investment on industry and port activities lead to the growth of clusters around these new centers, "fed" by a considerable migration from rural areas to these "new" urban areas. Overt time, these first large industrial centers were also promoted over time by both the settling of other industries and social and cultural services to the workers, strengthening the bond and identity relationship of the entire population.

It's in the 60s that the development of industrial activities - Margueira, shipbuilding and repair; Seixal, steel industry; Barreiro, chemical industry - founds its peak, marking the territory in socio-economic and cultural terms. In the same time, the populational growth becomes part of a process of

suburbanization of Lisbon. Boosted by the construction of the bridge April 25 (1966), the axis Almada-Fogueteiro becomes characterized by an high-density construction of multi-family typologies.

In the 70s, the economic juncture caused by the oil crisis in conjunction with the political and economic instability lived in Portugal, caused a crisis in most industries in the region, many of which progressively and over two decades have been decommissioned or abandoned. In the 90s the change of products nature, in production processes, and the increase in commerce and storage investments allowed a movement of spatial reorganization of activities - shifting economic activities (automotive industry) towards the axis Coina-Palmela-Setubal. In the areas of Siderurgia Nacional and Quimigal there was a process of conversion of some portions to new industrial units, but with little profitability and without an internal logic of development.

Resultant of a growth that has always favoured the connections to Lisbon, the internal connectivity of this area is weak, and exists between municipalities physically close, always with priority to those that have a direct link to Lisbon. Likewise, and despite efforts in recent years in promoting and developing local clusters of activities (example of the municipality of Almada), the Arco Ribeirinho Sul is still largely dependent on offer from the Tejo's north bank, especially with regard to employment and specialized services.

2.1 Changes in the territory and the history of the project

The lack of action, tools and adequate funds made the administration of the territory rather difficult in the post-25th April, consequence of strong social pressures and policies focused on the lack of adequate housing, infrastructure, public amenities and transportation.

It was only in late 1990 and early 2000, that EU's funding allowed the construction of important road infrastructure - construction of the Vasco da Gama Bridge in 1998, the IC32 (link to Coina) and A12 (Montijo - Setúbal) highways which reconfigures the east area of the territory. Furthermore, the rail link in the 25 de Abril Bridge (1999) and later the connexion with tram (Metro Sul do Tejo - 2008) initiates a new paradigm of mobility in the axis Almada-Fogueteiro, redesigning the very relation of the infrastructure with public space. In addition to a growing housing policy promoted by the real estate sector, the improving of the network accessibility immediately attracts the "investment" in the commercial sector, with the installation of several shopping centers[148], logistics platforms and development of industrial parks.

It is also with European fund programs that a series of cultural and sporting events (where we can highlight the construction of municipal auditoriums or theaters[149]) are built and some operations of public space rehabilitation begin. Most of these interventions consist in the regeneration of riverside areas with more or less extended goals, with a privileged relationship with the landscape and the river, restoring in many cases, sites of collective memory or of "industrial memory", frequently monumentalized and integrated in road accesses or recreational, cultural, sports spaces. Some of the interventions comprehend deeper reconfigurations in urban design, (case of Polis-Caparica), others the rehabilitation of historic centers (case of Nova Almada Velha) or by the association with

[148] Almada Fórum, Fórum Montijo, Freeport Alcochete, Rio Sul Shopping, Fórum Barreiro
[149] Fórum Cultural de Alcochete - 2005; Teatro Municipal de Almada - 2004; Cinema Teatro Joaquim de Almeida - reabertura 2005; Fórum Cultural José Manuel Figueiredo – Baixa da Banheira - restoration-2005; Auditório Municipal Augusto Cabrita - Barreiro - 2003

leisure facilities such as pedestrian lanes, bike paths, green areas (Polis Barreiro, Seixal-Arrentela ride, etc.).

The interventions and projects of recent years in the municipalities of the south bank reflect a "new" concern with the territory, particularly in the role of public space as part of "creating quality of life" and "urban value". This new awareness is crucial to the emergence of Arco Ribeirinho Sul project

2.2 The opportunity

The territorial strategy of the 2002's PROT indicates a revaluation scenario of Lisbon, introducing the idea of a "city of two banks" anchored in the Tejo's estuary as the major space of the metropolitan structure. A scenario that seeks to counter an extensive growth of outlying metropolitan structure, focusing on the development of a polycentric structure, in the correction of urban imbalances and in the safeguarding of natural and landscape values. This is the framework in which the role of Arco Ribeirinho Sul is set, as a structural area in the configuration of Tejo´s Estuary, as a new urban metropolitan space.

A number of initiatives of infra-structure is announced at the end of the last decade. The decisions in January 2008 of the future's Lisbon airport location at the Campo de Tiro de Alcochete, the construction of Tejo's third crossing, the creation of high-speed railway line and the installation of a logistics platform in Poceirão, together with the implementation of other infrastructure in a more local / regional level, mainly of accessibility, both reinforce the need to promote "rules" of growth and development for this area. According to the project proposal, these large investments may provide the opportunity to leverage other investments directly or indirectly associated with the infrastructure "layer", which is expected to act as a impulse for the development of Arco Ribeirinho Sul and its surrounding area.

The infrastructure centered at the Airport empowers the surrounding's urban growth, which normaly houses additional services to the airport. But the concern with the "destruction" of a landscape system (the montado) in the area chosen for the new airport, makes it deviate from that model of territorial occupation. The decision appears to point to the "displacement" to areas closer to the urban consolidated fabric, "rescuing" old industrial areas for new urban uses, specifically in land held by the Portuguese State - Quimiparque in Barreiro's municipality, Siderurgia Nacional in Seixal's municipality, and Margueira in Almada's municipality, with a total of nearly a thousand acres .

Setting the IC32 high-way as the limit of the urban area to consolidate, this option for urban development tries to combine two objectives:

- the safeguard of agro-forestry and natural landscape systems (that would otherwise suffer enormous pressures),
- the restructuring of riverside areas with a unique urban landscape and economic potential. The urban reconversion of some of these industrial areas and some accessibilities projects were already envisaged by other local studies and projects.

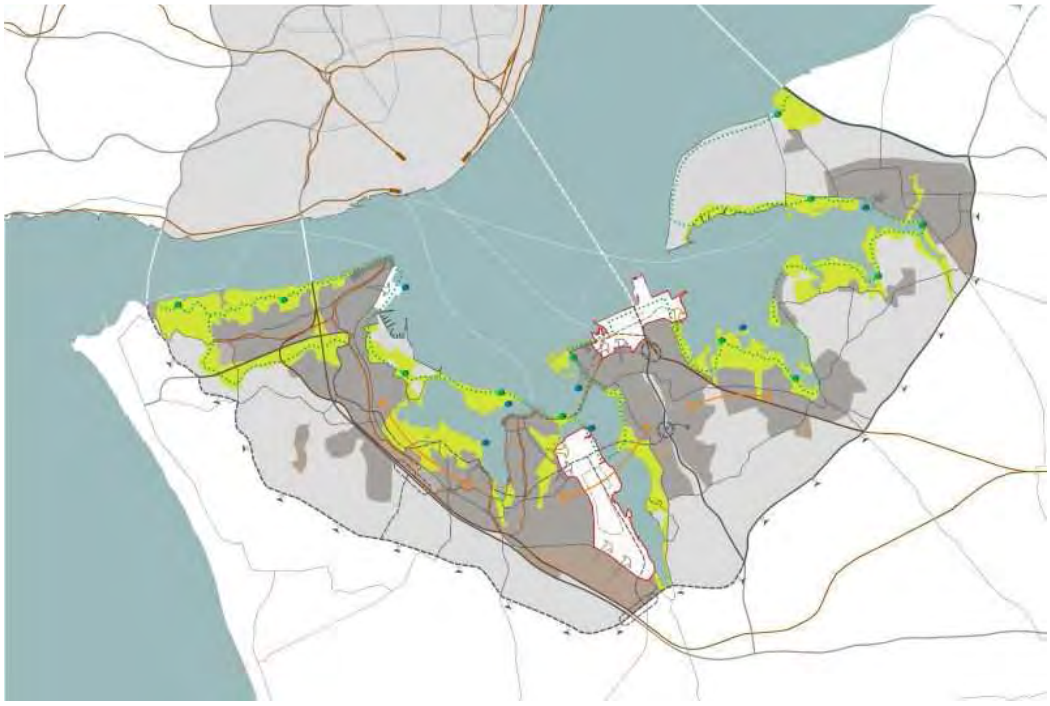


Figure 2. Arco Ribeirinho Sul - urban area to consolidate.

The project of Arco Ribeirinho Sul in the context of infrastructure configuration, aims to give them a new framework, considering it important enough to lead a strategy of sustainable development and economic promotion with effects throughout the Lisbon Metropolitan Area.

2.3 Strategic document - the launch of the bases for f the intervention

In September 2008, in resolution of the Council of Ministers[150], the Government launches the Arco Ribeirinho Sul project, outlining the main strategic guidelines and creating an interministerial working group (comprising seven ministries, and working closely with the municipalities of Almada, Seixal and Barreiro), with a mission to prepare within 90 days, a proposed strategic plan that includes:

1 - Delimitation and characterization of the area covered by the intervention;

2 - The definition of intervention priorities, projects and structuring of actions;

3 - The quantum of investment associated and proposals for its funding;

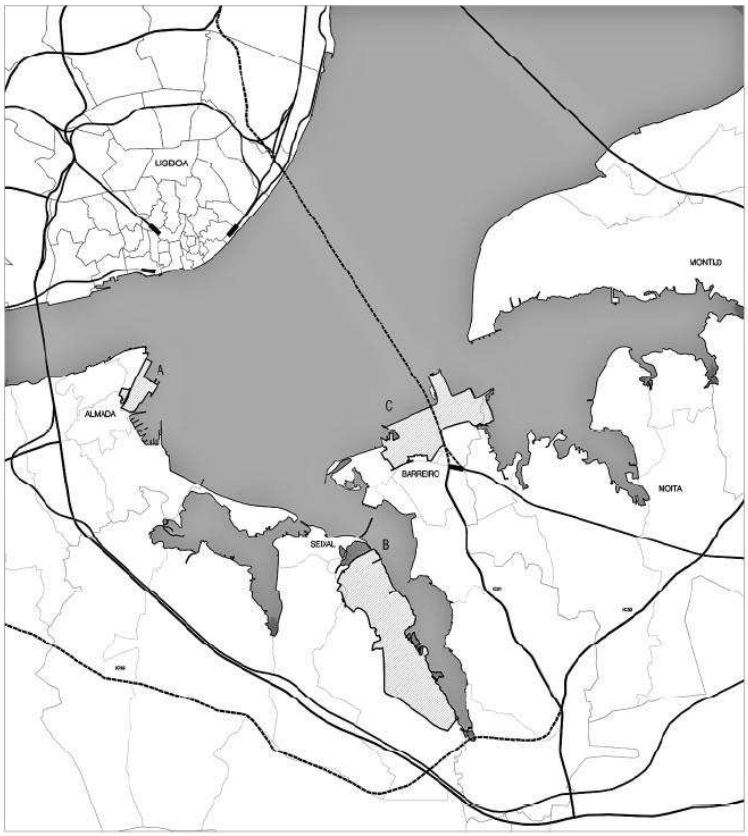
4 - The design and proposal of appropriate institutional solution to the project;

5 - The financial and physical planning of actions considered.

The document that establishes the basis for intervention and development models, was approved on July 23rd in Council of Ministers, coinciding with the formation of the company Arco Ribeirinho Sul, SA, coordinator of the overall plan. The document defines a time horizon of 18 years to complete the project, envisioning 17,000 new residents and the creation of more than 55 000 direct jobs, with an impact on the creation of another 66 000 jobs.

[150] "Resolução do Conselho de Ministros n.º 137/2008" published in Diário da República, September 12th 2008

The total area of intervention 881 hectares - 536 ha in Siderurgia Nacional, 290 ha in Quimiparque and 55 ha in Margeira - is equivalent to about three "Parques das Nações" - EXPO 98 intervention area.



A. Margueira
B. Siderurgia Nacional
C. Quimiparque

Figure 3. The total area of intervention.

The important question is: how to transform a number of spaces abandoned and decaying into a real opportunity for the reorganization of centralities in AML. The strategic answer of the project appears to be an approach that leaves the "old attractiveness" lost by the obsolescence of spatial models to build a scenario of a "new attractiveness" developing and promoting new opportunities.

We can identify overall objectives, structuring a series of ideas (somewhat vague at this point) that are defined throughout the document:

- Emphasis in the connection with river Tejo's
- Promotion of establishment of a young population.
- Creation of structures and urban spaces with physical and functional high quality

To carry out these objectives, the proposal sets out priorities:

- Economic activities with capacity to generate skilled employment compatible with the new uses (support of the new Airport, Poceirão's platform, tourism and leisure activities)
- Equipment - creation of "anchor equipments" and installation of community facilities in the key areas of education, health, sport and culture;

- Mobility and accessibility - establishment of a new accessibility network, privileging soft mobility, with implementation of collective transport solutions, pedestrian and cycling movement and public space adaptation to citizens with reduced mobility;
- Environment and landscape - restoration of the riverfront and development of a green structure that integrates a wide ecological corridor in the Arco Ribeirinho Sul;
- Identity and socio-cultural values - installation of services or equipments to mark and contribute to preserve the memory of these areas and development of a territorial marketing plan.

The structural projects correspond to initiatives necessary to occur an "irreversible" transformation in the territory. The proposal advocates the capacity to stimulate other interventions and to contribute to a significant improvement of the quality and attractiveness conditions. Among the structural projects include:

- Consolidation of business areas
- Installation or relocation of heavy industries
- Establishment of housing, commerce and services areas
- Installation of important equipments
- Installation of a creative industries center
- Installation of structures to support recreational boating
- Construction of the Tejo's third bridge
- Relocation of ferryboat terminals
- Construction of Lavradio's intermodal station
- Construction of Phases 2 and 3 of the tram line - Metro Sul do Tejo
- Completion of the highway-IC32 / CRISP
- Structuring the Ecological Corridor

Some of the projects here included, are the result of already planned intentions or large investments whose "responsibility" does not fall on the management or control capacity of the project.

Given its scale, complexity and importance, the achievement of the project´s objectives implies the making of numerous investments and to determine their funding. Some of them, especially those related to large infrastructure projects fall on State responsibility (through state companies or partnerships with the municipalities), with the possibility of some operations being licensed to private parties. In other cases, the document points to the development of partnerships between public entities or public-private partnerships to carry out the interventions.

Assuming the stipulated by the Council of Ministers that the intervention couldn't be costly to the State[151], the investment model presented for management companies is based on an initial investment - in infrastructure, in exterior repairs, management intervention and promotion and raising activities - for a return to be provided by marketing and selling the infrastrutured lots of land. Likewise, in the case of municipalities, investment in public facilities is reverted with the payment of fees, licenses and property taxes. The model ensures the commitment of the municipalities in the conduct of investment based on the implementation of future tax revenues that could reach an estimated 95,375 thousand euros.

[151] Model similar to EXPO 98's, that throughout its implementation resulted in a densification of the plan

The institutional model proposed takes into account the need for an overall project management at the same time of an agile and profitable interaction with other entities involved. Thus the document proposes the establishment of a management company - Arco Ribeirinho Sul, SA (a public company with 100% of the state capital), which coordinates the overall plan. This same company will create local companies for executing each of the plans with each of the municipalities correspondent, where it will participate with 60 percent of the equity (the remaining 40 percent rely on the responsibility of each municipality). These local companies have as their object the management and carrying out the urban renewal and redevelopment operations. The same institutional model states that the overall technical coordination and integrated implementation of the strategic plan shall be assisted by Parque Expo SA

Given this strategic plan of action, we can determine in accordance with the reality of urban area which are the range of themes and issues addressed by it, that are influenced by contexts of uncertainty or depend on time factors and how that affects the ability to forecast, plan and project.

3. The problem of time and uncertainty - challenges and issues of urban regeneration

In this chapter we are interested in constructing a problematic that based on the theme of time and uncertainty sets the framework and systematizes the issues raised by the intervention in a territory as multifaceted as this:

- How to respond to the conflict between the strategies of transformation / renovation and the rhetoric of conservation / restoration of the traditional city?
- How important is infrastructure for mobility and communication and what its role in the structure of the enlarged city?
- And how is it influenced by changes upstream or downstream in relations between center and periphery, between growth and "emptying out"?
- How to respond to a universe of demands and choices increasingly uncertain and unpredictable especially in demand for business locations or housing?
- How it responds to the specific needs of the communities they are intended?
- How to build decision-making processes in a context of diversity of interests and indeterminate planning elements?
- How to organize a vision of the future and by what means this vision is managed (plan? project? image?)?
- How to incorporate the emergence of new lifestyles and urban multiple identities?

We will select a point of view on the city which is temporal.

To explain the relationship between the city and time we start with the investigation of Kostof (1999) - the concept of urban process as a physical change over time. If it's usual to see the urban form as something finite and closed, Kostof argues that the city is a living element that reflects (at its pace) the rapid changes of society. The challenge is to understand and reconcile the competition between the economic and social changes and persistence of the physical characteristics.

This relationship between change and persistence is perhaps one of the most obvious manifestations of temporal dimensions in urban areas. It´s important to find others. Starting from the

local context and the intervention model will reveal a variety of situations and possible discourses with temporal factors in the transformation process, where we will highlight:

a. The predominant issues of the relation between community and individuals with the spaces they inhabit - the identity - is manifested in processes of representation and recognition, communication and participation. In an urban context, identity encompasses both the relationship with a more consolidated past, as it helps us to provide a framework and to design in situations of an uncertain future (construction of new identities).
b. The urgency of transformation, of circumstances of change and the creation of new relations show the importance of process. It includes plans and projects, the proposal of ways to reduce the uncertainty margins, but also social organization of space, relationship between urban players, tensions or a negotiating mode of collaboration. The process itself is the result of actions and reactions, which occur in time and space.
c. The role of infrastructure associated with the issues of centrality and competitiveness, highlights the movement as a key factor in the experience of the contemporary city: transport, mobility, accessibility, trade, flows, exchanges are a constant of today's city, and networks which support these systems in some cases depend excessively on an "top" urban element (airport, TGV, etc)

3.1 Temporal expressions in Arco Ribeirinho Sul

The problem of transforming a degraded area into a "center of economic and social dynamism " with the ability to adapt and sustain a piece of the new urban development, has several relevant aspects of time and factors of uncertainty that we can identify in the present situation since the viability of TGV, the real urgency of the new airport, or in a longer time span, the effect of climate changes in an estuarine zone.

Firstly the combination of technical solutions for infra-structure in the articulation of options regarding the interaction between partners with sometimes divergent interests, the conditions of timing and cost, the variable and dynamic nature of the intervention, reinforce the need to manage these various inputs and complex realities in a territorial context.

With the categories of identity, process and movement, we analyzed some of the problematic complexity.

a) The thematic of identity is common in any operation of urban regeneration.

In this case, it's perceived both as reflection on an industrial area with strong memories associated, and as a wish for a new identity role with impact on the entire territory of AML. It is from these extremes that identity issues are developed:

The industrial heritage and the representation of memory - resistances and opportunities

The sense of place, specific characteristics of the site, is the simplest form of identity. We can comprehend that a connection to heritage, to a collective memory, an image nurtured by history and by stories, form a "constructed" nature of strong identity. And it is with this starting point that we can assess the needs for change and the possibility of equilibrium between two concepts:

- The production of a historical identity and its representation in the place (the myth of an industrial past and the artefacts related to it)
- The response of the "new" urban design to the old industrial settings

The project identity - hopes and possibilities

One of the problems of post-modern identity is to avoid setting and to keep the options open. The projection of a desirable future is anchored in a possible appropriation or reinterpretation of identity to build a "future picture" - the identity of a project is a critical projection that seeks "what it could be". We can find within the territory expressions such as:

- The possibility of construction 'local' identities related to new activities and uses
- The dynamics and issues of social gentrification
- The promotion of a territorial image associated with quality of life

Identity as a form of territorial claim - chances of representation and recognition

In a broader context, the identity can also reflect a form of affirmation towards other realities. Whether in a local environment or in a context of global competition among cities, the process of identity construction is anchored in territorial and cultural attributes. Often used as a "brand" for publicity and promotion, the relationship between identity and territory can stimulate various scenarios:

- The assertion of an identity based on territorial distinction - "I'm from Margem Sul (South Bank)"
- The restoration and highlighting actions of cultures and customs related to the Tejo's Estuary - a hypothesis to "riverside identity "
- The multiplicity of registers and cultures in the Lisbon Metropolitan Area - valuing diversity

b) The issues in the domain of the process. Their dominance arises from the complexity of the proposal in the context of multiple interventions - the rehabilitation of different environments with different constraints - requires logical systematization of the various factors / elements in question. Likewise the timeframe of the proposal and the (un)certainties arising from it point to the need for a less formal logical reasoning and a more intentional and strategic. These are procedural issues featured prominently:

Coordination of agents, players, populations - participation and construction

The complexity of the intervention is also reflected in the multiplication of layers and interests. The development of a project of this magnitude requires a strong effort of conciliation and compromise among the various entities - public, private, regional, local - small organizations and large companies. The relationship of participation and construction can be expressed in situations such as:

- The management of interest and the regulation of public-private partnerships
- Participation as a process of construction of the territory
- The representation and coordination of divergent interests - relationship between communities and decision makers.

Stages, horizons and plans - design and tools

The development of a proposal like this does not acknowledges a concrete or closed temporal look - the relocation and modification will be constant elements within at least a 20 year period. An

approach to a territory in transition must always follow the changes underway. Examples of possible strategies may be:

- The update in the intervention program, according to new needs, or incorporating momentary or unforeseen opportunities.
- The investment on projects that are secure levers of a "sustainable development", creating local and self-sufficient economies,
- The design of public space as the key-element of the entire project, assembling to spatial and temporal discrepancies.

c) The theme of movement, in the form of infrastructure and centrality is the initial argument of the project, marking the strategic approach to the territory. It is from the network's "installation" that other horizons and lines of growth are drawn (attraction of capital, tourists, businesses in an international perspective). But this relationship between infrastructure and development is not always direct - other dynamics are relevant in context:

The program of infrastructure - integration and impacts on the territory

Today we can find within the city spaces exclusively dedicated to movement. In many cases the infrastructure "merely" gives access to certain sites forming in it way barriers for local crossing. Other cases exist where movement is intricately linked with generating other activities: the interaction between activities and movement of people is one of the main aspects of life in public space. In perspective of major infrastructure interventions planed for the territory we can address:

- The importance and real impact of the new airport at Campo de Tiro de Alcochete
- The creation of a "hard" infrastructure system and its relationship with the surrounding territory - the "tunnel-effect" and impacts on landscape
- The connections to other transport modes or the potential generated in metropolitan and regional relations.

The significance of mobility and local transport - systems and scales of intervention

The way we move largely determines how we experience the urban environment. The project includes proposals at various levels ranging from international connections to internal and local connections. Leveraging some alternative objectives which we emphasize:

- The leading role in the development of "greener" forms of mobility - development of tramway (MST) and the potential relationship of these new centers.
- A vision of mobility created from local public transport and focused on movement within the Arco Ribeirinho Sul
- An urban design that incorporates to the articulation of infrastructure with other activities and services, incorporating leisure, culture in Urban Design.
- The creation of infrastructure for light mobility - bicicle paths, pedestrian paths - linked to landscape systems and other natural values.

Aspects of accessibility and centrality - the potential of networks and flows

The vitality of place and its potential is largely determined by the movement of people and goods that pass through it - transport and communications networks allow trading of goods, information, ideas,

etc.. The transformations on urban system of mobility and the development of communication technologies can lead to re-consider the centrality of old systems and create others not yet foreseen. We can fit in this point:

- The creation of new qualified productive centers from the design and the role of infrastructure with connections in area surrounding - local and global.
- Installation of new economic activities and their location relatively to mobility networks - development of strategies for attracting and developing.
- Linkages between economy and space - the design of industrial areas and its impact on the landscape

In the three thematic ways analyzed there's an evidence of the variety of situations where we can explain the importance of matrix temporal in the characterization of the uncertainty theme in this project:

How to plan and design in this context of multiple variables undefined?

In search of an answer, we will have to anchor in relevant theoretical assumptions. That is what we'll do in the next chapter

4. Design and Uncertainty - How to build an unknown future

The modern planning was born as an autonomous subject with a particular social role, based on specific techniques. Attention was given to the city as a immense fixed capital - the rational and functional city design, in contained limits, homogeneous, continuous, simplified, supported by the premise of a man-type of universal needs.

In contrast the contemporary city is vast, heterogeneous, discontinuous, complex. In Francois Ascher (1996) perspective, we consider that it works with multiple and possibly conflicting rationales, forming an open system with unstable balance. To this process of territorial diversification corresponds also a social recomposition of cities through processes of flexibility, individualization and customization suited to the diversification of social needs.

Consequently the project in contemporary city suffers itself transformations. According Secchi (2003) it now has a much broader thematic horizon, it explores much more varied situations, rejects unification, codification and formal reduction and language, refutes the assumption of homogeneity - that changes, locally and over time, according to the culture of place and time, history, experience, sensitivity and tensions of the population.

4.1 Management of certainty and uncertainty in Urban Design - scenarios, hypertext, visions

Taking into account the changing of needs and contexts, we sought the support of theory to answer questions that may clarify the challenges posed to the design of the city.

If the indeterminacy is present in our experience of the city, how to consider it in the design process? How can we deal with temporal aspects of indeterminacy when we are designing for the long term?

For Secchi (2007) the instability of the contemporary city, the continuous displacement and reorganization of activities, obsolescence and decommissioning, the phenomena of degradation and filtering down to which result, actions of reuse, recovery and upgrading that may follow them, the

policies of gentrification of restricted and limited parts of the city which hosts, are at the same time, the cause and expression of positional values and horizons of meaning that are presented to us under the appearance of chaos.

Lynch (1976) also tells us that change management must be a cumulative process, rather than a jump to a certain future. The definition of strategies and time horizons or the link between physical and social change, can be used to mediate change, making it readable and acceptable, controlling planning techniques where objectives and situations change successively.

Therefore the design of the city does not need to be subject to long term plans (which will only increase the uncertainty). Rather it is necessary to keep track of this act in the near future and keep open the distant future to explore new opportunities while maintaining the ability to respond to change. In this case it is crucial to improve the control and decision process by which the environment is constantly replaned. Knowing this process will be part alone of the strategies for determining:

- Shorten the "waiting" between the challenge and response, establishing monitoring and control;
- Decentralizing decisions to better information points;
- Experiment and develop testable alternatives may increase the adaptive capacity without interfering with physical characteristics.
- As future possibilities are being shown, and their links with the present drawn, we can Foresee what can be done in the future.

What mechanisms of action can be used to respond to constant change and to future problems that do not know yet? How can the instruments and tools for planning cover new developments?

For Bernarnd Leupen (2005), the speed of modernization and unpredictability inherent in the change process becomes much more difficult to establish a viable reality for slower transformation elements. In the case of urban projects these factors are even more compelling. A project requires the maximum possible of certainty to be attainable, even when the conquest of certain proceeds in stages. In this case the potential-dependent responses and exogenous effects catalysts will define the early stages gradually.

On the other hand, Carmona (2003) tells us that if a project can give us some long term certainty, reducing the risk of development, it is only viable if it keeps enough flexibility to accommodate emerging and evolving process of change: to withstand unexpected, urban project should save degrees of freedom between the parts without losing continuity and readability. This system would ensure the integration of forms and mix of activities through implementation strategies with different time frames, targets and actions in the short-term, medium-term and long-term.

In the view of Portas (2000) the urban project is the result of a complex initiative, which reflects the more visible traces of the initial infrastructure, the suggestions of an urban image and the rules of negotiation with the agents for what they can't or shouldn't be completely defined at the startup. The plan (Portas, 2003) must now contain variable regulatory mechanisms that override the usual rules about what can or can not do, for rules on how and on what criteria should be made the administrative decision, when inputs are involved or how to generate initiatives that do not depend exclusively on traditional agents.

The activity of urban design is always open-ended and evolving, which makes the assistance and contributions a dynamic system. The urban project can not therefore be understood as an extension of architectural design, it is another thing. It is a project that is constructed by layers with different representations, geometry and degrees of uncertainty, incorporating as a central element in the time factor. Incorporates different logics to make the city, different interventions at different times, as the fragmented conditions of their viability are brought together....

The various urban elements are treated in diverse combinations and sequences in which the connections, contacts and references are always changing. The metaphor used is the "hypertext" (Portas, 2003) in which the grids general aspects / items to consider are defined (eg ecology, infrastructure, and activities) and each of these aspects, structures itself, in another grid theme, thinner, and so on. The action and thinking on the urban space, are the lines of action that move throughout these sub-grids, making connections - a hypertext structure allows us to pass from one medium to another, participate in multiple interactions, participate in a myriad of urban meanings etc.. In a similar context Secchi (2002) presents the concept of scenario: a polysemic term often used to define approximations, or references to a future - good or bad - as imagined possiblity. Scenarios are attempts to ask "what if?" In a context of urban transformations with several distinct and conflicting interests, we can ask what would happen if, by subjecting them to rigorous critiques, obtaining images of the future - scenarios - which would be partially incompatible. For Secchi it is in this antagonism that lies its importance. Given the current context of uncertainty, the deductive procedures today can not help build a coherent urban policy. The strategy could be to a patient and continuous construction of scenarios, a process of choosing between "conflicting images" produced by subjects driven by interests that are partially incompatible.

An essential tool for urban design is the creation, management and communication of a vision that explores present opportunities, while developing plans and strategies to be successfully implemented. The concept, found in Carmona (2003), is also developed by Sechhi (2003), with more depth. A vision is not a plan - is both less detailed and more complex, does not define specific rights and duties or construct procedures executives, but outlines a "vanishing point", a horizon of meaning while it specifies a strategy to achieve it. A vision is open and flexible, with a discriminating power based in formal and substantial coherence, a potential value.

4.2 The process of the project - a culture change

The process, in the area of scientific activity (as in the area of urban design), comes from a doubt, a hypothesis, of clues that lead the search for evidence to confirm or falsify it. It requires the division of work and interaction in a single act, in common language for various players with different roles evoking participation. From the process, considered as an operating mode of urban project, comes a future arrangement that is different from the exchanges and interactions between the parts. The process of change (Crozier, Friedberg , 1972) involves the transformation of an action system - is necessary that an entire system transforms itself in every aspects, from creating new relationships between players, new forms of intervention, control, etc..

A process is seen as a continuous flow of action, a succession of actions combined in time, a time span within which the events occur. It is in the process that the potential is reduced and

configured in present. It is also in the process that the work done on it and thinking by which it is done, acts on the problem, on the constraints and possibilities, while redefining the original context of new possibilities.

With regard to urban themes, Portas (2008) stresses the importance of process - as way to operate - in a context of unpredictability and unknown as part of the project's problematic. Especially when the context of the intervention is guided by:

- different institutional conditions and negotiations with private and cooperative parts.
- pashing of interventions, with relative indeterminacy given the multiplicity of players and uncertain demands.
- variable geometry of project parts, leading to the need for independent solutions in construction and duration time.

Portas (2008) concludes that the "culture of urban design" is increasingly determined by procedural options: choices of parts that may or may not be implemented, that are open or not, the more certain and more imponderable, corresponding to a context of uncertainty demands, programs, funding. It also includes situations of project implementation: the relationship between public and private players, negotiation and participation, the timing and evaluation of the intervention.

While in previous contexts it was possible to think in the future as certain event, a plan to be executed, fixed and determined as a "teleological" future, in contemporary (full of differences and unexpected), there are only possible perspectives, a future in open. This does not mean that we have to renounce imagining the future: on the contrary we need a construction process that allows the incorporation not only of the initial data, but mainly the changes that occur. In a process that does not contain only certainties, things defined, measured and determined, but that is the reflection of agents, resources, interaction between constraints and how they "evolve" in time and space will be built as a mirror of the territory that is gradually defined, either as simulation, as scenario, vision or outlook?

5. Conclusion - A different approach to the complexity of the city

We identified through out this article the main relationships between city and uncertainty, seeking the temporal dimensions of the urban, in a close relationship with city life, its processes and projects, the design of the city and the players.

In the end of this analysis we can make some considerations about the Arco Ribeirinho Sul project and its future development, pointing out some aspects worth of further studying with the progress of the project. Considering the timeframes estimated by the strategic plan of action - 18 years for the area of Quimiparque, 12 years for the area of Siderurgia Nacional, 15 years for the area of Margueira - we can question what contexts and needs may change, and how can it undertake the project. For example:

What is the feasibility / justification for intervention in case some of the large infrastructural investments do not follow forward or fall into procrastination. Could we find other logic for the intervention? Or parts of them? Or in phases? Will it be to exclude the hypothesis of a partial execution of operations on the area, noting for example that the urbanization plan of Margueira was launched even before the formulation of the concept of Arco Ribeirinho Sul.

In a more focused look at the financial level, a reflection can be made about the financing of intervention - tax revenue coming directly or indirectly from the sale of urban plots. If we take in account the current crisis in the housing market, can a project like this accommodate market fluctuations? In this point the strategic plan is not clear, either by referring briefly to the subject or by the embryonic stage of the project, but it deserves a closer study.

Economically, the plan's assumption is that the infrastructure of mobility will bring investments and interests to the area. While this cause-effect seems more or less certain, it would be need to assess more accurately at what scale and impacts at local and regional level. For example it would be important to understand the consequences of the implementation of part of this network or the ratio of the chronology of the infra structure with urbanization.

It is in a more regional level we can still question the effects of an intervention of this kind in the dynamics of Margem Sul in particular and the Metropolitan area of Lisbon. If it is proved that there is useful parallelism, it may be interesting to assess the role of EXPO's area in the regeneration of riverside context in the north area and the relationships of populations adjacent to this new privileged territory. What are the success factors in action: qualified public space, good infrastructure of mobility, cultural and leisure offerings? And the factors of failure?

For the development of this work, we highlight the importance of a reflection that is needed to today's "operational urbanism", in the decoding and organization of urban space, the profound changes on the ways to think, produce and manage the territories and cities, with factors of uncertainty

The current scenario is at all complex and we can only deepen the knowledge with bases of critical rigor: the city is a system of relationships and interdependencies so intricate that does not accept monologues, nor reducing visions. How to design and manage when the present is unstable and the future unknown, with multiple and conflicting players, the variables uncertain, if not with theoretical foundations and solid critical reflections, to the thinking and planning in the today's city?

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Public Spaces Form: a possible analytical framework

João Ferreira, Manuel Fernandes de Sá, Pedro Leão

CEAU (Centro de Estudos de Arquitectura e Urbanismo)

UFP-FCT (Faculdade de Ciência e Tecnologia da Universidade Fernando Pessoa)

FAUP (Faculdade de Arquitectura da Universidade do Porto)

joaocastroferreira.arquitectos@gmail.com

Phone/fax numbers: 00 351 226106241

The discussion of urban form has gained particular relevance in the context of the exhaustion of the modernist city model. From the mid-50th century XX, several movements, relatively independent of each other, challenged the modernist city paradigm, and seek to overcome its increasingly obvious limitations: the type-morphological studies of urban fabric; analysis the urban landscape, the relationship between the configuration of urban spaces and their use and the movements of public participation. Despite the relevance of some of the studies, such as those developed by Gordon Cullen, Edmund Bacon, Kevin Lynch or Spiro Kostof, the analysis of urban landscape and in particular of its formal elements of composition have faced a systematic difficulty in establishing a framework for shared references, support for continued line of investigation.This study aimed to build a framework of analysis of the elements of formal composition of public space built in the city of Oporto during the twentieth century. The aim is to use this framework as an instrument on analysis that will extend the discussion of the variables of its membership beyond the strict dichotomy between open / closed space. It is also our objective to create a lexicon to support the discussion of the transformation of public space, common to both laymen and professionals and to expand the discussion of public space beyond the limits of the defense and reaction covering a prepositional dimension. This analytical framework will be built with the support of an interactive platform for viewing geo-referenced information with an Internet connection - Autocad Map 3D - which will allow to collect, organize and view statistical information and mapping, incorporating various types of data - maps, images and alphanumeric data. In this way we create an expandable base structure for public space analysis having as base the analytical framework and several operators GIS software.

Keywords: urban form, Oporto, analytical framework

1. Context

From the mid-50th century XX, in the wake of the exhaustion of the modernist city, various movements, relatively independent of one another, challenge the eminently functionalist approach of the city and seek to overcome its increasingly obvious limitations. Within these movements, we can point out the following issues of study and debate; the studies that focused (1) on the type - urban morphology of tissues, (2) on the analysis of urban landscape, (3)on the relationship between the configuration of urban spaces and their use and (4) the demand for public participation and discussion.

The type and morphological analysis comprises several approaches, and we think it is important to draw the attention to the English school, which is an approach developed from the history and geography field's disciplinary and in particular the research conducted by MRG Conzen, whose main centre of research is the contemporary "Urban Morphology Research Group (UMRG), University of Birmingham. We can also point out the importance of the Italian school developed from the work of Muratori in the fifties, with relevant work subsequently developed by Caniggia, Maffei, Rossi and Aymonino on several Italian cities, being the main pole of this methodological approach the "Centro Internationale Studio dei Processi it per urban and regional (CISPUT), founded in 1981 in Florence. These studies have attracted interest beyond the national borders of Italy, of which is paradigmatic of the Italian influence a number of French type-morphological studies. These two approaches, in addition to other development in these areas, have been converging on common

forums for discussion, of which the more representative is the "International Seminar on Urban Form" (ISUF).

The type - morphological approach is particularly relevant for analysis and characterization of spatial transformations in urban tissues relatively consolidated, enabling an integrated approach to three dimensions: space transport elements, *cadastral register* and buildings, being also relevant the relationship established with urban planning. This integration, one of the most powerful features challenging partial or utilitarian visions, is particularly attentive to the long periods of time and to the continuities that underlie the urban structures. Nevertheless it may be a difficult approach to analyse or adapt by more proactive and rupturing movements.

The study of the relationship between form and use of urban space has attracted a wide interest, and this can be seen looking at examples as the studies of Jan Gehl or Oscar Newman, or how it has been widespread through the studies and method of analysis using the "space syntax" developed by Bill Hillier to quantify characteristics of space considered relevant to its type of appropriation.

Public discussion of the transformation of urban space is widespread, having been incorporated in most of the governance processes of the Western world. But its diffusion does not hide the difficulty of incorporating it in the creative process of architecture and urbanism, being this a highly reactive and difficult prepositional process. Its somehow strong integration in decision-making process is, most of the times, not accompanied by any significant set of methodologies for the analysis of formal characteristics. Thus it has become, most of the times, an independent transversal process without being able to communicate effectively with all the rest of the planning and urban design actors, specially its design teams responsible for the formal or aesthetic approach.

Within these movements, the analysis of the urban landscape is one that has revealed more difficulties in developing a continued line of research. The difficulty in overcoming the eminently personal nature of these approaches, despite the excellence of some of the interpretative proposals, particularly the work of Gordon Cullen, Edmund Bacon or Kevin Lynch, is a challenge that we understand as being relevant to meet. Even with the analytical grid suggested by Kevin Lynch, the most obvious case of an attempt to overcome the casuistic nature of the approach, it is difficult to identify a line of research with significant developments subsequent to its original wording. Moreover, the classification of Lynch: roads, boundaries, neighbourhoods, intersections, and the reference points, are related to the perception of the various components of the urban landscape and not directly to their formal composition.

The apparent difficulty in formulating a shared framework of reference raises questions that go far beyond the scope of this study, but that are important not to ignore, thinking about the concern that they might arise. In fact, the architectural discussion has availed itself with successive mechanistic, sociological, linguistic and ecological metaphors, to discuss their own disciplinary field, suggesting an inability or the desire to overcome their specific universe. Jacques Lucan argues that one of the most essential characteristics of the modernist project is there attempt to abandon the composition as a structural element of architectural design, reading instead the history of modern architecture as attempts to overcome the composition: the free plan, the neutral grid, aggregative structures; paradigm language, process and program (Lucan, 2009).

A significant number of authors have been devoting their attention to the formal analysis of architecture and in particular of modern architecture, among which we highlight: "Design Strategies in architecture, an approach to the analysis of form," originally published in 1989 by Geoffrey H. Baker, "Elements of architecture, from form to place", first published in 1990, Pierre von Meiss, "Analysing architecture", first published in 2003 by Simon Unwin and "Composition, non composition, architecture et Théories , XIX.éme.et XX.éme siècles "published in 2009 by Jacques Lucan. The publications listed above are far from exhausting all approaches to this subject, but they constitute a significant sample. Exhibiting some common features that are very clear: (1) eminently didactic, (2) the search for a timeless formal analysis, regardless of the architectural language adopted, (3) linked in some way with the phenomenological tradition, focusing the discussion of architecture to the construction of places, as opposed to undifferentiated space. Beyond these common aspects, the cited works try to answer the issue of the autonomy of formal composition, something overturned when the disciplinary discussion is systematically dealt using the analogies of external models that think the form as a result of an environment, social, political, or cultural influence.

When examining the formal structure of public space, it is important to highlight the work of Pierre von Meiss, Allan Jacobs, Spiro Kostof and Edmund Bacon. From these works devoted to analysis of the architectural space, it is possible to outline the the work of Pierre von Meiss, which stands out not only by the extent of its development, but especially for its clear assumption of the urban space as a part of architectural space. Its analytical grid is equally applied to indoor spaces and urban spaces. Understanding "the legibility of forms as figures as one of the obvious objectives of all the plastic arts" (Meiss, 2003) (p.22), the author argues the existence of a number of mechanisms that are used consistently over time and that are responsible for the perception of "order" in the built environment, which include: repetition and similarity, proximity, orientation, alignment, gradient, hierarchy, contrast, symmetry and balance. Their work also posit as particularly interesting: the distinction between articulation and continuity or fusion concerning the composition of the architectural object (another return to the concepts of Worringer: abstraction and empathy), the use of the analogy with radiation to understand the way objects or isolated buildings are part of the composition of an area, the notion of spatial density evocative of the degree of subdivision (actual or implied) of a given space, linking the most unified spaces to their capacity for evoking universal values and the spaces more modulated or rhythmic to a more "earthly" expression (p.106), the different modes of aggregation of spaces: linear, mesh, centralized, and by grouping (proximity and similarity) (p.118-120). This author also devotes considerable attention to the convexity of the spaces and to the ways they process the gaps of space, distinguishing three types of operations: opening, juxtaposition and overlap.

"Design of cities" first published in 1967, has a set of graphical representations that can still be considered one of the most expressive analysis of urban spaces. Understanding the city as an expression of the human will, it wants to dissect the actions / decisions considered more representative of the construction of urban fabric. The author rejects the assumption of urban form as a result of any immutable law arising from history and the succession of time. Instead, he advocates the possibility of urban form being the result of human will and expression of civilizations. In a very brief way, he refers "the future is what we make of it" (Bacon, 1992). This opinion, in opposition to the

assumptions of the analysis and morphological type approach, that were contemporary to his work, allows the analysis to focus on the decisions taken at the formal composition of public space by emphasizing the importance of the moments of spatial rupture.

Although presented as case study examples of almost every historical era, the book does not pretend to present a history of urban settlements or their composition, but these examples draw categories of intervention methods valid for all historical periods. As categories (methods) of construction of the urban fabric, he highlights: aggregation (space as connector), axes (distinguishing axis in tension or extension), mass as a connector (Bacon, 1992) (p.82-83). The connection between planning (highly abstract) and the physical construction of space, especially the relationship between unity and diversity of the composition is taken as a central issue in the composition of the city (Bacon, 1992) (p.319).

Allan Jacobs tries in the book "Great Streets" to find "ingredients" of a good public space. Restrict your search to the typology of the street, the most common urban space, examines a very broad range, of what it considers to be good examples. Of all the works that we have referred, this is the one where the author most clearly expresses his difficulty in escaping the eminently casuistic qualification of space and concomitantly the validation of any analytical grid generalization. The author attempts to signal the issues for the quality of urban spaces he has selected and refers to the difficulty in systematizing the diversity that he has found. Despite this reference, he identifies as the most common elements in this set of spaces: the ability to walk at several paces, a good relationship with local climatic conditions (wind, shadow, sun exposure), clear definition (walls, buildings, trees); diversity of elements of interest (advertising, shop windows, movement of people, buildings, gardens), marking the beginning and end; transparency limits (the possibility of seeing beyond the limits) and the structure around a spatial sequence (narrative).

The formal analysis of the urban landscape, in the outskirt of the modern movement collapse, has been subject to a growing interest, nevertheless it has not been able to forward a very stable research structure that may serve as a significant reference. This lack of a stable reference of analysis points out, in some way, the great difficulty that still exists in surpassing the contingencies linked to casuistic analysis or to go beyond the very basic and common differentiations of traditional versus modernist architectural conceptions and forms.

2. Objectives

The aim of this work is to build a grid to analyze the composition of public space. This grid should allow for its expeditious implementation so as to be easily applicable to a large number of spaces. This ease of application is essential to territorial analysis that tend to be systematic and close to monitoring the totality of the construction of public space within a given territory, and in a specific length of time. Thus we may register the least emblematic and visible initiatives in a more direct way. Only in this way we can avoid an approach based on case studies, which choice, prior to analysis, we fear may reinforce the risk of inducing results by a priori paradigms.

The systematization of a formal analysis, eminently plastic, is the main difficulty of building the grid. The analysis assumes a rationalization, understood as a decomposition of a unitary phenomenon, and the developing of a grid may also entail a deviation from the holistic architectural

design and art value, which in turn may explain the failure and even the implicit rejection of such attempts. Yet, the systematic avoidance of the discussion of the formal dimension of architecture and urban space is a cultural dimness that we should try to overcome. The unitary value of the artistic intervention, in which the intention and plastic achievement are inseparable, should not prevent the attempt to apprehend the meaning that words and architectural drawings allow. We understand as symptomatic this need to reduce the analysis of urban form to the strict opposition between the traditional and modernist city. If it is undeniable that the city is a modern development of the very idea of rupture, it is difficult to understand the form of the city exclusively from this strict separation. In fact, the spaces of the contemporary city are more varied and complex than this simple opposition suggests.

The construction of a formal framework of analysis should not be confused with any illusion of transforming the design of urban spaces in a deductive process. The grid may be useful as long as it contributes to the discussion of urban form, a process that is eminently exploratory. As rightly refers Von Meiss, the design is both the research of the problem and the solution (p.202).

3. Methodology

To construct the grid for the analysis of the compositional elements of public space we followed the following steps:

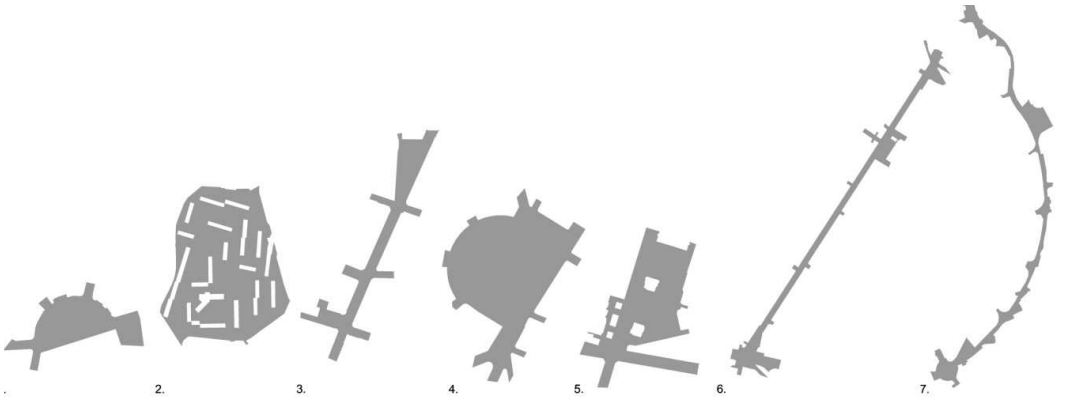
- Selected seven public spaces built in Porto during the twentieth century;
- Proceeded with a graphical analysis, for each case, of the following set of variables: elements that limit space, relationship to the built environment, system views, geometry, natural features, uses and pavements;
- Produce a drawing synthesising all the elements considered essential for the understanding of each of the areas examined;
- From the discussion of the drawings analysing the various spaces and the comparison of the drawing synthesising those spaces with the overlay of all elements analyzed, we tried to detect and take out what could be redundancies for further construction of an analysis grid, with the smallest possible number of variables. Furthermore, we tried to detect the most relevant spatial characteristics (derived from the combination of various elements) for the understanding of space.

When selecting the case studies, notwithstanding their small number, we tried to obtain a diverse enough sample of public spaces in terms of size, as well as of their typology and compositional structure, in order to allow the evaluation of the representativeness and validity of the variables under study and consider it for subsequent extrapolation. The area of each case study varies between 5.000m2 and 40,000 m2, comprise two squares, one street, an avenue, two spaces characterised by a modernist approach and a route.



.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street.

Figure 1. Built.



.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street.

Figure 2. Not built.

The selection of these variables resulted, first, in the set of themes that are identified when reading the text that are above referred and that are dedicated to the analysis of urban spaces, and, second, to the tracking in the analysis of each case study of relevant information missing for understanding some of those spaces.

4 Discussion of variables

4.1 Elements that bind public space

In trying to identify the elements that bind or delimit public space we distinguished: buildings (walls and buildings), constructed transitional elements (arches, peaks and outdoor courts), fences, doors and windows.



1.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street

Figure 3. Limits

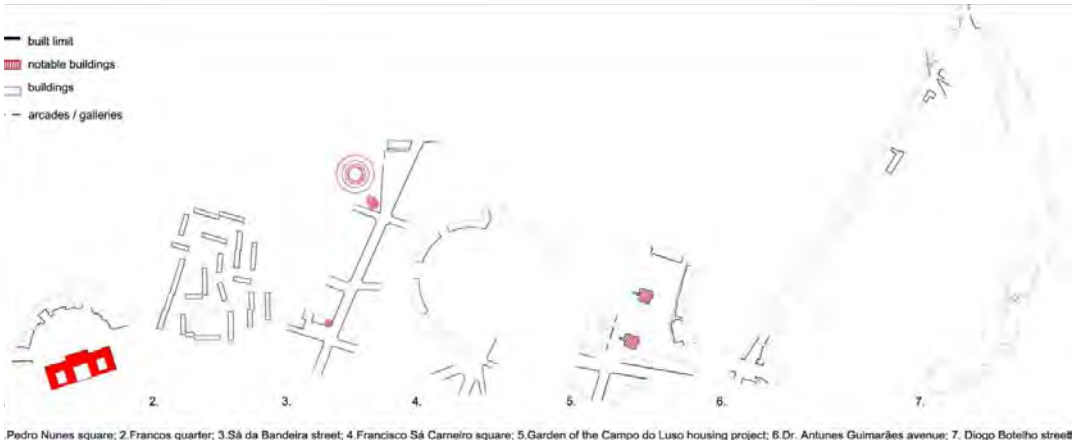
This distinction indicates clearly the low diversity of element types that formalize the demarcation of public space, but simultaneously points out the importance of the permeability of those boundaries. This means that, while the variety of elements that delimit public space can be considered negligible, the variation in those elements is significant and is introduced by differences levels and types of permeability, and point out as important elements the doors, windows, arches and porches.

Apart from permeability, another relevant dimension is the degree of clarity or definition that is expressed with the transition between public and private space or “vice versa”. If the cadastral boundaries between public space and private space are, almost without exception, absolutely clear, its space realization is not. In fact, places like arcades, porches, landscaped public spaces adjacent to buildings or private gardens visually very integrated into the public space, make it possible to create a very diffuse and hybrid transition

4.2 – The buildings as elements for the configuration of public space.

In this section, we intend to evaluate the type of relationship established between buildings and public space. For this purpose, we distinguish three categories: shaper buildings, polariser - buildings and exceptional buildings.

Shaper buildings are the ones whose formal characteristics establish a direct link with the public space configuration, usually by sharing a common boundary. The former distinguish themselves from the polariser – buildings since these participate in the public space configuration establishing a more distant relation and marking its presence mainly as an autonomous object. The exceptional buildings are relatively autonomous in relation to the other two and refer to buildings where function and formal characteristics work cumulatively and powerfully in the characterization of the public space, acquiring an imminently symbolic dimension within the urban context.



Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street

Figure 4. Buildings

The distinction between shaper buildings and object-buildings has to do with the opposition between traditional and modernist urban fabric, even though it also allows identifying other differentiations that escape this opposition. The modern urban space tries, in the formulation of Le Corbusier, the construction of a continuous urban area, largely independent of the implantation of buildings. Corbusier's aim was to challenge the traditional structure of the city founded upon a network of public spaces clearly understood and with a direct link between urban form and the limits of the buildings. The widespread failure of many interventions based on modernist assumptions, of which one of the most criticized is the lack of spatial differentiation and whose epitome is the opposition between space / place, that was responsible for structuring many analysis of public space since the seventies of the XX century, led to a reconsideration and revaluation of the enclosure of space in direct correlation with the buildings. Nevertheless, the analysis that we developed is not based on the distinction between isolated and integrated buildings in the urban tissue, but on the relationship that they establish with the urban space.

The distinction we are trying to establish is between buildings or built fronts that give shape to the public space in a very tactile way, that we can designate as "shoulder to shoulder", and the object – buildings that participate in the organization of public space through a relationship that is perceived as more distant and visual. In formulating the concept of building – object it is important to call upon the idea of "radiance" developed by von Meiss (p.25) and the idea of "Nodes" - centres of attraction that you can enter in terms of what is explained by Kevin Lynch. Unlike von Meiss, we chose to use the concept of radiance in clear opposition to the boundary and not as a common feature of all buildings. In our approach, we believe that the elements that delimit the public space are eminently "porous" or "absorbers" of the "Space radiation".

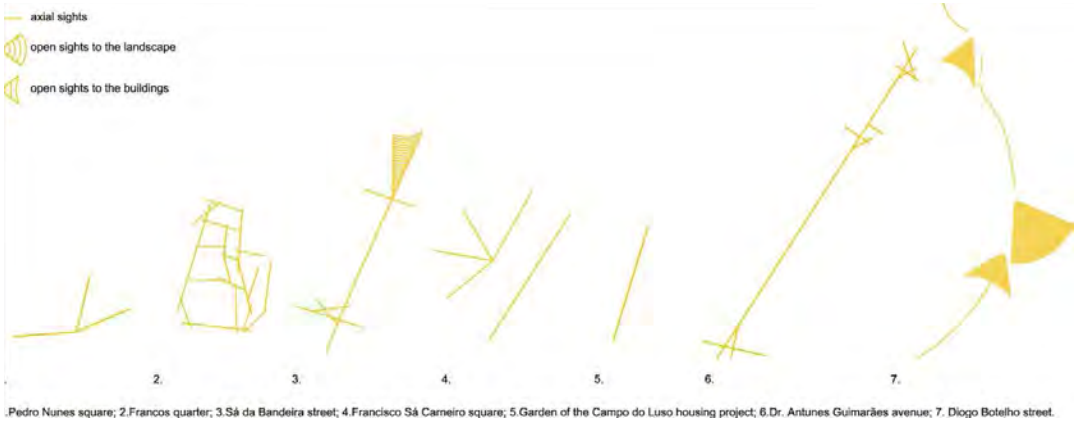
Thus, they act as important supports for the possession of and interaction with public space, which is something different from what happens with the radiating elements that transform and relate with public space by spreading their influence. Von Meiss points out an important issue concerning the spatial "radiation", which is the increase of its importance in result of the physical marking of the limits of its influence (p. 94-95), referring in this respect the relationship between the design of the floor of the Plaza Campidoglio in Rome and the statue of Marcus Aurelius that is placed there.

The difference between the dichotomy isolated building / building inserted into the urban fabric and the dichotomy shaper - building / polarised - building - is particularly explicit in the analysis of the district of Francos, where buildings although isolated define the form of public space, establishing its shape and boundaries. This difference is, in our view, due to a dichotomy that begins with the analysis centred on the building and its characteristics, while our analysis begins with the public space characterization. In fact, the formal relationship established between the buildings and urban spaces are often hybrid and richer than suggested by simple opposition between "tabula rasa" and "space channel". Not only isolated buildings conform the public space, but also buildings placed in urban networks adopt polarizing compositional strategies (Piazza of Pedro Nunes and Sá da Bandeira street) and in some cases contribute to the characterization of certain space and buildings with different spatial relations (as in Plaza de Velazquez and the Housing complex of Luso). The study that seemed to be more paradoxal from the set is that of Avenue Dr. Antunes Guimarães, where we consider the houses that flank this avenue as objects and not as shaper buildings. This view is supported by the fact that the shapping of the public space is done by a sequence of elements as rows of trees, walls, and private gardens, which create an effective distance parting public space and buildings, both physically and perceptually, making irrelevant the variations or even failures of that urban front.

The distinction between buildings of exceptional characteristics is the more objective and independent one, allowing to identify cases of buildings that in terms of formal and spatial characteristics assume an eminent public character, particularly in respect to access to interior public equipments, and relevance in the characterization of the public space, surfacing the distinction between collective and public spaces.

4.3 – Sights

When analysing the sights we take notice of two important aspects: key visual appropriations of space and the participation of the landscape in shaping the public space (a view beyond the space).



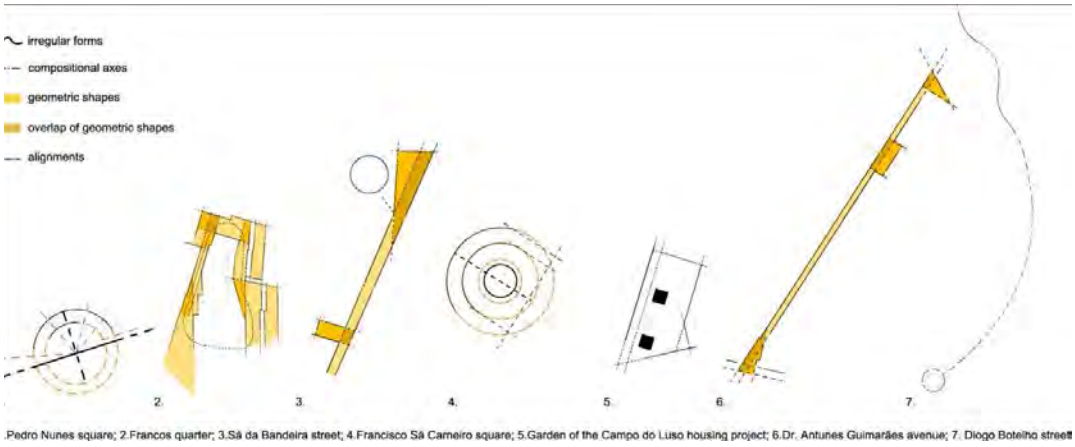
.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street.

Figure 5. Sights

When we mark the set of dominant views, it is possible to highlight the most coherent and linked compositional systems, as the channel space of streets or the polarizing elements of the composition. Moreover, spaces whose composition is not so clearly hierarchical as the neighborhood de Francos

or the Housing complex of Luso make it almost impossible the selection of privileged visual axes. This marking of sights makes explicit the relevance of the convexity of some compositional spaces, being this one of the most relevant dimensions for the evaluation of the closure of the spaces. Nevertheless, it does not put out other dimensions, since both the visual axis or the opening of sights assume the existence of a polarizing element, and it is not sufficient the simple visual opening, when a visual delimitation is absent.

4.4 – Geometry



1.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street

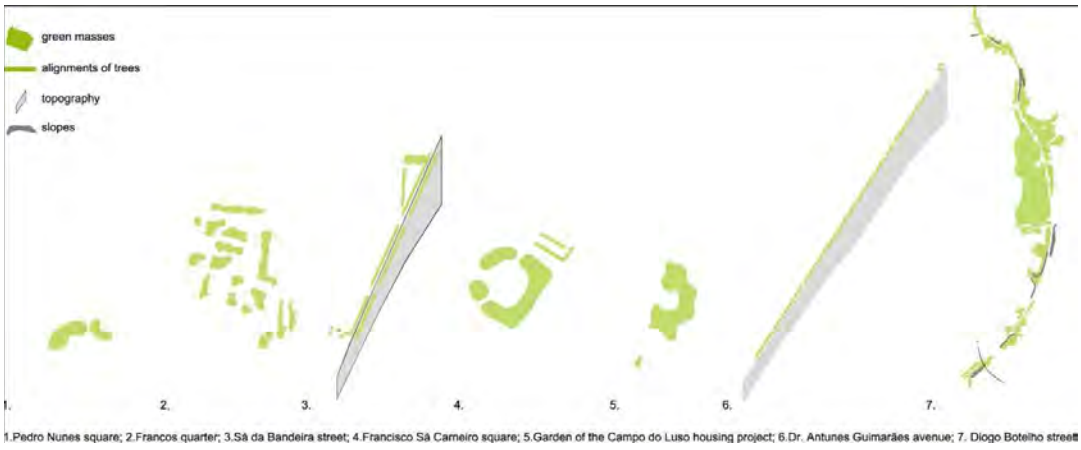
Figure 6. Geometry

Among the elements that we mentioned, the one that stands, by its frequency, is the axis of symmetry, associated with the roads or motor routes, which is a virtually inseparable element of composition. Those traffic lines are the elements constituting the physical space that seems to be more rigid in their design. The regularity in width (generating an axis of composition, which, in turn transforms itself most of the times, in a symmetrical axis) associated with a normative measurement of radio curvatures is sufficient for the generation of a compositional system that is self-sufficient and sometimes autonomous.

In addition to the axes of symmetry, the visual axes are also very relevant, as well as the use of regular geometric forms. The visual axes show extensive relations between the form of urban space and certain elements, usually buildings or parts of buildings, where the intention of marking the urban landscape is clear. An approach that is very close to that enunciated by Kevin Lynch, when he speaks about the elements that constitute reference points in the city. The regularity of geometric shapes is another way of clearly and effectively marking the uniqueness of a particular area. In all of our practical cases studies, the circle is the regular geometric shape that is more often used. In the case of the Plaza Império, the format adopted, in addition to its functional adequacy in the regulation of motor traffic, is explored using diverse elements (monument, trees, ratio between monument and built construction) in order to underline the symbolism of the shape beyond its functional dimension. In two other study cases, Pedro Nunes and Francisco Sá Carneiro plazas, the use of circle sections is enough to give a very strong formal identity, demonstrating that even when truncated or split the regularity of geometric figures is a powerful urban space compositional tool.

4.5 – Natural Elements

From the study of natural elements two factors stand out: the absolutely essential role for the spatial characterization of the topography and the relative low spatial diversity of the natural elements that are appropriated by the design of urban spaces: trees (differing linear structures or solid), vegetation and water.



1.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street

Figure 7. Natural elements

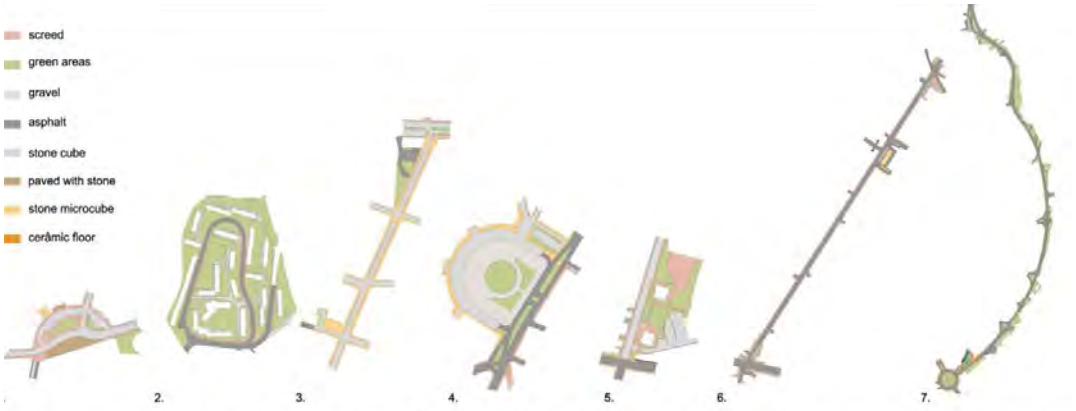
It is important to note that our analysis is not exhaustive and has ignored the natural light, which is an element of spatial characterization of first magnitude. In relation to the importance of this omission, we note that Jacobs in the listing of elements that recurrently contribute for the space qualification of streets has elected trees and the comfort induced by a proper relationship with the climatic characteristics of each region of that space (Jacobs, 1993).

The relationship established with the topographic variable is relevant in two distinct aspects. The enormous capacity that our physical environment has for transforming itself may have led to an increasing gap between urban design and topographic conditions, which in the early twentieth century are still fully notable in the design of the city. Moreover, the topographic modulation keeps intact its power for conforming space, being crucial to the understanding of all the cases examined.

From our analysis there is still a narrow range of natural elements in the spatial characterization of spaces, and it is relatively simple to reduce the contribution of natural elements to a single element: trees (in alignments or in gathering) in which the water element, that has a long tradition of involvement in urban design, has an apparent lack of participation.

4.6 – Coatings

In respect to the floor coverings, we understand that it is sufficient to distinguish: cement screed, micro-cube, gravel, granite cube, asphalt and vegetation.



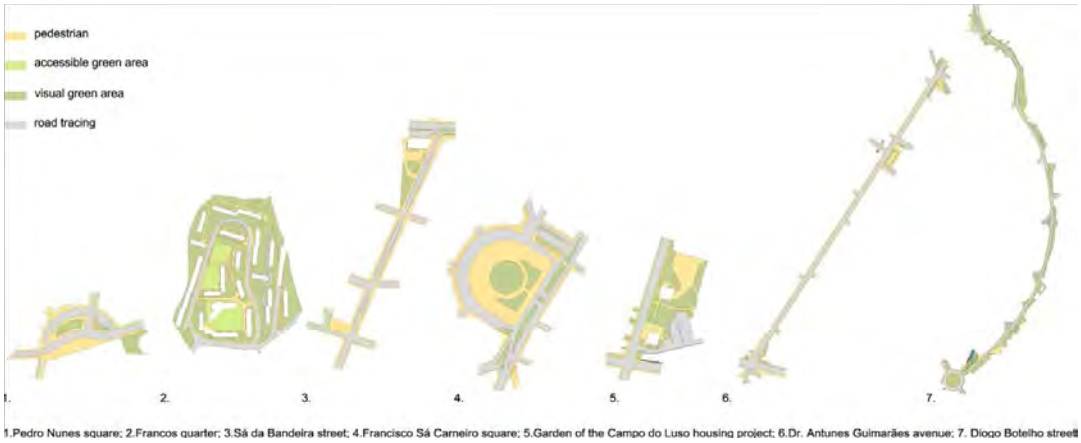
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Figure 8. Pavements

Plan drawings representing the design of pavements and the differentiation of materials are, comparing with all the other type of representations that are used, the more "realistic." This finding suggests the importance of the design of pavements in the identity and perception of space. From the analysis of the coatings of public space, follows an almost total correspondence with specific uses, i.e., it is difficult to distinguish a plan drawing of public space uses from a coating plan drawing. This similarity is indicative of a predominantly functionalist design with relatively little variety of covering finishes. The limited range of construction solutions as result the normalization of those spaces and provide in this way a framework for the continuity and regularity of that public space, which is not very suitable if we do not want to think of public space as the "underside" of urban life and, on the contrary, think of it as its protagonist. The former assumption may be a valid option in many cases, but may be misleading, since the public space, either in form or in its use, shape the city, expressing and conditioning its perception, being unrealistic the assumption of a possible political or aesthetic neutrality.

4.7 – Functions of public space

The analysis of public space uses distinguishes the most common uses: the pedestrian movement, the circulation and car parking, the outdoor equipment and the walking and visual appropriation cover vegetation.



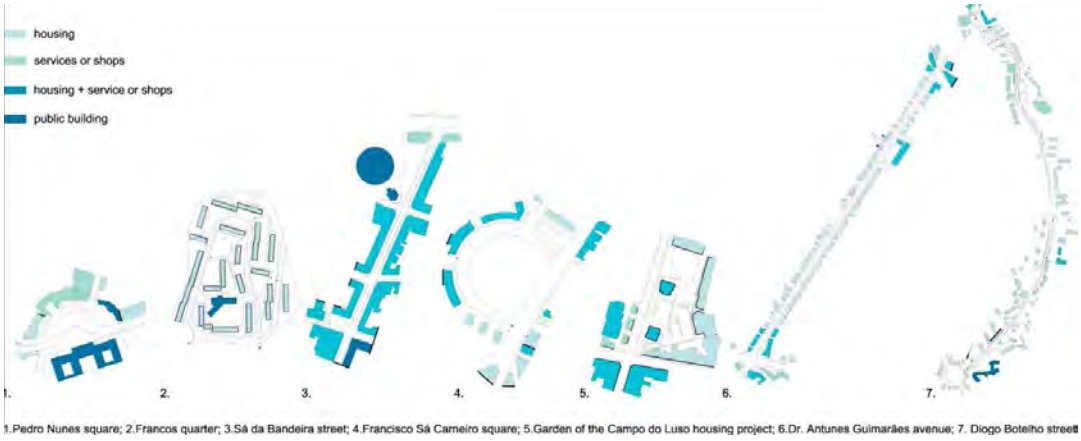
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Figure 9. Functions of public space

As was already mentioned, the relationship between the public space functions and the coatings that are used is almost absolute. The inclusion of car traffic in urban areas is one of the most conditioning factor for the design of the public space covering since it involves almost always the segregation and the normalization of the road or street layout. The eminently multifunctional feature of any public space, giving support to several activities simultaneously and being a place of expression of the diversity of urban life, is not commonly expressed in the design of pavements, which is curiously the strongest representation of space imagery.

4.8 – Functions of the adjacent buildings

In this section we intend to analyze the functions of the private space directly served by public space. Among these functions we distinguished: trading, housing, housing + services + trade and public amenities.



1.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street

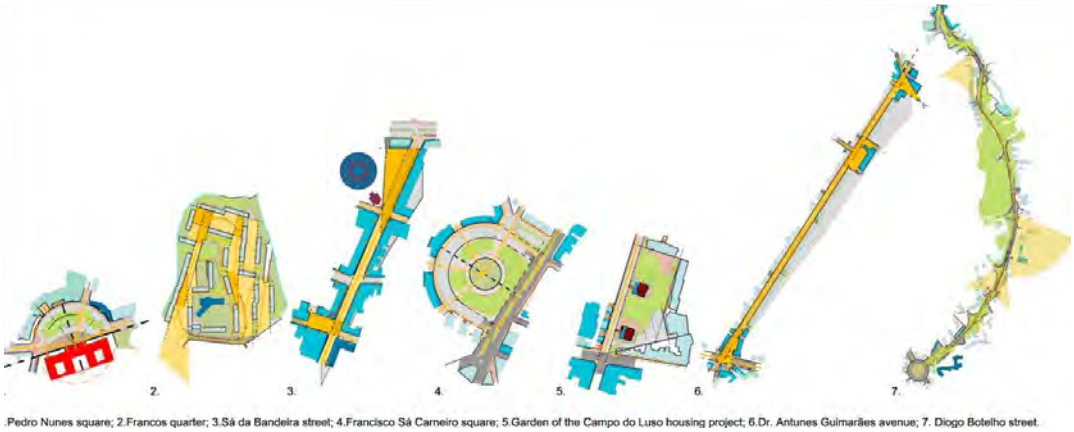
Figure 10. Functions in the private space

This distinction allows us to identify the hypothetical mono-functionality of tissues and signal the buildings in which their public service is unique. The relationship between the functions of public space and the design of its shape is very important (almost absolute in the case of the coating materials) while the relationship between public space and the functions of the building it serves is far

less linear. However, the relationship between private uses and transparency of the limit of public space is very direct and may be an important factor for the induction of the consistency of the urban form elements.

What we left out of this study and needs research was the relationship between the functions of private space and the civic appropriation of public space, as well as the analysis of the relation between public spaces / collective spaces.

4.9 – Synthesis versus Overlay



.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street.

Figure 11. Overlay



.Pedro Nunes square; 2.Francos quarter; 3.Sá da Bandeira street; 4.Francisco Sá Carneiro square; 5.Garden of the Campo do Luso housing project; 6.Dr. Antunes Guimarães avenue; 7. Diogo Botelho street.

Figure 12. Synthesis

From the analysis of the synthesis plans that we created it can be noted that the most relevant elements for understanding the formal composition of the public space are the geometry and the natural elements. Parallel to these two elements it is also highlighted the importance of the permeability of the boundaries. This finding is curious because the analysis drawings that present more realistic representations are the ones related to coatings, which seem to be always absent in the synthesis drawings. To understand this apparent paradox we posit two reasons: in the first place, this absence is not so significant because the geometry refers, in many cases, to the settings of the

coating, in the second place, the form of coatings is the result, in most cases, of other space delimiters and configurational elements. The design of the coating develops, in most cases, in parallel, as if it was a repetition at various scales of the general shape of space.

5. Transverse spatial characteristics

In addition to the recognition of the elements to be elected to build a framework of analysis for the formal dimension of public space, this study has allowed us to identify a set of spatial characteristics (resulting from one or more elements) that should be considered in the construction of the grid for that analysis.

5.1 Autonomy of figure /defining the boundary

One of the most crucial aspects to the comprehension of form is the ease with which it is read as a figure, which is one of the inductors of the importance of opposition figure / background in the psychology of perception (von Meiss, p.22). To this effect are particularly relevant, in the cases that were studied, the clarity of the elements marking the boundaries and the simplicity of the geometric shape that define the form. The clarity of the elements that define the boundary can be brought into question, if there is a clear coherence between these different elements. An example of this questioning is the district of Bairro de Francos where the gap between the public space boundary, defined by the buildings, and the road infrastructure design, creates an interstitial space without formal or functional autonomy and undermines the readability of the form of various spaces. Furthermore, the simplicity of the geometric shape of spaces is a key facilitator of our reading, while figures, but should not be regarded as indispensable. In some instances, this clarity can be achieved with formal elements that act as enforcers of a particular reading of space and in these cases the formal differences are added in a more complex way. This is the case, for example, of Praça D. João I (not included in the studies), in which the geometric shape of the rectangle is used to stabilize the dispersion of elements contained therein.

5.1.1 – Start and End

The importance of marking a beginning and an end, in the composition of urban spaces, is identified by Allan Jacobs and is particularly relevant in linear spaces. The marking of the extremes or ends facilitates the reading of the urban spaces as a spatial sequence, encouraging the construction of a spatial interpretative narrative of the space (which is another of the listed variables). The most common modes for marking urban spaces are: enlargement, relations with notable buildings or polarizing elements and resemblance to regular geometric forms. Nevertheless, the existence of a spatial variation in the conformation of a given area may not be explicit enough to make the transition between two spaces, particularly when there are no visual barriers. Such cases are, for example, the top source of Avenida Dr. Antunes Guimarães, where, notwithstanding the variations of the several elements that are relevant to the composition of the public space, as the extension, the high buildings and the commercial functions, it is almost imperceptible the transition between Avenida Dr. Antunes Guimarães and Avenida do Conde da Covilhã.

5.2 - Enclosure: concavity / convexity

Enclosure is one of the most constant themes in the discussion of urban spaces, particularly since the urban analysis focused on the comparison between figure / background of traditional and modernist spaces undertaken by Colin Rowe. Since then, a strong enclosure of spaces has been frequently advocated as a prerequisite for the creation of spatial identity in contemporary cities and even the outline of the buildings matches the boundary of public space. However, following the analysis that we have undertaken, we believe that there is the need to be more cautious with this association. In fact, if we consider the case of Avenida Dr. Antunes Guimarães, it is found that in most of its development, the limit of Buildings does not match the public space, but matches the walls, and there is even an outspread of the elements that configure those limits (trees , wall, furniture, building), that are also subject to a clear formal identity of the space. Moreover, the strict correlation between the edge of the building and the boundary of public space does not prevent the space of *Bairro de Francos* from having a clear reading or perception. The formal clarity, through the coherence of the various factors or elements, which contribute to the characterization of space seem as a more significant research trail to the enhancement of spatial identity than the dichotomy of the concavity / convexity.

5.3 – The limit's permeability

The importance of the limit's permeability is referred by diverse authors, especially by Allan Jacobs, and it is confirmed by our synthesis of various plans. Among the elements of permeability, we draw attention to: openings in the landscape, shop windows, visually open private gardens and open windows and doors at ground level. The permeability allows the expansion of the visual field beyond the traditional division public / private as well as the ease of passage between these two areas. It is the elements that combine these two possibilities, as windows or transparent entrances, that most strongly contribute to this feature of permeability.

5.4 – Consistency (narrative)

From our synthesis analysis of the plans, the aspect that is most decisive for giving the strongest formal identity to spaces can be described as its ability to "tell a story", which happens when it formal structure is supported by a spatial narrative. For this to happen, the decisive aspect is the consistency (but not uniformity) of the various elements that are present. For the construction of coherence, in the case studies that we presented, we note the relevance of: a hierarchisation (within the topics of composition, one is dominant, being the remaining elements obliged to the strengthening of the topic, or its supplement as a variation), the competition of various elements for the expression of a particular spatial feature and the creation of a shape (understandable as figure) capable of significant visual identification and able of assuming the role of "subject" of the composition.

The importance attached to the consistency of spatial compositions, raises two interesting questions for further research: the relevance of the narrative as an adequate interpretation of the contemporary

world and the role played by the representation methods and techniques adopted (the methodological tool) for communicating the results.

The adequacy of narratives for understanding the contemporary world was explicitly called into question in the formulation of postmodernism (Lyotard, 1989). The recovery of this instrument challenges that view. Is the role of narratives to allow meaning and building interpretations of our cities and architecture in contemporary world recoverable? In fact, is the important of the narratives crisis really only applicable to the grand narratives, maintaining its relevance for smaller scales, thus just not being applicable when trying its generalization?

The adoption of representations methods with a high degree of abstraction and highly synchronous, as plan drawings, may have contributed to the importance of the narrative as an instrument of interpretation and structuring of urban space configuration. The plan allows an isotropic view, omitting the differences in approach and visual perception and favouring a unified interpretation of space. The narrative interpretation favours the integration of various elements in a common structure. This combination allows us to question the possible induction of the result. Furthermore, the plan favours, used as a more realistic representation, floors and its design of coatings and these factors are not determinants in the development of synthetic plans. This apparent paradox allows as to infer that the relation between the isotropic view inherent in plan drawings is not sufficient to justify the importance of a Unitarian interpretation, as the one supported by the "narrative" and that the latter is based on an effective spatial logic perceptible beyond the strict condition of a determined visual approach. Our perception of public space is not based on a sum of images but on an aggregation of information that is structured to create an understandable spatial overview. It seems that to create this overview it is particularly important the possibility of identifying a shape and / or understand a logical relationship between the various urban elements. In the analogy we have been using, it is a character and a story, with the particularity inherent to the plastic composition, where the "character" and "history" are the same physical objects.

6. Conclusions and further work

After the discussion and the formal analysis of public spaces that we presented in the former headings, we think it is possible to forward the first draft for an expedite analysis grid to be applied for urban spaces study. This grid should be able to distinguish between elements of formal characterization and abstract characteristics. The elements correspond to physically explicit events in space, while abstract characteristics correspond to the categorical variables, to which various elements can contribute, as we explain next.

We decided to distinguish the elements by sub-groups: the demarcation between public space and private space (buildings, walls, fences); permeabilization of public / private limits (views over the countryside, shop windows, private gardens, archades, doors); geometry (plan alignments, altimetry alignments, regular geometric forms, lines of symmetry, visual axes), natural (rows of trees, massive trees, water, topography), coating (cement screed, micro-cube, gravel, granite cube and asphalt), the start and end markings (enlargement, notable buildings, polarizing elements) and buildings (shapers, object and exceptional).

In addition to the listed elements the analysis allowed to identify some spatial features, abstract characteristics, that the grid should check: narrative coherence, autonomy of form, the permeability limits, concavity / convexity and the correlation between type of coating and public space functions. With the exception of the correlation between the coating and public space functions, the other variables are very hard to objectify in such an approach. In order to overcome this difficulty, we propose that the grid, when addressing the remaining features, should allow the choice of a binomial option "very significant" or "negligible" and the identification of the elements that contribute to the consolidation of each one. Thus we assumed an expeditious approach to the idea of grading and began searching for hypothetical correlations between spatial characteristics and compositional elements. This may allow the development of a more objective and detailed registration of the gradation of the former characterization.

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The role of architecture in Oporto creative city's project

Sandra Alves, Gonçalo Furtado

Faculdade de Arquitectura da Universidade do Porto

Telephone: 00 351 226057100

Oporto is a Portuguese city with a wide historical and cultural heritage but, like many other small and medium European cities, has suffered from not having always been properly ruled. At this point, when most cities face an identity crisis, and globalisation becomes a reality, concepts such as Creative Cities and Creative Industries offer important resources for the formulation of policies and strategies for urban planning. In an attempt to be the driving engine for rich economical development (and consequently for the cities revitalization), the potential of Creative City presents an important challenge in terms of innovation and investment, assuming in itself the role of becoming a pole of attraction for many of visitors. Facing the difficulties of the global competitively, small and medium regions (like most of Portuguese regions), need to associate themselves in networks, to share ideas and solutions, in order to become recognized at a national and international level, and Creativity and Culture are possibly the main agents for urban, socio-economical development, and in this line of thought, public authorities are responsible to create the conditions for this development to happen. In this sense, there is much to do, starting perhaps by changing attitudes, and make people and places turn more towards their creative side in order to find competitive solutions capable of helping Portuguese cities out of the deep depression they are in. In this paper we intend discuss the role of Architecture in Oporto Creative City's project.

Keywords: Creativity, Creative Cities, Creative Industries, Oporto, Architecture.

Introduction

In nowadays-global era, creativity and knowledge present themselves as a challenge to many cities, standing as the driving force for culture and welfare. The present article, prepared to be presented at 2010 CITTA, we focus specifically in the city of Oporto.

This article finds its parallel on our broader investigation on the issue *Expression of the Phenomena in Portugal and what could be the potential role of architecture in the northern cities*. This presentation aims towards a reflection over the c*reative city*, the potential of this phenomenon in the city of Oporto, and the input it could potentially benefit from through the subject of Architecture.

The article was divided in three chapters. In the first chapter we hastily revisit the city and its evolution until its contemporary shape.

In the second chapter, divided in three sub-points, we reflect upon the perspectives of *creativity* as the starting engine for urban development, starting to describe the terminology associated to the subject. We will approach some key-concepts as well as historical developments that refer to reference cases and protagonists, and also to the opportunities available in face of the global competition scenario.

On the first sub-point we will refer to the concept of *Creativity*, on the second sub-point we will refer to the concept of *Creative Industries*, and on the third, to the concept of *Creative Cities*. The focus of these concepts provides a basis for the understanding of our reflection cantered in the city of Oporto.

In the last chapter we will approach the phenomena of *creativity* as far as it is related to the city of Oporto and more specifically in what concerns Architecture. The reflection focuses on Architecture as an industry of creativity. In fact, to a great extent, an appropriation of urban spaces and architectural objects occurs; and that takes place in a time when the very city is going through an identity crisis, a fact that also brings back to the necessity of acting on the historical centres.

This last chapter was structured very much in the same manner as the previous. Firstly we will try to synthetically understand the city of Oporto taking into account its evolution towards and until contemporarily. In a second point we will approach the phenomena of *creativity* in the city, and, in the last point, the potential role of Architecture in the aforementioned phenomena, now and then alluding to the history of this city.

The article and its conclusion aim at giving the due emphasis to the relationship Architecture may establish with the phenomena of *creative cities*, as well as other opportunities and challenges that are presented to the city of Oporto comparing with what happens elsewhere and with the reference cases. We ought to highlight the importance of the subject matter's role as well as the very architect in the shape of the *creative city*.

From city to global dinamycs

In this chapter it would be of our interest to hastily refer back to the process of the evolution of the cities and to the way this evolution presents itself in its contemporaneous condition of the 21st century - a *Creative City*.

In fact, nowadays the city finds itself geared by globalisation and by the dynamics of multiple fluxes (physical and informative), that encompass new urban-territorial organization models (independent from agglomeration and physical proximity). Until arriving to that way of organization, the cities went through long transitions that have reflected themselves in particular building shapes, as it is synthetically outlined in the following point.

The city

If we could go back historically until the foundation of the cities, we can observe that these have always reflected common factors, such as geographical location, technological advances or social organizations.[152]

In this sense, the genesis of the city takes us back to the sedentarisation of Man. Originally that can be seen in far back in time human clusters of the Antiquity (Mesopotamia, etc.). And, in the Middle Ages, the city would be defined as an encompassed space (by walls), possessing a public space (the market-place) from which the dynamic of fluxes is defined.

In the traditional city, a tight web composed of neighbourhoods and traversed by the emptiness of the streets already define some public spaces (markets, gardens, etc.). Only later on, with the expansion/fragmentation of the city, some co-lateral question related to the urban voids arose. It is a moment of discontinuity, coinciding with the Modern Movement in which a supra organized city is proposed. To this Modern City, followed the Metropolitan City, full of tensions and movements.

If the Traditional City grew around what already existed, nowadays city has become an organism of multiple expansions and stagnations. If, in the first the limits were well defined (by the

[152] Many authors have studied the history of cities, see for example:
Benevolo, L., 1999. *História da Cidade*. São Paulo: Perspectivas.
Mumford, L., 1982. *A Cidade na História: Suas origens, desenvolvimentos e perspectivas*. São Paulo: Martins Fontes.
Delfante, C., 2000. *A Grande História da Cidade: Da Mesopotâmia aos Estados Unidos*. Lisboa: Instituto Piaget.

opposition between built and natural), since the industrial development (and the first movement towards freeing the use of the land), the cities suffered modern expansions that turned them into the contemporary metropolitan mosaics. As synthesised in the previous text: *"to the uthopic and reformist alternatives, to the spacio-functional and social unbalancement of the city that was produced by industrialization, a modernist proposal of hipper-organization and of segmentation gained ground, which is not in a manner of casting away responsibility from the problem of centre versus outskirts. In nowadays expanded city, based on the third sector and no longer on industry, fluxes, accessibility, interaction and communication webs acquire a strategical importance."*[153]

In fact, if anything characterizes the Actual City, is the fact of it acquiring shapes that extend themselves through the territory, expressing the urgency of new interwoven mobilities.[154]

On the other hand, nowadays Metropolis has become the stage of events of a diverse scale and nature. As to this, the architectural structures are in conflict and, often become auto-referential assuming iconic roles. Both the cities as their architectures compete to get the attention of the great human masses, becoming thus, the spring of cultural and economical fluxes.

Alongside, the contemporaneous dynamics of the late capitalism seemed to point out to enormous changes to the city. For instance, it points out to the need of multiple infra-structures (as an airport, underground systems, etc.). On the other hand, also the need architecture has to deal with the new structural system of cyber space.[155] A new nervous structure of the city, composed by the communication networks that articulate the production, consumerism, in housing and recreation centres.

Summing it up, besides its physical structures (buildings, equipments, transport networks, etc.), the city started to take into account the paramount need of communication spaces, to its life (for instance: chat rooms). These are spaces that create a reality parallel to the physical, reproducing virtually otherwise traditionally physical spaces (for instance: public squares, streets, shopping centres, etc.), becoming true cornerstones to social communities. These are spaces that potentate society's accessibleness, drawing a new urban-social configuration, based on the informative exchange and on the interaction mediated by information systems.

All in all, the Contemporaneous City results in a reality of which is difficult to establish the boundaries. After the impact of industrialization, of the modern and of metropolitisation, the city pursues its mutation origination expanded shapes, multi-centralized and multi-peripherical shapes progressively articulated by the network's fluxes. The new urban complexes express the forces of the global capitalism, which also reflect, on their part, the behaviour changes of the individual, alongside great changes in the domains of work and of recreation.

These entire city related phenomena, claim, on the architect's part, for a reflection and a need of confrontation with a context that is in itself dynamic.

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[153] Furtado, G., 2009. *Redes, Fluxos e Interações Expandidas: A sobrevivência da cidade e o ethos global*. In: AAVV, Arq/a, nº74, p.76.

[154] On this subject, see for example:
Ascher, F., 1996. *Metapolis ou L'Avenir des villes*. Paris: Editions Odile Jacob.

[155] On this subject, see for example:
Mitchell, W., 1995. *City of Bits: Space, place and the infobahn*. Cambridge: The MIT Press.
Borja, J., and Castells, M., 1997. *Local y Global: La gestion de las ciudades en la era de la informacion*. Madrid: UNCHS.

City and creativity

On the footsteps of the previous chapter, in which we have revisited the city's evolution towards its contemporaneous shape, it would be of our interest now to focus on the objectives of *Creativity* that have been put forth as the vectors for the development of the 21st century. In fact, creativity, as a spring force of the cities has been object of the research of many authors and institutions, in the last few years. In the run of the nest chapter we will refer to the concepts of *Creative Industries* e *Creative Cities*, as well as to the implications and relationships of these with the area of Architecture.

Creativity

Nowadays, the proneness is for the majority of the world's population to reside in cities, sharing a same *global ethos*, the structural basis of society and of economy are also being challenged.

As it was mentioned before, cities are going through periods of transformation, which were sometimes accompanied by loss of competiveness. Nowadays cities are facing one of such critical periods, at the identity level, and in that context, the creative thought and innovation arise as conclusive factors for production. It has always been recognised that, creativity was a factor of revitalisation and of projection of the city. However, to the traditional city (which incorporated in itself several mutations), the phenomena of globalisation and of late capitalism, articulated with the new imperatives of creativity, have been associated.

If science, technology and industry were the main interest areas during the 19th and the 20th centuries, on the new century, such areas are orientated to the generation of *creative knowledge* and *innovation*.

In this context, it is demanded of the very cities to assume active roles in the configuration of a *knowledge economy*. In fact, many cities are places open to change and to new cultural stands, aiming to permanently share experiences and ideas with the goal of being able to potentate themselves globally. They intend to be urban spaces in which one is able to create imaginatively, cities that grant de development of such ideas, the establishment of new relations and their coming to substance. Let's point out that, in this sense, several institutions and organisations (such as Universities and Research Centres, etc.) acquire in the dynamics of the city and on their creative project, a strategic standing point.

As to *Creativity* there are various available references according to the different areas of knowledge.

In Landry's words, creativity *"involves thinking a problem afresh and from first principles; experimentation; originality; the capacity to rewrite rules; to be unconventional; to discover common threads aimd the seemingly disparate; to look at situations laterally and with flexibility."*[156] Creativity is a mental process that involves the generation of new concepts and ideas as well as their association with pre-existing ones. To Howkins, creativity is simply *"having a new idea"*[157], based on the following

[156] Landry, C., and Bianchini, F., 1995. *The Creative City*. London: Demos. p.18.
[157] Howkins, J., 2002. *The Mayor's Commission on the Creative Industries*. In: J. Hartley, (ed.), Creative Industries. Blackwell Publishing, 2005. p.118.

four criteria *"be personal, original, meaningful and useful (POMU)"*[158]. To a great extent, creativity is an inventive and experimental act that sometimes includes assuming risks and making mistakes.

Creative industries

In the suit of the concepts referred to as *creativity*, arouse the concepts of *creative industries* and *creative cities*. Such concepts have gained influence in academicals and political discourses, presenting themselves as a resource for formulating strategies and policies of urban and cultural planning.

In fact, it can be seen that a great number of Institutions have taken possession of such concepts for their political and economical practices. To that, same examples and some cases of success can be found in distinctive contexts. For instance in the United Kingdom, where initially this concepts gained room for great expansion, but also in other European countries, countries in Eastern Asia, besides Australia and Canada.

On the other hand, side by side with national institutions, also international institutions have adopted such ideas (for instance: CE, OCDE, UNESCO, etc).

Further to the aforementioned appropriations, it is also important to recognize that several authors have offered decisive contributions. Among those we must name Charles Landry (1995, 2000) and Richard Florida (2002). And among the agencies and institutions, we point out to the *UK Government's Department or Culture, Media and Sport* (1998), that has been developing operative concepts in the scientific panorama and on the elaboration of policies since the 90s until recent times. It would now be of interest to refer that the various existing definitions share the idea of *creative knowledge* and of *innovation*, however, are not in agreement as to other aspects.

The aforementioned sector of the *Creative Industries* is, all in all, an emerging sector in several countries. Its origin refers back to a set of cultural activities called traditional, which have evolved to creative Industries. Such an evolution was, to a great extent, due to the technological development and to the integration of the communication networks (for instance: the Internet) as a means of connexion and mobility. However, let it be said that the *creative industries* diverge from the *cultural activities* due to the innovative fusion of three factors: *creativity*, *innovation* and *economy*.

The concept of *creative industries* refers to, according to the UNESCO *"to industries which combine the creation, production and commercialization of creative contents which are intangible and cultural in nature. The contents are typically protected by copyright and they can take the form of a good or a service. Cultural Industries generally include printing, publishing and multimédia, audiovisual, phonographic and cinematographic productions as weel as crafts and design."*[159] According to the UNESCO, the concept of *creative industries* encompasses: *"a broader range of activities which include the cultural industries plus all cultural or artistic production, whether live or produced as an induvidual unit. The creative industries are those in which the product or service contains a substantial element of artistic or creative endeavour and include activities such as*

[158] Howkins, J., 2002. *The Mayor's Commission on the Creative Industries*. In: J. Hartley, (ed.), Creative Industries. Blackwell Publishing, 2005. p.118.
[159] UNESCO, 2006. *Understanding Creative Industries: Cultural statistics for public-policy making*. Paris: Global Alliance for Diversity/ UNESCO.

architecture and advertising. In this article, these terms are used precisely and are not synonymous nor interchangeable."[160]

As we have seen, the definitions are not yet in agreement in a whole, being in the process of scientific maturation.

If the concept of *creative industries* arose in Australia in the beginning of the 90s, only by the end of that decade did it obtain relevance. Such relevance was due, to a large extent, to the *UK-Government Department for Culture, Media and Sports (DCMS)* and to the creation of the *Creative Industries Unit and Task Force*.

In the *Creative Industries Mapping Document*, the *creative industries* appear defined as *"industries which have their origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and explotaition of intellectual property."*[161] That would be used as reference to other studies and investigations, allowing, on the other hand, for the coming to life of new definitions.

In John Hartley's perspective, the concept of *creative industries* possesses a relation with prior concepts such as *creative arts* and *creative industries*. On the other hand, it equates some transformations as to the image of the consumer and citizen. In Hartley's words: *"The idea of the Creative Industries seeks to describe the conceptual and practical convergence of the Creative Arts (individual talent) with Cultural Industries (mass scale), in the context of new media Technologies (ICTs) within a new knowledge economy, for the use of newly interactive citizen-consumers"*[162]; varying according to place and circumstance; *"In the USA creativity is consumer and market-driven, whereas in Europe it is caught up in traditions of national culture and cultural citizenship."*[163]

Another author, John Howkins, did also an interesting appropriation, referring himself to the Information Society (which has kept us company for many decades, in parallel with the boom of the media and telecommunications), as something that has not enough presence and that is coming to its end: *"If I was a bit of data I would be proud of living in an information society. But as a thinking, emotional, creative being - on a good day, anyway – I want something better."*[164] Howkins thus points to a change in paradigm and in perspective: *"When I say I have an idea I am expressing a more personal view, and making a different claim, from when I say I have some information (…) We need information. But we also need be active, clever, and persistent in challenging this information. We need to be original, sceptical, argumentative, often bloody-minded and occasionally downright negative – in one word, creative."*[165]

In fact, overlapping the ongoing Information Society, *knowledge* and valorisation of *creativity* add up as a key-factor to the *global competiveness*. And the socio-economical development is circled by the complementarities between creative sectors, information technologies and the globalisation of the communication networks.

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[160] UNESCO, 2006. *Understanding Creative Industries: Cultural statistics for public-policy making*. Paris: Global Alliance for Diversity/ UNESCO.
[161] DCMS, 1998. *Creative Industries Mapping Document*. UK Department for Culture, Media and Sport.
[162] Hartley, J., 2005. *Creative Industries*. Blackwell Publishing. p.5.
[163] Hartley, J., 2005. *Creative Industries*. Blackwell Publishing. p.5.
[164] Howkins, J., 2002. *The Mayor's Commission on the Creative Industries*. In: J. Hartley, (ed.), Creative Industries. Blackwell Publishing, 2005. p.117.
[165] Howkins, J., 2002. *The Mayor's Commission on the Creative Industries*. In: J. Hartley, (ed.), Creative Industries. Blackwell Publishing, 2005. p.117.

Let's now say that the *creative industries* are a set of (sub) sectors of creation and of industries. Their nature and associations diverge and are thus difficult to circumscribe.

For instance, in the selection of the sectors that are part of the *creative industries* of the *UK DCMS*, (which referred to the recognizing of this subject in the area of the cultural and economical advances), we find the following domains: Advertising, Architecture, Arts and Antiques, Design, Fashion Design, Video and Cinema, Entertainment Interactive Software, Music, Performative Arts, Publishing, Software and Computer Services, Radio and Television. This set of sectors finds distinctive associations in n the work of other authors and institutions. For instance *Symbolic Texts Model* by David Hesmondhalgh; *Concentric Circles Model* by David Throsby; *WIPO Copyright Model* from World Intellectual Property Organisation; *UIS Trade-Related Model* from UNESCO; or *Americans for the Arts Model* from Americans for the Art.

Creative cities

We would like to share the opinion that independently from methodological differences, the, mapping of the c*reative industries* brings, by its own right, several contributions. For instance in what concerns to the local or regional development, to the operations of urban renovation, etc.

In fact, it is in these contexts that the *creative industries* have become of use as promotional elements of economical growth and projection of the city. As a corollary, we have afterwards assisted to the emergence of the wider concept of *Creative Cities*, which has been used in terms of a resource to several areas that range from politics to urban planning. In fact, the idea of *creative city* has been applied to academical and political speeches associated to good urban practices and that describes a field of work interested with arts and culture associated to economy.

In this domain, authors such as Charles Landry, have questioned themselves as to the success of some cities despite others, acknowledging *creativity* as the great opportunity in the new Global Era. In this author's statements: *"historically, creativity has always been the lifeblood of the city. Cities have always needed creativity to work as markets, trading and production centres, with their critical mass of entrepreneurs, artists, intellectuals, students, administrators and power-brokers."*[166] Are places where races and cultures mingle and *"places which allow people room to live out their ideas, needs, aspirations, dreams, projects, conflicts, memories, anxieties, loves, passions, obsessions and fears."*[167]

Accordingly, other perspectives underline this relationship between city and creativity. Richard Florida, particularly in his book *«The rise of the Creative Class (...) and how it's transforming work, leisure, community, & everyday life»*, defends the existence of a *Creative Class*. According to, it is in the capacity that cities have to catch the *creative class* that we can find the due success. He also defends that: *"creativity and cities revolves around a simple formula, the 3T's of economic growth: technology, talent, and tolerance."*[168] As to *technology*, it has always been one of the key-factors for economical growth. *Talent* is defended as human capital, also stressing out that *"places with more human capital grow more rapidly than those with less."*[169] In that sense, the very urbanization

[166] Landry, C., and Bianchini, F., 1995. *The Creative City*. London: Demos. p.11.
[167] Landry, C., and Bianchini, F., 1995. *The Creative City*. London: Demos. p.11.
[168] Florida, R., 2005. *Cities and The Creative Class*. New York: Routledge. p.6.
[169] Florida, R., 2005. *Cities and The Creative Class*. New York: Routledge. p.6.

appears as the basis for growth, innovation and production. To Florida, *tolerance* is also a factor that allows cities to capture technology and talent: *"Our work finds a strong connection between successful technology and talent-harnessing places and places that are open to immigrants, artists, gays, and racial integration. These are the kinds of places that, by allowing people to be themselves and to validate their distinct identities, mobilize and attract the Creative energy that bubbles up naturally from all walks of life."*[170]

Summing it up, Florida defends that the level of development of a given region depends on its ability to attract and retain talent, thus maintaining levels of innovation and of competition; and bestowing the public politics with the challenge of creating urban contexts, which favour such attractiveness.

In fact, *urban contexts* present themselves as spaces that allow for the flux of cultural and creative products, the urban density becoming the condition for their success. Dense cities thus appear to be those, which congregate more creativity and more innovation. This is due to the fact that *creative industries* feed precisely on diversity and on change, developing well in multi-cultural urban contexts. These contexts (that can at once possess their own local characteristics) are also globally and locally connected by means of *Clusters*. Michael Portes defined such c*lusters* as *"geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g. universities, standards agencies, trade associations) in a particular field that compete but also cooperate."*[171]

If the *urban contexts* appear as a significant issue in this subject, it would also be of interest to identify knowledge as a relevant aspect for the maintenance of competiveness and attractiveness. That, to a great extent expresses an oscillation on the way of thinking and of acting on the part of the economical and institutional sectors.

Today, after the problems generated in the course of the processes of modern urban mutation (for instance: industrial decline, degradation of the welfare and the challenges of the globalisation), it was up to the cities the task of developing skills for attracting and fixating *talent* and *creativity*.[172] The very cities allowed for *creativity* once they exponentiate socio-cultural stimuli and absorb their main resource (people).

In fact, it has to be said that in a c*reative city* is not the artists and creative people who are involved in the *creative economy*, (creativity encompasses all of those who answer to problems in an inventive way). Human intelligence, imagination and creativity are stated here as human resources, taking a similar place to that previously bestowed to the infrastructures. It is the creativity of those who inhabit (and take the leadership) of a city that determines its success. They are all fundamental to the urban development and they all interfere to its identity and local image, as well as to the welfare and well being of life in society.

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[170] Florida, R., 2005. *Cities and The Creative Class*. New York: Routledge. p.7.
[171] Porter, M., 2000. *Local Clusters in a Global Economy*. In: J. Hartley (ed). Creative Industries. Blackwell Publishing, 2005. p.259.
[172] On this subject, see for example:
Florida, R., 2005. *Cities and The Creative Class*. New York: Routledge.

In agreement with the promotion of the creative dynamics, cities can progressively intensify their own *creative economy*[173], which often becomes a significant propeller for urban renovation (for instance of the city centres). For example, a township that decides to invest in culture, exponentiates the growth of creativity on its inhabitants, reinforcing the necessary tools to face the challenges of today's harsh global economical situation. On the other hand, knowledge makes the individual more active, demanding and critic, the essential conditions for a democratic communitarian growth.

In a way, *creativity* and *culture* promise the ability to function as the main catalysing agents for territorial organization e urban, social and economical regeneration. To the due public entities, is left the task of creating contexts favourable for such a growth. Thus, from the very central areas of the cities, it would be possible to reinforce the accumulation of economical activities based on knowledge. At the same time, the intensification of this process may expand itself to the spaces of the aforementioned peripherical areas. For instance, to the ancient industrial zones, which can profit from the occupation by new talents.

All in all, the goal is that, facing the difficulties of competition in a global world; small to medium regions (like the Portuguese regions mainly are) can share ideas and solutions. On the other hand, they can congregate themselves in webs with the aim of can gaining scale and notability both national as well as internationally.

Oporto city and creativity

After briefly framing it, the aim of this last chapter is to focus on this research work subject matter. That is, the subject of creativity and the paradigm of the creative cities in Oporto.

It would seem useful to say some words on the city of Oporto. It is, to begin with, a city at the North of Portugal that possesses a vast historical heritage. Nuno Portas recalls that: *"Any city that possesses characteristic elements which are not necessarily considered national heritage but which are important once it is through them that the citizen commonly identifies his homeland. It is this heritage that constitutes the originality of a given place, possessing thus of a great cultural value, both local and regionally, and also a great value as far as architectural, historical and emotional culture."*[174]

After this statement by Portas, it would be of our interest to describe how Oporto, as a specific city, evolves, in its urban-social, cultural and architectural shape. After that, on the second chapter, we will try to understand with what did the industrial culture evolved in the national panorama and most specifically, in the city of Oporto. On the third and last chapter, we will try to establish a relation between Oporto, as a city, and the area of Architecture: how does Architecture becomes a significant component of culture; and how can Architecture define itself as a cultural showcase, for instance, how can the production of a single building become an event of knowledge.

[173] On this subject, see for example:
Flew, T. *Creative Economy*. In: J. Hartley (ed.), Creative Industries. Blackwell Publishing, 2005.
[174] Portas, N., 2005. *Os Tempos das Formas: A cidade feita e refeita*. Guimarães: DAUM.

Oporto city and its buildings

The historical evolution

As it has been said, it would be of our interest to briefly summarize Oporto's urban evolution,[175] and to point out to the existence of many notable architectural objects.

Like many other cities, Oporto has suffered great alterations along history. Originally it was a city surrounded by walls that surrounded *Morro da Sé*, with narrow tortuous alleys, having grown from there in all directions and, by the Middle ages, it demanded the building of further walls.

During the 14th and the 15th centuries, due to the economical power of Oporto and of its neighbouring areas, new roads and public squares appeared. Later on, by the end of the 18th century, the city was once again spilling over its walls. This century would be marked by the construction of some of the most emblematic architectural works of the city. From which we must point out to the *Church and Tower of Clérigos* (1731-1763) by the Italian architect Nicolau Nasoni, himself also responsible for other works such as *Palace of Freixo* (1743-1748). Nasoni (1691-1773), was born in Italy and was a talented and multi-tasked artist, his genius extended to the domains of architecture and of decoration, having been in charge of the drawing of plans for farms and gardens, carved work, assemblage and goldsmith, bronze and iron.[176] His studies were taken in Siena, were he had learned his trade with the painter Nasini, further from having benefited from the contact with other masters, monuments and works done in that area (especially Florence and Rome). His education would produce work first in Malta and latter on in Portugal, where, during many years he stood as a multivalent artist. The *church, building and tower of Clérigos*, is all in all one of Nasoni's most important works and surely the most relevant in the religious field.

At the same time, the English John Carr, was also called upon to outline the *Hospital of Santo António* (1779). Carr (1723-1807) was born in England and his education was mainly self-taught, having learnt with the building practice, complemented with the study of manuals of architecture, such as that by Robert Morris. From this last one, Carr absorbed the conventions of the Palladian Style[177]. Carr's work deals essentially with its homeland and one of the few projects he produced outside that region was precisely the *Hospital of Santo António*, in the city of Oporto.[178]

It would also be interesting to refer to the great city's urbanist, D. João de Almada. He would be responsible for the enlargement of several streets (*S. João, Sta. Catarina ou S. Ildefonso*), and he would draw the street network, producing new arteries, of a narrower profile but of great urban range. That has produced an urban network that even today can legible.[179] João de Almada e Melo (1703-1786), Master of Souto d'El-Rei, was in fact a great labourer of Oporto's urban expansion of the 18th century and the main responsible for the downtown's organization. He was born in Alto Minho, from a family with strong military tradition, due to what he was called in to Oporto to put an end to a mutiny

[175] For a review of the historical evolution of the city with an morphological emphasis, see: Guardiá, M., 1994. *Atlas Histórico da Ciudades Europeas: Península Ibérica*. Barcelona: Salvat.
[176] Loureiro, O., 1987. Nicolau Nasoni: *Vida e Obra de um Grande Artista*. Porto: Gráfico Reunidos, Lda.
[177] Note that the Palladian style derives from the practical and theoretical work of Andrea Palladio, an Italian architect (1508-1580), and refers to the personal aesthetic of its own. The Palladian style was based on the symmetry, perspective and values of the Greco-Roman classical architecture.
[178] http://en.wikipedia.org/wiki/John_Carr_%28architect%29, accessed on 02/06/2010.
[179] On the intervetion of Almadas, see for example:
Ferrão, B., 1997. *Projecto de Transformação Urbana do Porto na Época dos Almadas: 1758-1813 : Uma contribuição para o estudo da cidade pombalina*. Porto: Faup.

situation. He remained in OPorto until the end of his days, putting all his effort during almost three decades on the embellishment and magnificence of the city.[180]

Evolution proceeded on the 19th century[181], with the enlargement being now complemented by some specific aspects. In fact, it would be with the 18th century like repetitive housing that the city would gain a sense of unity, encompassing its various streets, Figueira also refers that *"Transforming the city in a chimney, Oporto is by the end of the 19th century, an urban nucleus of consolidated industrial production, with small textile factories peeping from the waste land and the logging of the working men being solved in dreadful conditions at the backyards of a business orientated bourgeoisie. The "ilhas" appear."* [182]

On the other hand such an industrialization is linked to the construction of the *bridges D. Maria and D. Luís*, that stand today as city icons. In this sense, it is of special interest the fact that it was Gustav Eiffel who projected and directed the work on the bridge of Ponte de D. Maria (1876/1877). As we know, Eiffel (1832-1923) was a French engineer that took part in two of the best-known world famous monuments (the Statue of Liberty, New York and the Eiffel Tower, in Paris). He studied in Paris in a prestigious engineering school becoming a specialist in metal constructions. Shortly after the building up of the *D. Maria Bridge*, the second mentioned bridge was projected.[183] *The bridge of D. Luís* (1886), was conceived by Théophile Seyrig, equally with metallic structures but with a further two trays. Seyrig (1843-1923) was born in Berlin but it was in Paris that he obtained his engineering education, having stood therein and associating himself to Gustav Eiffel. From this association with Eiffel, Seyrig will participate in the works for the *bridge D. Maria*. Later one, and at a time that the association between the two men was coming to its end, Seyrig goes for and obtains the project for the *bridge D. Luís* in Oporto. This, in fact, would be his great masterpiece.[184]

As well as the buildings that we have referred to, other emblematic constructions took place by that time: the *Marine and Trade Academy* (1807), the *Crystal Palace* (1865), the *Stock Palace* (1880).

Later on, at the transition to the 20th century, appears the *Station of São Bento* (1901), by the architect Marques da Silva, a landmark for the industrial progress and the arrival of the railway to the city centre. The railway station owns its name to the late *Monastery of São Bento de Avé-Maria*, which stood before in the same location. Its architect, Marques da Silva (1869-1947), studied at the *Oporto Fine-Arts Academy*, having moved afterward to Paris where he got his architecture's diploma. Coming back to Portugal, he was the author of several works, some of which obtained awards at the *Paris Universal Exhibition* of 1900 and in Rio de Janeiro, 1908. Later, in 1907, he was nominated professor of Architecture at the Oporto Fine-Arts School, becoming its director in 1913.[185]

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[180] http://pt.wikipedia.org/wiki/Marques_da_Silva, accessed on 02/06/2010.
[181] About this period, see for example:
Günther, A., 2002. *Porto, 1763/1852: A construção da cidade entre despotismo e liberalismo*. Porto: Faup.
[182] Figueira, J., 2002. Escola do Porto: Um mapa crítico. Coimbra: Edições do DA/ FCTUC. p. 23.
[183] About Eiffel and his bridges, see:
Gama, M., 1989. Pontes *de Gustav Eiffel no Norte de Portugal: Edição comemorativa do centenário da Torre Eiffel, 1889-1989*. Porto: Edição Edarte.
[184] http://paginas.fe.up.pt/~azr/pontes/seyrig.htm, accessed on 02/06/2010.
[185] About architect Marques da Silva, see for example:
Mesquita, M., 2006. *Marques da Silva: O aluno, o professor, o arquitecto*. Porto: Catalogo de Exposição.

The modernization of Oporto occurred during the first mandatory of the already implemented Republican Government, which marked a political change. The growing of the *Allies Avenue* to North, meeting *Praça Nova* (nowadays *Praça da Liberdade*, where, at the time, stood the Town Hall).[186] These are remarkable projects, initially by the English architect Barry Parker. Barry Parker (1867-1947), English architect and urbanist, was born in Chesterfield, studied in London and stood out by having made popular the movement *Arts and Crafts*[187]. However, its contribution in the field of urbanism gains a larger dimension once the production, after 1902, of neighbourhoods and cities under the concept of *Garden Cities* - houses built in green spaces – such as Letchworth e Hampstead. Later on, with the Portuguese intervention by Marques da Silva and Correia da Silva, the new Oporto city centre would be produced.

New expansionist plans for the city are being proposed during the *Estado Novo* (1930/40), with new street outlines that go through and above the old compacted web, allowing the city's squares and monumental buildings to breath.

The "Escola do Porto"

In this chapter, besides the urban historical evolution of Oporto, we will continue to point out to the most notorious architectural objects of the city. It is of our interest to approach Oporto's history in its intricate connection with the subject of architecture and of its culture (pedagogical, etc).

Since a very early stage that the Fine-Arts School had a standing position in the city of Oporto and through the standing positions of some of the important names that lived therein. The aforementioned project of the *Allies Avenue* was, after all, defined by the director of that school since 1913, Marques da Silva. Marques da Silva would also, some years later, project a great example of the Decor Art in Portugal: *Casa de Serralves* (1931). He was an important architect who would influence an entire generation form Arménio Losa (1908-1988) to Januário Godinho (1910-1990).

It is interesting to point out that the first decades of the 20th century are, as far as architecture is concerned, times of great change and vulnerability.[188] Among others, the *Building and Garage of the Comércio do Porto* (1928-1932), both by Rogério de Azevedo (1898-1983), represent such a change and such a linguistic evolution. The architect Azevedo was equally linked to the School as a professor.

As to the profound evolution suffered, we must not forget the contribute bestowed by the Modern Movement. This appeared in Portugal by the 30s, having been interrupted at the following decade due to the fascist and nationalist values of the government at that time. However, such a censorship would not prevail in face of the modernist ideals.

In this context we ought to point out to Carlos Ramos (1897-1969), one of the most influential figures of the Portuguese Architecture and its teaching. Ramos, who started his teaching career in the 40s, would become director of the *"Escola do Porto"* in 1952.

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[186] On this subject, see for example:
Tavares, R., 1985-1986. *Da Avenida da Cidade ao Plano para a Zona Central : A intervenção de Barry Parker no Porto*. Porto: Câmara Municipal do Porto, Sep. "Boletim Cultural da Câmara Municipal do Porto", 3-4, 2ª Série.

[187] About "Arts and Crafts", see for example:
Thomas, G., 2000. William L. *Price: Arts and Crafts to modern design*. Nova Iorque: PAP.

[188] About the history of Modern Movement in Portugal, see:
Fernandez, S., 1988. *Percurso: Arquitectura portuguesa* : 1930-1974. Porto: FAUP.

The *"Escola do Porto"*, clustered around Ramos, expressed a pedagogical openness and a cultural expansion with consequences on the Oporto as well as national architectural panorama. For that, it essentially counted with the contribution of several new assistant teachers including Fernando Távora (1923-2005), Mário Bonito (1921-1976), Agostinho Ricca (1915-2010), José Carlos Loureiro (1925), João Andresen (1920-1967), Octávio Lixa Felgueiras (1922-1996) and Arnaldo Araujo (1925-1982).

The contribution of recently architects that got their diplomas therein was also important and they would be linked to the evolution of the local and national Architecture. It was also expressively important the fact that many among those have come to Oporto to see Modern Architecture or to finish a degree they had started in Lisbon.

Summing it up, the modern push forward by Carlos Ramos and the School promoted a new generation of architects and, under its vanguardist vision, emerged today's recognized "*Escola do Porto".* In Figueira's own words: *"The Monastery of Saint Lazarus gains expression: a world apart, with academical and recreational activities that Ramos approves of and promotes, and that will turn the Oporto School into a self-sufficient communitarian space, beyond the contingences of the claustrophobic day-to-day of the Salazarian times."*[189]

By the end of the 40s, more specifically in 1948, occurred the *1st National Congress of Architects*[190], marking a step taken on the national architecture and its teaching. Standing as a manifestation opposite to the political regime, it assumed definitively the modern assumptions.

Dating from 1950, two years after[191], the institutionalisation of the Degree in Architecture by the High School of Fine Arts of Oporto, a degree that out stood, has said before, in the architectural milieu. The conditions for the teaching architecture to focus on the practice and to reflect directly what was being done in the atelier were thus assembled; and with the 1957 Reformation Act, the pedagogical practice was institutionalised. In Figueira's own words: *"The pedagogical practice of what will be known as the Oporto School will be found in the deepening of the hands on practice and teaching of architecture which can not be separated without need from theoretical or literary mystery but only constructive objectiveness and an heritage based on good taste."*[192]

Also the participation in the CIAM[193] by some national architects[194], marked strongly the Portuguese architecture and helped on the divulgation of the international modern movement in the Portuguese architecture. (In this sense, Le Corbusier, Alvar Aalto, Bruno Zevi and the modern Brazilian were some of the most influent figures). The same stands in relation to the reflection undertook by some of our national figures.

In the 50s, Fernando Távora in particular, undertook a reflection over the identity of architecture, which has left an imprint in Portugal, opening doors for the architectural development

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[189] Figueira, J., 2002. *Escola do Porto: Um Mapa Crítico*. Coimbra: FCTUC. p. 28.
[190] On this subject, see for example:
1º Congresso Nacional de Arquitectura. Maio/ Junho de 1948. Promovido pelo Sindicato Nacional dos Arquitectos com o patrocínio do Governo. Edição Fac-Similada, Lisboa, Ordem dos Arquitectos, 2008.
[191] About the period of 1950s in portuguese architecture, see:
Tostões, A., 1997. *Os Verdes Anos na Arquitectura Portuguesa dos Anos 50*. Porto: FAUP.
[192] Figueira, J., 2002. *Escola do Porto: Um Mapa Crítico*. Coimbra: FCTUC. p. 48.
[193] About history of CIAM, see for example:
Mumford, E., 2000. *The CIAM Discourse on Urbanism, 1928-1960*. Cambridge: The MIT Press.
[194] Note that the architect Fernando Távora was present in the CIAM of Hoddesdon, Aix-en Provence, Dubrovnik and Otterlo.

denominated *"terceira via"*. This is translated in buildings such as *Casa de Ofir* (1958), the *Mercado da Vila da Feira* (1959) or the *Pavilhão de Ténis* (1960).[195]

Also the magazine *Arquitectura* constituted, after 1956, a fundamental means for the publicizing of the architectural culture, disclosing the works Fernando Távora, Álvaro Siza (1933) and of Nuno Teotónio Pereira (1922).

As Figueira points out, this *"(…) constituted, during the time, a pioneer platform for debate, with an editorial proposal that sides the critical vision of rationalist architecture/urbanism, in a process formulated more by Lisbon architects – again Nuno Portas – than by Oporto architects, where de denouncement of schemes and the utopia of functionalism are mitigated by a sense of affectionate ownership"*.[196]

In the decades of the 60s and 70s, following the new modern suppositions of the "Oporto School", many were the architectural examples that emerged. Namely unifamilar dwellings as it is an example the *Casa Alves Costa* (1971) by Álvaro Siza, by *Casa de Sérgio Fernandez* (1973) by himself or the *Casa Marques Guedes* by Alexandre Alves Costa and Camilo Cortesão (1974).

These experiences were accompanied by some sort of consecration from the *"Escola do Porto"* and most of all on the part of one of Europe's most influent architects, Álvaro Siza Vieira.[197]
In fact, by that time, the work of Siza Vieira gains ground, namely the *Casa de Chá da Boa Nova* (1963), the *Piscina de Marés* (1966), the *Banco de Oliveira de Azeméis* (1974), or the *Casa Beires* (1976).[198]

It is also during these decades that the aforementioned "Oporto School" traverses revolutionary moments, rejecting an intromission by the governmental regime and its authorities as far as its activities are concerned, this state of rejection only came to an end with the Revolution of the 25th of April, 19754. Then, the conditions for the proper functioning of the degree.

In the installed *SAAL (Serviço de Apoio Ambulatório Local)*[199] in particular, it was put to trial the attempt to link professional practice to schooling. In Oporto, the process would present some specificities such as the involvement of the populations and the nature of the areas where it took place (urban centre, allotments or open derelict spaces) in an anti-reformist and anti-capitalist manner. In Figueira's own words: *"In the core of the school, the SAAL is the culmination of a process that had already put the students on the go, by the denial of drawing and that will profit from the proximity and complicity that had been established with the populations"*.[200]

However, as it is known, the SAAL project would be dismantled, and little by little the militancy installed in the milieu would be diluted. And during the 80s and the 90s, the School would acquire a new sense and identity.

In this context and once more, it is important to emphasise the great contribute given by the work of Álvaro Siza. This author would obtain the most important award of architecture: the *Pritzker*,

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[195] Tavora, F., 1993. Fernando Távora : percurso=a life long trail. Lisboa: Centro Cultural de Belém.
[196] Figueira, J., 2002. Escola do Porto: Um Mapa Crítico. Coimbra: FCTUC. p. 48.
[197] On the work of the architect Alvaro Siza, see for example:
Jodidio, P., 1999. *Álvaro Siza*. Barcelona: Taschen.
[198] Jodidio, P., 1999. *Álvaro Siza: Architecture and design series*. Universidade de Virgínia: Tashen.
[199] About SAAL, see the publication:
Bandeirinha, A., 2007. *O Processo do SAAL e a Arquitectura de 25 de Abril de 1974*. Coimbra: Imprensa da Universidade.
[200] Figueira, J., 2002. *Escola do Porto: Um Mapa Crítico*. Coimbra: Edições do DA/ FCTUC p. 64.

in 1992. Siza is the author, in the city of Oporto, of nowadays *Edifício da Faculdade de Arquitectura*, in 1986, and of *Museu de Serralves*, from 1991-99.

Besides this architect, others also sprouting from the School have become examples of success. Namely Eduardo Souto de Moura (1952), author of an important work, such as the construction of the Mercado *de Braga* (1984), the *Casa das Artes* (1988), or more recently the *Estádio do Braga* (2000/03).

Summing it up, it is important to state that the *"Escola do Porto"* and its leading figures have always had a great deal of importance along the 20th century in the local architecture of the Oporto city.

As architects, they have produced emblematic buildings at the same time as they were searching for the ideals of a modern democratic culture. Nowadays, the reputation of the so-called *"Escola do Porto"* spreads beyond the national borders and is one of the city's great attractive.

Oporto city and its culture

It this chapter we will focus on the cultural evolution of the national panorama giving particular emphasis to the city of Oporto

The national context

It would be interesting to start by saying that, along the last decades, we have seen a rise in the offering of artistic services and of new cultural dynamics. To a great extent, this rise confirms the importance that the municipal politics possess in the development of that sort of activity. Such is particularly important outside the great metropolitan centres of Lisbon and Oporto, where the concentration and offer by institutions of this sector is greater, be it private or public.

The construction of new equipments, geared by the municipality has been essential, in the dynamics of the cultural and entertainment sector of many places. As examples, we have equipments like show rooms, libraries, theatres, museums, etc. In Portugal, we must point out to Pedro Costa[201], in what investigation on this area is concerned and with writings over the theme *creativity*.

In one of his recent studies, Costa (2007) comes to some conclusions as to the current tendencies in the distributing of artistic-cultural practices and activities in Portugal. According to him, there is in Lisbon a great concentration and attractiveness as to the cultural heritage, artistic industries and activities and creative industries. However, outside these centres, only very seldom do we see the emergence and location of artistic industries, as some specific nucleus, generally associated to High School Educational centres. In cities of a medium size, there is an effort for the consolidation of cultural activities, mostly by public incentive.

According to Costa (2007), among the politics that incentive culture and creativity of a regional or local character, we can outline some aspects such as: the construction of show rooms, municipal theatres, non-profitable cultural organizations, strategic municipal plans for culture, intra-urban cultural projects, networks of thematic or territorial programs, municipal partnerships for programming and managing culture or cultural heritage networks.

[201] About the work of Pedro Costa, see:
Costa, P., e Babo, E., 2007. *As Indústrias Culturais e Criativas: Novos desafios para as políticas municipais*. In J. Portugal e S. Marques (ed.), Gestão Cultural do Território. Porto: Setepés.

The construction of show rooms/municipal theatres has been a structuring factor of new artistic-cultural dynamics of medium size cities. Such has served as a focus for the publicizing and gearing-up culture with effect on the territory and on the populations. On one hand it serves diversity and quality in artistic-cultural practices, on the other hand, it contributes to the reinforcement of centrality and development of the area in which it is included.

As for the non-profitable organizations, according to the author, they possess a potential role in the assertiveness of the cities, as to the regional territorial or international context; an example is *Fundação de Serralves*, in Oporto.

The strategic municipal plans for culture allow for the sector of cultural and creative activities to assume a main role in the local development, contributing for the reinforcement of competitiveness, better life style of the populations and for socio-territorial cohesion, for instance the strategic plan for Évora's culture.

As to the intra-urban cultural projects, Costa states that they are systems of local production, innovative or some how clustered and focused on the production of cultural products. For instance *Bairro Alto*, in Lisbon, an area that congregates a set of diverse activities with a specific image and management which has been able to sustain itself along the centuries.

The territorial or thematic networks of programming are dynamics promoted by institutions which find their partners in the neighbourhoods and that associate with the goal of gaining scale advantages framed by a regional or national scale.

Municipal partnerships for programming and managing culture, according to Costa (2007), are the management of artistic-cultural resources in partnership. Heritage networks are associated to real estate patrimony distributed by the territory assuming an enlarged vision, as is an example the *Rota dos Frescos*, in Alentejo, or *Aldeias Vinhateiras* in the classified area of *World Patrimony of the Douro Vinhateiro*.

The set of the described cultural initiatives, following Costa's (2007) exposition and classification, have, in the last few decades been changing some of the territorial dynamics. In fact, culture has become a strong propeller of the territorial development in Portugal, so much at a local level as at a national and, punctually international level.

The culture in Oporto city

In this chapter we will try to understand Oporto as a city turned to culture.

We will start by saying that the revolutionary period of 1974[202], and subsequent political instability had a great impact in the city's culture. That mirrored what has occurred in many contemporary societies where for instance education changed from privilege to public necessity. Apart from all the rest, Oporto at this time, maintained some of its typical character, when compared to other cities (such as Lisbon or Coimbra) where the great centres of intellectual formation were more solid and thus culturally more developed. Mario Dorminsky[203] recalls from this time that Oporto discovered entertainment after discovering the *"night"*, in the 80s. In his own words: *"In all the city*

[202] About this period, see:
Fernandez, S., 1988. *Percurso: arquitectura portuguesa: 1930-1974*. Porto: Faup.
[203] Marques, A., Melo, M., and Dorminsky, M., *A Ocupação dos Tempos de Lazer*. In Oliveira, L., Aguiar-Branco, J. e Branquinho A., Porto: Uma Cidade Boa para Viver. Porto: Porto Editora, 1999.

bars, night clubs and night orientated entertainment spaces multiplied. Nightlife started early, in a first stage, but latter on the animation hours started to flow into the dawn. Entertainment was seen as a way of life, more so, as an extremely profitable economical activity".[204] Oporto is not yet seen as an assumed entertainment city. It has, however, a set of infrastructures capable of conciliating and focusing these infrastructures towards culture. On the other hand, if Oporto needs entertainment and culture spaces, it also needs the public for such spaces (for instance, entertainment spaces are yet not much more than mere shopping centres).

On the other hand it would be also interesting to approach Oporto potential as a touristy destination. As it was said, Oporto has always been a region very much devoted to work and to trade. The city and the region of Oporto have started to turn to tourism, lacking now of an identity that would ensure the region's touristy versatility and all the potential residing in what was on offer.

In fact, Oporto's first concern must be to create a touristy image that would bring to light *"Oporto's"* name, which is already connected internationally to wine and football. The city and region possess ground structures that can be easily adapted to projects of a touristy nature

The city is rich in multi-use institutions (cultural, sportive and of entertainment), which have the potential to attract tourism and turn it into something dynamic.

It would interesting anyhow, to identify at the same time the existence of another problem that has been dragging along throughout the years – patrimony degradation. The creation of the CRUARB[205], for the city's rehabilitation is one of the first steps taken towards solving that problem.

Only in the last few years did the public entities and the general public started to give to the existing buildings their proper value, as well as to culture and to the spaces associated to culture. For instance, apart from the *Coliseu do Porto* and the *Tivoli Theatre* which have always been privileged spaces for the publicizing of culture in Oporto, the rehabilitation of the *Museu Nacional Soares dos Reis*, as referred:

"With the exception of some detail interventions, the Museum only becomes the stage for remodelling and expansion after 1992: a remodelling and expansion project by the architect Fernando Távora. Slowly advancing, the project is finished by July 2001, integrated in the event Oporto, European Capital of Culture. This remodelling allows for the renovation of the exhibition's discourse in Portuguese painting and sculpture of the 19th and the 20th centuries, and, also, of the decorative arts which, for the first time can now be seen in the same spatial unity".[206]

This are aspects of the same nature as the rehabilitation of the *Casa Museu Guerra Junqueiro* (1994-1997), the *Casa do Infante*, the *Museu do Vinho do Porto*, the *Museu da Alfândega*, the creation of the *Museu de Arte Contemporânea de Serralves*, the creation of the *Fundação Marques da Silva*, and the emblematic *Casa da Música*, among others.

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[204] Marques, A., Melo, M., and Dorminsky, M., *A Ocupação dos Tempos de Lazer*. In Oliveira, L., Aguiar-Branco, J. e Branquinho A., Porto: Uma Cidade Boa para Viver. Porto: Porto Editora, 1999.

[205] About CRUARB, see:
Loza, R., 2000. *Porto Património Mundial: CRUARB 25 anos de reabilitação urbana*. Porto: Câmara Municipal do Porto.

[206] http://mnsr.imc-ip.pt/pt-PT/menu_edificio/HighlightList.aspx; accessed on 30/06/2010.

Parallel to what was referred and to the fact that Oporto had been the European Capital of Culture, in 2001[207], that had triggered a more active role on the part of the public entities in the culture of the town, from then and along the last decade, some alterations to the city starting to be noticeable, not only at the level of urban re-qualification but also and more recently, on the rehabilitation of the building area.

The *Fundação de Serralves*[208] and the projects it promotes seem to be taking a major role, so much on the urban agglomerate in which it is included as on the artistic and cultural dynamics of the town. An important role at the level of the city's stressing out of its value over the territorial context, both regional and international (as well as in the cities network).

On one hand, the effects produced at the city level comprise the constitution of a new centrality. That enables new structures, agents and professionals who, working with and for *Serralves* have consolidated and rotted themselves in the city influencing the ability for attracting outside visitors and strengthening relations with other structures and organisations of similar sectors.

This very aspect allows for the emergence of a clustering process in the city that can be referred taking for instance the example of the relations with the dynamics of the art galleries of *Rua Miguel Bombarda* (which have recently generated an effect of diversification of artistic and cultural activities in that area), or the relations at the level of programming with other central institutions (like the *Teatro Nacional de S. João* or the *Casa da Música*).

On the other hand, besides the effects at the level of the city, other effects must be referred to as far as the network of relations and cooperation with other artistic and cultural programming centres at an international level are concerned. This inclusion drags along the very city towards new international cooperation spaces at European or worldwide level.

Still on what concerns the territorial perspective, let's point out to the phenomena of the rising cooperation and consultation that has been developed by the *Fundação* near other municipalities of the North and remaining national territory, this strategy of relationships with other institutions (public or private) has ensured the viability of several projects in the field or contemporaneous art publicising, and, subsequently, the fading out of the asymmetries previously referred to which still exist between the great centres of Lisbon and Oporto and the remaining national territory.

Summing it up, the m ore prepared the people in such areas are, the greater will be the keenness to see public shows in which they find expression.

Oporto as a creative city

Before advancing to a focus in Oporto as a creative city, it would be interesting to retain the significant existence of a qualitative cultural performance like the existence of qualified spaces and structures as well as the existence of interested publics. The link between the patrimony, the

[207] About this event, see for example:
Alves Costa, A., 2009. *A Requalificação da Baixa Portuense:Uma oportunidade para o Porto, em 2001*. Porto: FAUP.
[208] About Fundação de Serralves, see for example:
Barata, P., 2001. *Museu de Serralves: Álvaro Siza*. Lisboa: White & Blue.

existence of several local institutions and tourism is paramount for the development of Oporto in both the local and international territory.

As already referred in this chapter, we intend to relate Oporto as a creative city to architecture. As mentioned in the previous chapters, the city of Oporto underwent a growth and development that not always have been straightforward and in accordance to rules and that, in the last decades, lead to a certain loss in the well-being of its inhabitants.

Many have been the factors that lead to the emptying of the town in the last decades (for instance: freezing of rents, some equipments were obsolete, lack of investment and of modernisation in the central areas), which, alongside with the lack of pertinent politics, turned into a decline in the historical centre of the city.

In a certain way, it can be said that the investment shifted to the outskirts and other less qualified urban areas, where the land value was inferior and the management patterns less requiring. The outskirts surely were made stronger, but they have not acquired a sense of identity such as can be found in the embryo of the city; we are talking of a shaded periphery of less value and demanding less investment (at the level of equipments and infra-structures offering), which does not show identity and identification.

In this context, the city of Oporto, centre of all its metropolitan area, faces nowadays the challenge of revitalising its historical centre (and its built area, abandoned, degraded and obsolete).

It is in this context that we speak of Oporto's potential as a *Creative City*, the issue that most interests this article. In fact, even public entities – regional and national – found the need to adopt their speeches according to this in an attempt to promote the city's revitalization.

The road to be taken consists in repositioning the centre as an attractive space so much for those who have deserted it as to those who are returning to the city.

A city, which is the space where most of the collective facilities and superior level services are located, besides holding an impressive architectural and cultural heritage. On the other hand, it is imperative to reconsider the city as the centre of an extensive and disperse metropolitan area.

It is in this complementarity of identity factors, as many other cities and examples of a global level, that Oporto could become, based on its creativity, a competitive city and, as a consequence, increase the development of all the surrounding Northern area. It is thus of interest to promote *Creativity* as a means of generating economical power and qualified work, understanding it as a key contribution for a new paradigm of development and economical dynamics in an area marked by a profound crisis. In fact, creativity can be a key inductor for economy, bestowing the *Cultural and Creative Activities* with the main role in the organisation of the territory, given its capacity to attract dwellers and visitors and also for ameliorating its experiences and welfare.

Recently it has been verified that small breeches of the *Creative Industries* have started to proliferate in town. We are speaking of organisations and businessmen who invest in the city based on new ideas, and that justify the city's ability for attracting many visitors and, progressively, inhabitants. Other events in several areas of a national or international scope, linked to different areas frequently also constitute the necessary springboards for the cities' revitalization and renovation.

As far as architecture is concerned, we would like to make a pair or specific references. Namely the *Casa da Música* by Rem Koolhas, a building that came to life during the event Oporto 2001, and whish stands as an example of success in terms of cultural risking. Nowadays, alongside with other city's institutions, like *Museu de Serralves* by Álvaro Siza Vieira, which have had an important role in the cultural dynamics at an international level.

Parallel to this, it is important to recognize that buildings such as *Casa da Música*, icons to which the Urban Planning resorts to with the focus of gearing up local tourism and subsequently the economy. With the accelerated rhythm of competition between different regions, the iconic architectural influences are true urban resources for cities and countries. As Busquets states: *"In a recurrent manner, urban centres throughout the globe are in a constant search for singular architectural pieces associated to a 'star architect' system that can deliver an architectural trademark."*[209]

A pair of reference buildings can be seen in Oporto as outstanding examples. Landry (1995, 2000) and Florida (2002) referred to this type of constructions as paramount starting engines for revitalisation of the urban areas of the city. Usually they end up by being reference cities and attractiveness, dynamic cores.

Summing it up, along the last few years, creativity and its related industries came to be, in many cities and their doers, a means of urban intervention of their own right. A means that is able to develop historical centres and peripheral depressed areas and that, by its capacity to attract and to fixate critical masses, may offer, in Oporto's case more that an opportunity, a true challenge.

A change in paradigm becomes imperative to the consolidation of a cultural development strategy which, articulated with the economy, may find support in the sponsorship of cooperation networks, involving creative agents, economical agents and communities towards a sustainable development of the region. As for the rest, Architecture possesses a unique role in the process.

Conclusion

The potencial role of architecture for the Oporto creative city's project

The article presented, along its three segments, has related the paradigm of creative industries with the city of Oporto focusing on its potential as a creative city, and, in more specific terms, emphasizing the potential of Architecture in the process.

As it was already referred to, the explanation was structured in three chapters. On the first chapter we have recalled synthetically that the cities possess an evolution process prior to their present shape and fashion. This growth of primitive shapes to the shapes of industrialization and to the modern up to the recent metropolis fashion.

On the second chapter, we present a series of key-concepts related to creativity (a mental process of generating ideas) recognizing their potential for the revitalisation and projection of the city. According to the concept of *Creative Industries* (set of cultural activities evolving to creative industries), considering it to be an emerging sector in many countries. Such an evolution takes place at great speed due to the speed of the very technological evolution and integration of communication networks, however, presents itself in a distinctive manner form more traditional cultural activities due

[209] Busquets, J., and Correa, F., 2006. *Cities X lines: A new lens for the urbanistic project*. Harvard: Nicolodi. p.41.

to a singular conjugation of factors, *Creativity*, *Innovation* and *Economy*. Lastly, I have exposed the concept of *Creative City*, as the outcome of the integration of *Creative Industries*, cities and political speeches. Several were the authors that have reflected over this issue and, as seen, some of them inclusively studied the success of those particular cities as creative cities. In a broader sense, they have advanced with new concepts found to be productive, as a creative class and defending that by attracting a creative population into the cities produces effects over the economy and over the revitalisation of the cities and urban environments.

In the last chapter, based on the frame work that we have been stressing out, focuses specifically on the object of study, relating the paradigm of *Creative Cities* to the city of Oporto and bestowing particular emphasis of the creative potential that can be derived from Architecture, a brief history on the shape of the urban evolution of this city and of its most emblematic buildings. As seen, Oporto is a city rich in built historical patrimony possessing specific morphological-cultural characteristics. The going over this historical patrimony and city icons, offered material for a reflexive exposition about the relationship of the city with the well-known *Escola do Porto* and its protagonists as far as Architecture is concerned.

Following in suit, we have focused, on the last chapter, in the cultural dimension. The exposition focuses initially over the Portuguese context, namely over the relation of culture with patrimony and with the artistic activities and cultural industries that were meanwhile produced, so much in the great urban centres as in small agglomerates of people.

Afterwards the focus turns to the city of Oporto, approaching culture as an intrinsic factor of the city and a paramount one to be implemented. It can be verified that over the last years, developments were to be registered as well as some specific measures as the rehabilitation of museums and theatres as well as the construction of new show rooms.

Architecture, in this sense, presents itself as the necessary area for a city that wants to be considered creative may compete globally. Architecture, through its intervention on the environment, may it be at an urban level or focusing on a single building, may function as a pole of attraction for many visitors and frequently catalyse the revitalisation of many of the city's sectors.

Architecture may inclusively have a fundamental role in Oporto's success as a Creative City, and in several fashions. Besides the singular building or icon that attracts visitors on its own, by the protagonist role of the very architect, or as a cultural show room housing cultural activities as well as creative industries. The very city of Oporto may be a favourable stage to creativity and, on the other hand a stage rich in built and historical patrimony that also functions to attract new publics, as it should also be inhabited by new ideas and activities which may help the city to become competitive both national and internationally, dragging along all the surrounding Northern region.

Part 4. Transport Planning and Logistics

Urban revitalization and transport: local factors and driving forces from a stakeholders´ view

Maria Spandou, Camila Garcia, Rosário Macário

CESUR - Center for Urban and Regional Systems

Department of Civil Engineering, Technical University of Lisbon,

mariaspandou@ist.utl.pt, camilagarcia@civil.ist.utl.pt, rosariomacario@civil.ist.utl.pt

Phone/fax numbers: 00 351 21 841 8417 - 00 351 21 841 9865 / 00 351 21 849 7650

Urban revitalization has been the center of attention during the last decades as a means to tackle the city- or neighborhood-wide decline problem, which is evident in many worldwide urban environments, through its serious implication in all aspects of human life (physical, environmental, social, economic, health, historical and cultural). The roots of this urban decline should be searched within a wide spectrum of combinations of macro drivers and/or location-specific factors. In the framework of the "Strategic Options for Integrating Transportation Innovations and Urban Revitalization" (SOTUR) project of the MIT Portugal Program, we defined urban revitalization as a process that comprises of a set of urban management strategies to facilitate economic, social, environmental, cultural and historical (re)development of problematic, deprived and derelict urban areas. It is evident that urban revitalization cuts across many public policy areas, but our perspective is primarily transportation- and land use-oriented. In this context, the objective of this paper is to present the process and outcomes of a the "Imagining Urban Futures" Stakeholders Workshop, aiming at the identification of driving forces and local factors that implicitly and/or explicitly have an impact on urban revitalization policies in Portugal, and namely in Lisbon, Porto and Coimbra. This initiative is embedded in a greater participatory scenario building exercise, comprised of a series of Workshops that, on the one hand, capitalize the knowledge and expertise of a variety of urban revitalization-related stakeholders, and on the other hand, promote the development of a participatory culture, and its consequent learning effects, in Portugal.

Keywords: Urban revitalization; Transportation; Land use; Scenario building; Stakeholders

1 Introduction

Urban revitalization has been the centre of attention during the last decades as a means to tackle the city- or neighbourhood-wide decline problem, which is evident in many worldwide urban environments, through its serious implication in all aspects of human life (physical, environmental, social, economic, health, historical and cultural). The roots of this urban decline should be searched within a wide spectrum of combinations of macro drivers and/or location-specific factors. Indeed, contemporary cities have faced many changes in the past decades.

As Preteceille (1990) notes, around 1950´s the phenomenon of urban sprawl emerged and formed the contemporary city landscape, affecting all aspects of human life (society, economy, environment), supplanting though sustainable development. Indeed, inner-areas lost a great amount of population, which moved in the suburbs, with direct impacts, among others, to land use (unplanned incremental urban development, low density mix of land uses on the urban fringe) and travel characteristics (travel patterns, distances, transport mode selection etc). Furthermore, the economic crisis of the mid-1970s and the subsequent movements of economic restructuring have had considerable impacts on the spatial organization of economic systems, on the social structure and operation of urban systems, and, through that, on urban policies (Preteceille, 1990).

In this context, the objective of this paper is to present the process and outcomes of the "Imagining Urban Futures" Stakeholders Workshop, aiming at the identification of driving forces and

local factors that implicitly and/or explicitly have an impact on urban revitalization policies in Portugal, and namely in Lisbon, Porto and Coimbra. This initiative is embedded in a greater participatory scenario building exercise, comprised of a series of Workshops that, on the one hand, capitalize the knowledge and expertise of a variety of urban revitalization-related stakeholders, and on the other hand, promote the development of a participatory culture, and its consequent learning effects, in Portugal.

The structure of the paper is the following: in Sections 2, 3 and 4 we delineate the theoretical framework of our analysis by presenting a brief literature review on the issues of urban decay, sustainability and urban revitalization respectively; then in Section 5 we position land use and transportation in the urban revitalization context and in Section 6 we present briefly the urban revitalization policy in Portugal. In Section 7 we describe the process and the results of a participatory scenario building organized in the framework of the "Strategic Options for Integrating Transportation Innovations and Urban Revitalization" (SOTUR) project; finally in Section 8 we elaborate on the conclusions derived from this planning exercise and their implications for further research.

2 Urban decline

Urban decline is a concept that essentially emerged because of the degradation and deprivation of the inner-city areas as a consequence of the urban sprawl phenomenon and the relocation of a critical mass of households in the fringe of the city and in the suburbs. According to Mason (1999), deprived areas are commonly understood to have the following characteristics:

- A high level, or proportion, of individuals or households, who experience a range of negative or undesirable circumstances, either singularly, or in combination, which significantly reduce their overall well being: these include, for instance, low incomes, unemployment, poor health, bad housing conditions, and lack of skills.
- The concentration of these 'deprived' households and individuals in an area coupled with the undesirable aspects of that area: poor environment, poor housing, neglected open spaces, abandoned shops and houses, high crime levels, lack of services, shortage of job opportunities, all of which can act to reinforce the level of deprivation experienced by the community.

Urban revitalization (or development /redevelopment) has emerged as a response to urban decline problem. The type and level of various interventions aiming at achieving urban revitalization vary according to local needs and urban trends. As a result, a variety of terms that refer to this redevelopment process are commonly used interchangeably; these include: regeneration, renewal, redevelopment, rehabilitation, conservation, restoration, revitalization, reconstruction, refurbishment, renaissance etc. It should be noted that the conceptual distinction among these terms in the literature is not always clear.

3 Sustainability

Urban revitalization is a process heavily dependent on the local context and the vision for development, adopted by the responsible decision-makers and planners. No uniform regeneration theory can be developed because "the process is too dynamic, too swift moving and too unpredictable for that" (Couch et al, 2003). All urban revitalization initiatives, whether small or large

scale (i.e. neighbourhood, area-based or city-wide), seem to converge to one concept; sustainability and the way it adapts to the needs and local problems of each community. Furthermore, as Finco and Nijkamp (2001) note, sustainable development policies should cover multiple fields like urban rehabilitation, urban land use, urban transport systems, urban energy management, urban architecture and conservation policy, and urban cultural policy.

Thus, sustainability is both the goal and the means of achieving these goals that should be incorporated in the vision for the development of a place, and of the community in general. This framework sets a base for what urban revitalization aims at, tailored to the problems and needs of each location of intervention and seen from a community point of view.

4 Urban revitalization

Urban revitalization (or (re)development) has emerged as a response to the urban decline problem. The type and level of various interventions aiming at achieving urban revitalization vary according to local needs and urban trends. As a result, a variety of terms that refer to this redevelopment process are commonly used interchangeably; these include: regeneration, renewal, redevelopment, rehabilitation, conservation, restoration, revitalization, reconstruction, refurbishment, renaissance etc. It should be noted that the conceptual distinction among these terms in the literature is not always clear.

We consider that the term “revitalization” overarches the initiatives that bring back life to a problematic area and incorporates large, medium and small scale projects that aim at the restoration, rehabilitation and/or renewal of the built and physical environment, as well as the stimulation of the activities that take place in this environment. Thus, we introduce the following definition:

Urban revitalization is a process that comprises of a set of urban management strategies to facilitate economic, social, environmental, cultural and historical (re)development of problematic, deprived and derelict urban areas.

By strategies we refer to the implementation of single or combinatory (packages of) policy measures that serve different policy objectives (e.g. infrastructure, pricing/taxation, funding/financing, technology, legislation, governance etc). Urban revitalization, as a process, aims at tackling, individually or as a whole, issues and problems that systematically encumber the sustainable evolution of modern cities. It is exactly this element of sustainability, and its extensions to the citizens´ well being, that delineates a very complex environment, characterized by numerous cause-effect relationships which span along interdisciplinary and cross-policy domains.

4.1 Social aspect

The social aspect of urban revitalization addresses issues of social equity, social inclusion and community building (alternatively community cohesion or social capital (Litman, 2009)). The perception of the social exclusion term currently revolves more around the concepts of racial and ethnic discrimination, but we consider that covers more aspects than this. For this reason, we adopt Madanipour´s et al (1998) approach, who define social exclusion as a “multidimensional process, in which various forms of exclusion are combined: participation in decision making and political

processes, access to employment and material resources, and integration into common cultural process.

Often, exclusion and marginalization, spatial segregation and the increasing concentration of marginalized groups come together with a number of other problems, such as increasing unemployment, increasing criminality, decreasing quality of the dwellings and public space, and a declining quality of life in these neighbourhoods in general, not as a consequence of increasing concentrations of marginalized groups, but more as the cause of the changing population structure (Andersen and van Kempen, 2003).

4.2 Economic aspect

The economic aspect of urban revitalization can be disaggregated in three main categories: private investment and increased economic competitiveness, employment, and business location. Special consideration should be given to the role of the retail sector, from both demand as well as consumption point of view. Indeed, successful regeneration is under-pinned by sustainable economic development which integrates all aspects of policy and strategy. An integrated planning approach that combines retail with housing, enterprise, education and transport, can ensure the maximum positive impact of an investment (Business in the Community, 2007).

Furthermore, entrepreneurship and private investment can be considered as major drivers of economic revitalization with influence to employment stimulation and tax generation. In this context, a GLA Economics (2005) study on the retail sector in London reports on the following social benefits of retail-led regeneration schemes:

- Social inclusion through increased retail provision in underserved areas, where resident population has the opportunity to access retail facilities, and job opportunities´ creation.
- Economic regeneration through revitalization of local economy by acting as a catalyst for further development and increasing the amount of money that is generated in and circulates in the local economy.
- Physical regeneration through brownfield land development and consequent improvement of the quality of the local environment. For instance, two great retailers, Tesco and Sainsbury's, have set targets to locate the vast majority of their new stores on brownfield sites and have so far been successful in achieving those targets.

Although business location and accessibility are highly correlated, McQuaid et al (2004) note that policies to restrict business development to accessible sites may decrease business efficiency and in some cases may deter business investment altogether, with negative implications at local, regional and national level. There are many empirical examples of economic urban revitalization initiatives worldwide, with Business Improvement Districts (BID) having a salient position. Friesecke (2006) defines BIDs as a geographically defined and mostly inner city area, where property and business owners make a collective contribution to the maintenance, development and marketing/promotion of their commercial district.

4.3 Physical/Environmental aspect

The physical aspect of urban revitalization is related to the physical deterioration of the built and natural environment that the urban fabric develops in. According to Doratli et al (2004), obsolescence of the built environment can be considered to be a process through which most of the problems of traditional urban quarters are being generated. They also identified the following categories of obsolescence:

- Physical/structural obsolescence: the effects of time, the weather, earth movement, traffic vibration, poor maintenance, which result in the deterioration of building fabric;
- Functional obsolescence: it arises when buildings may fail to meet contemporary standards and requirement of the user/potential user;
- Locational obsolescence: changes in terms of ownership pattern, social composition, land and property values, rate of rents, vacancy rates, incompatible uses, type and amount of new development, may turn building location unfavourable, in terms of accessibility to other uses, markets, and suppliers, transportation infrastructure and the like;
- Image obsolescence: uncomfortable traffic circulation, noise, smell, vibration in old quarters, may make buildings unattractive;
- Official/legal obsolescence: restrictions (e.g. regulations for conservation areas), absence of financial incentives and lack of willingness of property owners to restore and rehabilitate their property, may, in turn, reinforce official obsolescence.

As far as the natural assets are concerned we can distinguish two key dimensions: environmental protection and environmental justice. The first dimension corresponds to the environmental degradation, in terms of land, water, air, energy consumption, biodiversity etc, which has been the centre of research attention for the past years. The second dimension is wider and refers to the existence of environmental risks and hazards and equal distribution of investments and benefits, access to information and participation in the decision making process, without discrimination, whether direct or indirect, at any jurisdictional level.

4.4 Health aspect

Public and individual health are issues that have gained more attention in recent years, as far as the identification of the health impacts of decisions and interventions, as well the integration of health policy with other policy areas are concerned. A conceptual framework of the factors that affect health policy is presented in Figure 1.

The urban environment is of particular interest regarding the health issue. Indeed, Vlahov et al (2006) state that urbanization is a major public health challenge for the 21st century, as urban populations are rapidly increasing, basic infrastructure is insufficient and social and economic inequities in urban areas result in significant health inequalities.

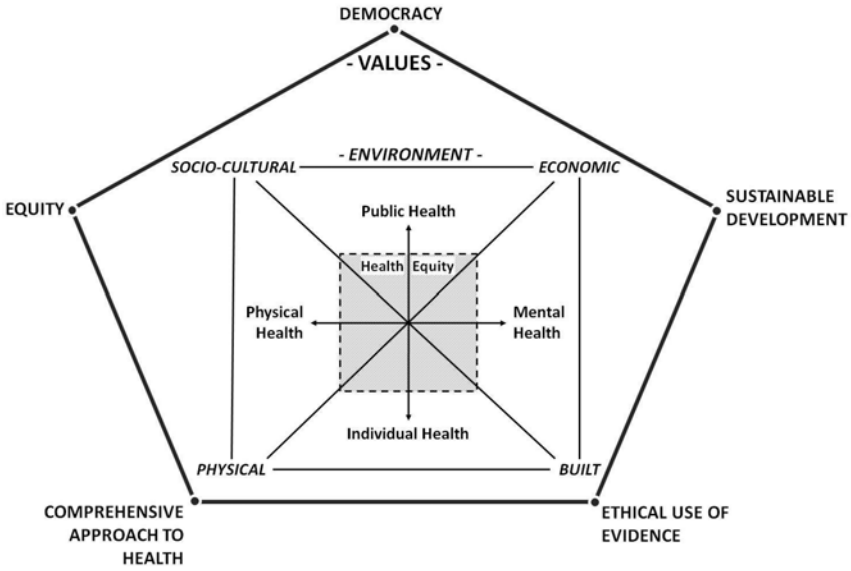


Figure 1. Conceptual framework of the factors that affect health policy.

During the last decade, Health Impact Assessment (HIA) has been discussed worldwide as being an important tool for the development of healthy public policy (Finer et al, 2005), while the International Association of Impact Assessment outlined the following set of values and principles for the practice of HIA (Quigley 2006):

- democracy;
- equity;
- sustainable development;
- ethical use of evidence; and
- comprehensive approach to health.

Health impacts of transportation can be identified in various levels, with primary and secondary implications to other aspects of human life, such as accessibility (to health services, employment opportunities, housing, leisure etc), environmental implications (pollution, energy consumption, space occupation), traffic safety and individual well-being (physical and mental health, community inclusion/exclusion).

Thomson et al (2006) carried out a synthesis of evaluations of national urban regeneration programs in the UK for a time period from 1980 to 2004, and concluded that regeneration programs may lead to some small positive impacts on health and socio-economic circumstances, but adverse impacts are also possible, while impacts on health or impacts on the socio-economic determinants of health, let alone social distribution of these impacts, are rarely assessed.

Towards the same direction Thomson et al (2008) presented a summary of research on conducting HIAs of transport interventions and they concluded that there is a wide range of possible impacts, which means that policies may be beneficial in some respects and harmful in others; there may also be differential and conflicting impacts depending on the level (individual vs. population),

location, and timescale of measurement that adds further to the potential for conflict between impacts and also increases uncertainty around overall benefits and harms.

Frumkin et al (2004) argue that the impacts of urban sprawl in health lie primarily on the reliance on private cars, which is based on a well established relationship between lower density development and more trips by private car. Consequently, the increase in this type of trips causes more pollution, motor vehicle crashes and pedestrian injuries and fatalities.

Frumkin et al (2004) further argue that certain land use decisions cause less physical activity, affect the quality and quantity of the water, contribute to the intension and expansion of the heat island effect, and also affect mental health and the social capital. Indeed, Samimi et al (2009), who investigated the effects of transportation, land-use, and built environment along with demographic and socio-economic factors on people's general health and obesity, concluded that transit-oriented development has a significant positive impact on the general health and obesity of the people, by establishing statistical association between auto-use, transit-use, block-size and health-related variables, allowing for a combination of demographic and socio-economic effects. In numerical terms they found that a 1% decrease in the use of automobiles is correlated with a 0.4% decrease in the prevalence of obesity.

To sum up we provide in Table 1 some examples of topics that constitute common strings that are addressed by urban revitalization and urban health initiatives.

Table 1. Examples of common urban revitalization and urban health themes

Issues affecting physical health	Issues affecting mental health
• Environmental degradation (air / land/ water/ noise pollution) • Access (health and social services, housing, leisure, transportation, education) • Living conditions (housing, water, waste management) • Unemployment • Occupational health • Physical (in)activity • Safety (road accidents, building quality) • Security (criminality) • Drug, alcohol and other substances abuse • Stress (at work, at home, while driving/ commuting) • Heat/cold-related morbidity & mortality	• Stress (at work, at home, while driving/ commuting) • Unemployment • Occupational health • Poverty • Ethnic / Racial / Social exclusion • Social capital

4.5 Historical / Cultural aspect

UNESCO defines cultural heritage under several main categories (Ebbe, 2009):

- Tangible Heritage (Immovable, e.g., traditional buildings, historic city centres and archaeological sites);
- Movable, e.g., paintings, sculpture, coins, and manuscripts; Underwater, e.g., shipwrecks, and ancient cities);
- Intangible Heritage (e.g., oral traditions, performing arts, rituals, knowledge, and skills);
- Natural Heritage (e.g., natural sites with cultural aspects such as cultural landscapes and physical, biological, or geological formations)

Furthermore, other concepts, such as historical architectural, historical and industrial heritage are used in the literature, so as to define a certain part of the cultural heritage in an area.

The inner-city historical centres have been a primary target in urban revitalization initiatives, from a building assets renewal and historical conservation point of view. According to Ebbe (2009), the conservation of cultural heritage supports urban revitalization by preserving city liveability, increasing competitiveness, and creating a wide range of income-earning opportunities. Indeed, there are direct linkages among cultural land use, travel patterns, transportation infrastructure, and economic development, since these facilities constitute attraction poles, based mostly on the fact that they induce trips with urban, regional or even international origin. Furthermore, traffic emissions, pollution, noise, and vibration are significant parameters that affect negatively the heritage structures and their survival through time.

5 Land Use and Transport as Urban Revitalization Vehicles

Integration of land use and transport policies has been an extensively studied research topic (for a comprehensive review see Rayle (2008)) for the past decades. There is a complementary relationship between these two policy areas, especially from a sustainability point of view; land use strategies have an impact on transportation and vice versa, thus the idea of integrating and coordinating planning in these sectors emerged as a natural evolution. There are many global examples of integrated land-use transport and transit-oriented development in the literature (e.g. Houston, Washington D.C., Portland, Vancouver B.C., Ottawa-Carleton, Curitiba - Parsons Brinkerhoff (1996)) that constitute good or even excellent practices towards this direction, but there is also the other side, the critics, that contest the effectiveness and value of such an effort (see Litman, 2004).

Wegener and Fuerst (2000) introduced the term land-use transport feedback cycle, which appositely captures the casual relationships and impacts that characterize this common approach. Building up on this work, Walle et al (2004) summarized this set of relationships as follows:

- the distribution of land uses over the urban area determines the locations of human activities such as living, working and leisure;
- the distribution of human activities in space requires spatial interactions or trips in the transport system to overcome the distance between the locations of activities;
- the distribution of infrastructure in the transport system creates opportunities for spatial interactions and can be measured as accessibility;

- the distribution of accessibility in space co-determines location decisions and so results in changes of the land-use system.
-

6 Urban Revitalization in Portugal

According to Aguiar (1999), the history of Portuguese cities reflects very closely the country's response to political, legal and socio-economic processes, where recent urbanization trends, inappropriate legislation and national and local political priorities have led to the decline of city centres in Lisbon and Porto. Furthermore, as Partidário and Correia (2004) note, in the last two to three decades Portugal experienced considerable territorial modifications as a consequence of social and economic structure changes, associated to significant population migratory flows, both within and across the national borders. Currently, the main characteristics of Portuguese cities are the following (Balsas, 2007):

- relatively high magnitude of the decline and deterioration levels of the housing stock in city centres;
- lack of appropriate legal instruments or funds to reverse physical and socio-economic decline in their city centres;
- harmful effects of rent control.

Additional factors to be taken into account include: rising income levels, changes in lifestyle preferences, the liberalization and easy access to credit and a huge increase in the construction of new homes (Balsas, 2007).

Ribeiro (2008) reports on a number of revitalization initiatives in Portugal lead by the Institution of Habitation and Urban Rehabilitation (e.g. Recria, Rehabita, Recriph, Solarh, Programa LX – Reabilitar o Centro, São Paulo community etc) , while noticeable urban revitalization initiatives are World Exposition EXPO'98 (Figure 2), Lisbon´s Baixa Pompalina (Figure 3), Porto´s Baixa (2001 European Capital of Culture) (Figure 4), Coimbra´s waterfront (Figure 5) etc, some of which made use of EU Community Support Framework Funds (URBAN, PROCOM, URBCOM, POLIS among others).

From the above mentioned programs, the POLIS program (Program for Urban Regeneration & Environmental Improvement) is of great importance. It´s primary objective is to improve the quality of life in the cities, through interventions in the areas of urban planning and environment. This can be achieved by improving the attractiveness and competitiveness of the urban poles that play a relevant role in structuring the national urban system (www.polis.maotdr.gov.pt). The program was built around the following key principles (Partidário and Correia, 2004):

- demonstration based on objective evidence;
- mobilization around urban environmental improvement;
- interference with urban complex realities to enrich cities perception, expectations and identity;
- recognition and respect for social actors sensitivity and respect.

In order for the greater and location-specific goals of POLIS to be achieved, different tools are used to tackle issues in the areas of urban space management, functional diversity, urban signaling,

accessibility, transport, telematics and promotional actions (Partidário and Correia, 2004). Indeed, Partidário and Correia (2004) identify five categories of instruments, i.e. planning and project, environmental management, institutional, capacity-building and public participation instruments. Furthermore, from an institutional point of view, a number of anonymous POLIS enterprises of exclusive public capital were created, on the basis of a 60% and 40% shareholders´ relationship between the State and the Local Authorities. This structure also reflects the level of financial contribution of each partner to the project (Partidário and Correia, 2004), combined with EU funds, primarily through the III Community Support Framework (CSF III). Furthermore, the POLIS Program Coordination Office (GCPP) was created under the Ministry of Environment and Spatial Planning (MAOTDR), so as to promote articulation of different funding sources, maximize synergies and ensure that projects meet both the objectives of the program and operational activities of the CSF III. This Coordination Office is also responsible for the dissemination, promotion, quality control of projects and evaluation of the implementation of the Polis Program as a whole. During the period of 2000 - 2006, many urban revitalization projects where implemented throughout Portugal as can be seen Figure 6.

Another revitalization initiative, undertaken by the Institution of Habitation and Urban Rehabilitation (Instituto da Habitação e Reabilitação Urbana – IHRU), is “Critical Neighborhoods” (Bairros Críticos). The initiative “Operations of qualification and urban reintegration of Critical Urban Areas”, contributes to the operationalization of a strategic guideline oriented towards the socio-urban integration of territories that display factors of critical vulnerability, both from an urban-architectural and organizational point of view, as from a socio-economic point of view (Franke et al, 2007; Sousa, 2008)



Figure 2. Lisbon´s Park of the Nations (Expo 98).



Figure 3. Lisbon´s Baixa Pombalina.



Figure 4. Porto´s Baixa.

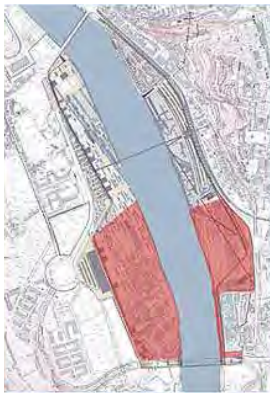


Figure 5. Coimbra´s Riverfront.

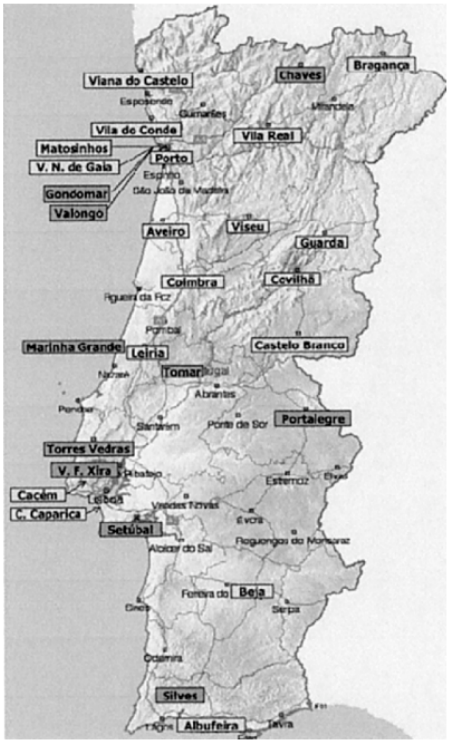


Figure 6. Geographical location of the 28 selected cities. Source: Partidário and Correia, 2004.

7. Strategic Options for Integrating Transportation Innovations and Urban Revitalization (SOTUR) Participatory scenario building workshop

7.1. SOTUR project outline

Strategic Options for Integrating Transportation Innovations and Urban Revitalization (SOTUR) is a project embedded in the research activities of the MIT Portugal Program, initiated in October 2007 and with a 30-month duration. The project´s main specific objectives are the following:

• Design and simulate good practice solutions for innovative strategies on the interaction between Land Use and Transport, especially aimed at the revitalization of urban areas.

• Improve the utilization of innovative transport solutions (modes and or services) and public transport, and to increase the attractiveness and liveability of decaying urban areas.

• Enhance the understanding of agents' behaviour – including corporate and personal investment decisions - considering social, economic and political interests.

• Provide recommendations for urban management through better articulation between the different decision levels.

To achieve these goals, SOTUR is structured on a set of eleven interrelated Work Packages (see Figure 7). The need for a series of Stakeholders Workshops was identified, aiming at involving relevant stakeholders in various phases of the project. This way, robustness, validation and acceptability of the processes and the results are promoted, capitalizing at the same time the expertise and experience of a diverse group of stakeholders in the fields of transportation, spatial planning and urban revitalization.

"Stakeholder Scenario Building: Imagining Urban Futures" is the first participatory exercise, aiming at the identification of driving forces and local factors that implicitly and/or explicitly have an impact on urban revitalization policies in Portugal, and namely in Lisbon, Porto and Coimbra. The results of this Workshop will constitute input to the next phases of the project, primarily in the form of probable evolution scenarios of crucial exogenous forces and the consequent strategies that will have to be adopted in the context of transportation, land use and urban revitalization. Finally, two more Scenario Building Workshops are planned.

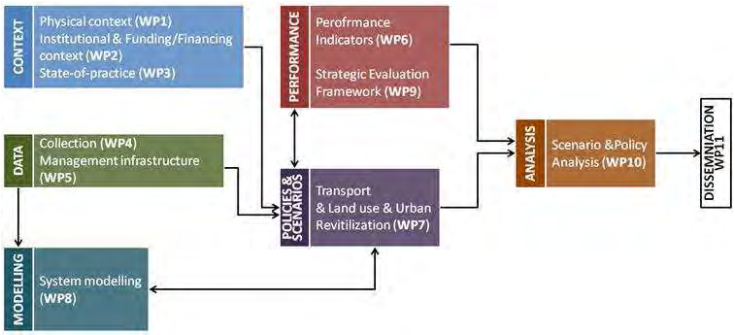


Figure 7. Interrelations among SOTUR Work Packages.

7.2. Workshop description

The first SOTUR Scenario Building Workshop took place in Coimbra in January 2010 (from now on Workshop I). The main objectives of Workshop I are summarized herewith:

- familiarization of Portuguese stakeholders with the conceptual, as well as the empirical, explicit and implicit, causal relationships among urban revitalization, transport and land-use;
- familiarization with the participatory process of scenario building;
- compilation of salient local factors and driving forces for the Portuguese cities of Lisbon, Porto and Coimbra, that could constitute structural elements for the creation of plausible scenarios that will test the impacts and effectiveness of transport and land use strategies towards urban revitalization.

To ensure ex ante a certain degree of robustness of the outcomes of the workshop, a diverse group of stakeholders was invited, consisting of public and private sector representatives who exhibit competences and activities in the strategic, tactical and/or operational levels in the areas of transport, land use, housing, urban revitalization, urban planning, real estate, environment etc. Indeed, as presented earlier, urban revitalization is a multifaceted concept with implications in the social, economic, environmental, institutional, health, as well as historical/cultural realm, thus the analysis that was aimed at in this Workshop required for high diversity of stakeholders, i.e. with different background and participation levels in the decision-making process. Nevertheless, the number of participants that was invited should not hinder or create difficulties in the workshop process per se. For this reason, although an extensive list of possible stakeholders was identified, the SOTUR research group reduced the sample into 50 participants, representing national, regional, as well as local interests. The final turnout reached 39 stakeholders, while 14 members of the SOTUR research group assisted throughout the process. A summary of the profiles of the participants is provided in Table 2.

Table 2. Types of entities represented by Workshop I participants

Ministry	2
Transport Regulator	4
Construction & Real estate Regulator	2
Regional Authority	3
Municipality	9
University (except for the SOTUR Research Group Members)	5
Transport Operator	7
Urban rehabilitation company	6
Parking-related entity	2
SOTUR Research Group Members (university professors, students)	14

As mentioned earlier, the primary objective of the workshop was the identification of macro (driver forces) and micro (local factors) parameters that according to the stakeholders´ experience and perception will affect urban development in Portugal in the next 20 years. The initial part of Workshop

I consisted of a plenary session, where the participants were introduced with the SOTUR project and its progress, the concept of urban revitalization and its transport and land use implications, as well as the participatory scenario building process as documented in the literature and in practice. These presentations set the ground for the roundtable sessions of Workshop I, where the stakeholders were given an active part, as will be described in the following paragraphs.

Stakeholders were allocated into five roundtables according to geographical criteria, representing basically the Metropolitan Areas of Lisbon and Porto, and Coimbra. National-level stakeholders were allocated to the city tables according to their areas of activities and their professional background. Furthermore, the discussions were facilitated by a moderator - member of the research group - with profound knowledge and experience on the issues of urban revitalization, transport and land use, as well as high perception of the reality of the city that each roundtable represented.

The roundtable discussion process was divided into two parts; the first roundtable session, following the plenary session, was more brainstorming-oriented, aiming at identifying local factors and driver forces that are relevant to urban revitalization, transportation and land use, through a semi-structured discussion among the participants. More precisely, the first part roundtable session was initiated by the moderators on the basis of three fundamental questions (Table 3) which delineated the framework within which the discussion should take place. Throughout the roundtable sessions the moderators carefully stimulated the discussions among the stakeholders, avoiding heavy guidance but ensuring at the same time that the discussion was not exceeding the framework set in the outset.

Table 3. Fundamental questions in the outset of the roundtable sessions

Question 1:	What are the urban revitalization problems that your city faces?
Question 2:	What are the main factors (causes) that have produced the problems?
Question 3:	How will these factors evolve over the next 20 years, and/or will other factors or other relevant problems emerge?

After the participants of each table reached a consensus on a list of driver forces and local factors according to their views and perceptions, during the second roundtable session, they were asked to position these driver forces and local factors according to the perceived and expected levels of uncertainty and importance. At the outset of this task, the need for clustering similar drivers and factors was identified by the stakeholders, narrowing down this way the amount of drivers and factors to be processed. Furthermore, during the positioning task, the moderator was responsible for stimulating the discussion on the rationale for each placement, contributing to the final consensus of each table. The results of this second roundtable session are described and analysed in detail in the following paragraphs.

The workshop ended with a plenary session, where the research group presented to the participants the classifications of all roundtables, pointing out the convergence and divergence among the macro drivers and micro factors. Finally, a meta-analysis of these results provided the output of the workshop, that is a number of crucial – in the sense of high importance and high uncertainty - exogenous factors that according to the consensual stakeholders' view of their future

trends, will affect the development of transportation, land use and urban revitalization in Portugal in the following future.

7.3. Results

As described in the previous paragraphs, each stakeholders´ roundtable concluded in a list of driver forces and local factors that implicitly or explicitly are expected to affect the development of transportation, land use and urban revitalization in Portugal. Clustering into categories and estimation of the trend development in respect of the levels of importance and uncertainty was also performed; importance, in the sense of degree of influence and impact, and uncertainty in the sense of probability of predicting the development of this factor.

According to our meta-analysis, factors that seem to be the most important and yet are most uncertain include models of governance especially in terms of coordinated planning among municipalities, policy guidance and unified visions, as well as economic uncertainty and credits favouring new housing. Factors that were considered to be important and certain include housing policy leading to increased suburban development and urban decline in city centres, changing demographics and population ageing in central areas, quality of building stock and public spaces, as well as building technology. Furthermore, the research team proceeded in a higher level of factor clustering as follows (see also Table 4):

- Political/Administrative factors are aggregated in terms of eight variables: Capital city-centrism, Legal framework, Model of governance, Public finance, Policy guidance, Bureaucracy, Housing policy, and Security
- Demographic factors are aggregated in terms of seven variables: Age distribution, Lifestyle expectations / quality of life, Migration flows, Tourism, Security, Social network, and Motivation for participation
- Economic factors are aggregated in terms of eight variables: Credit, Tourism, Demand for space, Capital-centric development, Real estate market, New lobby force, Energy market, and Mobility price
- Built environment factors are aggregated in terms of three variables: Topography, Building stock, and Public space
- Participants acknowledged the emergence of new technologies (especially building technologies) as a driving force in addition to the natural environment in terms of abiding by environmental regulations

Table 4. Stakeholder´s raw input, factor aggregation and important/uncertain classification

	Factor	*Stakeholders´ input*	*Table*	*Important & Uncertain*
Political/Administrative	Capital city-centrism	EU and national investments favoring Lisbon	Porto	√
	Legal framework	Legal framework instability for land-use planning and urban regeneration	Coimbra	√
		Rent control / real estate taxes not penalizing long-term vacant property	Porto	
		Difficult expropriations	Lisbon	
		Real estate regulation	Lisbon	
		Land-use policies	Lisbon	
	Model of governance	Inexistence of a supra-municipal structure	Coimbra	√
		Inexistence of a supra-municipal structure	Porto	√
		Lack of inter-municipal planning	Porto	√
		Models of governance	Lisbon	√
	Public finance	Lack of financial structures for urban rehabilitation	Coimbra	
		Lack of funding for public transport from central government or surrounding municipalities	Coimbra	
		Rent control / real estate taxes not penalizing long-term vacant property	Porto	
		Uncertainty in policies regarding property and income taxes	Porto	√
		Financial sustainability of local authorities	Lisbon	
	Policy guidance	Lack of strategic guidance from central government for local policies/investments	Coimbra	√
		Lack of unified vision for city	Porto	√
		Increasing role of stakeholders as facilitators of urban regeneration	Porto	
		Lack of coordinated urban policies	Lisbon	√
	Bureaucracy	Horizontal/vertical competition	Coimbra	
		Administrative costs/inertia	Porto	
	Housing policy	Rent controls / real estate taxes not penalizing vacant property	Porto	
		Mono-functional suburban areas (only residential)	Lisbon	
		Degradation in social insertion neighborhoods in the city fringe	Lisbon	
		Lack of definition for historical heritage and what should be preserved	Lisbon	
		Difficult expropriations	Lisbon	
	Security	Safety and security	Lisbon	

Table 5. Stakeholder´s raw input, factor aggregation and important/uncertain classification (cont´d)

	Factor	*Stakeholders´ input*	*Table*	*Important & Uncertain*
Demographic factors	Age distribution	Influx of students and young families	Coimbra	√
		Influx of students	Porto	
		Population ageing in city centre	Porto	
		Capacity to attract young middle class families	Porto	√
		Population ageing	Lisbon	
		Population ageing in city centre	L2-6	
	Lifestyle expectations / quality of life	Lack of parking in rehabilitated housing	Coimbra	
		Change of consumer behavior (shopping malls)	Porto	
		Capacity to attract young middle class families	Porto	√
		Lack of parking in historical neighborhoods	Lisbon	
		Abandonment of the city centre	Lisbon	√
		Values set of the new generation	Lisbon	√
		Quality of life standards	Lisbon	
	Migration flows	Out-migration to neighboring municipalities	Coimbra	
		Migration flows	Lisbon	
	Tourism	Increase in tourists	Coimbra	
	Security	High poverty rate leading to crime	Porto	
		Safety and security	Lisbon	
		Isolation and security	Lisbon	
		Security	Lisbon	
	Social network	Social disparity	Porto	√
		Lack of social bonding within neighbors	Lisbon	
		Social disparity (immigrants)	Lisbon	√
		Isolation and security	Lisbon	
		Immigration	Lisbon	
		Social network	Lisbon	
	Motivation for participation	Increasing role of stakeholders as facilitators of urban regeneration	Porto	
Economic factors	Credit	Financial crisis affecting demand for rehabilitated housing	Coimbra	√
		Easy access to bank credit for suburban housing	Lisbon	√
		Credit favoring new housing	Coimbra	√
		Economic uncertainty	Porto	√
	Tourism	Increase in tourists	Coimbra	
	Demand for space	Lack of business spaces, development of suburban office parks	Porto	
		Change in development paradigms	Lisbon	√
	Capital-centric development	EU and national investments favoring Lisbon	Porto	√
	Real estate market	Attitudes towards renovation	Porto	
		Lack of unified vision for city	Porto	√
		High prices of dwellings in the city centre	Lisbon	
		Real estate speculation	Lisbon	
		Real estate market economy (land and housing)	Lisbon	√
	New lobby force	Increasing role of stakeholders as facilitators of urban regeneration	Porto	
	Energy market	Cost of energy	Lisbon	√
	Mobility price	Cost of travel	Lisbon	√

Table 6. Stakeholder´s raw input, factor aggregation and important/uncertain classification (cont´d)

Built environment factors	Building stock	Vacant buildings in city centre	Porto	
		Classification of the historic city centre as World Heritage site	Porto	
		Housing quality status	Lisbon	
		Building stock degradation	Lisbon	
		Lack of definition for historical heritage and what should be preserved	Lisbon	
		Abandonment of the city centre	Lisbon	√
		Quality of building stock	Lisbon	
	Public space	Quality of public space	Porto	
		Lack of public spaces in the city centre	Lisbon	
		Lack of adequate infrastructure in the city centre	Lisbon	
		Public space cleanliness	Lisbon	
Technology factors	Building technology	Lack of technical capacity to rehabilitate	Coimbra	
		Lack of parking in rehabilitated areas	Porto	
		Costs of renovation are higher than for construction	Porto	
		Lack of parking spaces in the historical neighborhoods	Lisbon	
		Emergence of new technologies	Lisbon	
Natural environment factors	Topography	Hills deterring access	Coimbra	
	Environmental regulations	Adherence to environmental regulations	Lisbon	

Finally, a number of factors emerged in the discussions, which from a closer perspective are related to the strategies/policy options that may be employed, rather than constitute exogenous, uncontrollable factors. The issue raised from this analysis is the disperse perception on behalf of the stakeholders of the endogeneity and exogeneity of the factors, as well as the distinction between the scenario and strategy concepts.

Among these factors, as summarized in Table 5, it is evident that transportation-related strategies, among others, in conjunction with urban revitalization are highly regarded by the stakeholders. More precisely, public transport, transport network and pedestrian facilities are the issues considered by the stakeholders. Also, there is direct connection and interdependence between these strategies and the exogenous political/administrative, demographic, economic, built environment, technological and natural environment factors identified earlier.

Table 7. Factors that could be affected by strategies/policy options

Factor	*Listing in report*	*Table*
Architecture	Increase functionality and comfort of rehabilitated housing	Coimbra
Pedestrianization	Provide proper transit service in pedestrian areas	Coimbra
Suburbanization	Purchase of new houses outside city centre	Coimbra
	Placement of important public facility in peripheral areas	Porto
	Location of social housing neighborhoods in peripheral areas	Porto
	Mono-functional suburban areas (only residential)	Lisbon
	Degradation in social insertion neighborhoods in the city fringe	Lisbon
	Activity dispersion into new Lisbon Metropolitan Area (LMA) centralities	Lisbon
Public Transport	Construction of Metro Mondego	Coimbra
Transport network	Improvements in road network	Porto
	Traffic congestion	Lisbon
	Unbalance in public transport fares and quality of service in suburban area	Lisbon
	Lack of transport intermodality in the suburban areas	Lisbon
	Lack of public transport coverage in some areas of the city	Lisbon
	Subway expansion towards suburbs vs. consolidating city centre accessibility	Lisbon
Rent control	Rent controls / real estate taxes not penalizing long-term vacant property	Porto
	Rent control decreasing the quality of rental housing	Porto
Office suburbanization	Lack of business spaces, development of suburban office parks	Porto
	Activity dispersion into new Lisbon Metropolitan Area (LMA) centralities	Lisbon
Public space	Quality of public space	Porto
Tax policy	Uncertainty in policies regarding property and income taxes	Porto
Freight transport	Goods loading/unloading periods	Lisbon

Conclusions

This paper presented the process and outcomes of the first Stakeholders Workshop of the “Strategic Options for Integrating Transportation Innovations and Urban Revitalization” (SOTUR) project which aimed, firstly, at the elicitation of a set of driving forces that influence urban revitalization and a subset of factors affected by these drivers. The next step in this process, which will also be of participatory form through subsequent workshops, involves research on possible strategies that might or will need to be implemented in order to promote urban revitalization in Portugal, in the framework of exogenous forces and factors that was derived by the stakeholders-experts.

Overall, there is a general agreement among participants in the three cities (Lisbon, Porto and Coimbra) regarding the importance and certainty of the factors articulated. Furthermore, the six drivers (Political/Administrative, Economic, Demographic, Built Environment, Technology, and Natural Environment) are “universal” which means that they are common for the three cities and represent changes at a higher level than local factors. Drivers however, can have different manifestation and importance in the different cities.

Each of the six drivers can change, implicating e.g. increase or decline, improvement or deterioration, intensification or wane, which are called states. The states that a driver can take are extremely important for scenario building, which is the next step of our participatory exercise, where

each scenario will build upon a combination of driver states (e.g. economy could be increasing, population ageing, technology advancing, decisions more centralized, etc.).

Finally, the participatory process per se will be evaluated in the end of the workshop series through a dedicated survey among stakeholders. It can be said though in advance that joining this great diversity of stakeholders in this exercise, exposed each one of them to a number of different opinions and perspectives on national and local issues that may have not have be heard otherwise. Thus, except for the participatory culture infused to the participants, the outcomes of the workshop could be an indirect input to the decision-making process of urban revitalization in Portugal.

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Estimation of a mode choice model for long distance travel in the Portuguese National Transport model

Vera Palma, Álvaro Costa, Michiel Bok, Sandra Melo

CITTA - Department of Civil Engineering

Faculty of Engineering, verapf@fe.up.pt

Phone number: +351 225 081 019

The Portuguese National Transport Model (PoNTraM) represents the supply and demand of medium and long distance travel within the country. After initial development between 2006 and 2007, follow up research has recently got under way to significantly upgrade the demand model. The scope of PoNTraM is to evaluate transport measures that have a regional or national impact, such as the construction of a new national airport or a high speed rail link. It considers five modes relevant to long distance travel: car, bus, rail, taxi and high-speed rail, and the demand models are calibrated on a large-scale household survey. The model supports the decision making of transport network investments by providing passenger forecasts or highway link flow projections. By doing so it can be used to prioritise network development investments, which is increasingly important with the current pressure on available funds. This paper focuses on the validity of the demand projections by comparing the demand elasticities from the model with empirical studies in international literature. Demand elasticities can be used to describe the aggregate change in demand for a given mode subject to a certain change in its cost or travel attributes. Cross elasticities measure the change in demand for a given mode subject to changes in the attributes of competing modes. The elasticities implicit in the current model are derived from model runs for a number of elasticity scenarios. The comparison shows that the elasticities and cross elasticities for the conventional modes (car, rail and bus) are comparable to the elasticities found in literature, confirming the plausibility of the results. The results also show useful insight into the key areas for improvement; in particular the demand responses to changes in travel time and for high speed rail are not yet satisfactory requiring a revision of the mode choice model.

Keywords: Transport, Mode Choice, Elasticities

1 Introduction

The scope of the Portuguese National Transport Model (PoNTraM) is to evaluate transport measures that have a regional or national impact, such as the construction of a new national airport or a high speed rail link, and has been developed recently (FEUP, 2007a; Abrantes and Pimentel, 2007). It considers five modes relevant to long distance travel: car, coach, rail, taxi and high-speed rail, and the demand models are calibrated on a large-scale household survey.

PoNTraM can be used to prioritise network development investments, which is increasingly important with the current pressure on available funds. The results can be used to forecast revenues, support vehicle planning, or to analyse effects on competing modes (for instance reduction of congestion on highways). In recent case studies (Costa et al., 2009) the PoNTraM was first used to generate passenger forecasts for different planning alternatives for a new High Speed Rail between Lisbon and Porto. In the second case study the model was used to optimise the coach timetables, and show its secondary effects on the competing modes. The results showed how optimisation scenarios can help to increase the market share of the coach, and even reduce highway traffic on some parts of the road network. This can help in improving the revenue for coach companies, optimising their operational costs and as a side effect reducing congestion on the car network (Costa et al., 2009).

The construction of a new high speed train line is currently a lively planning issue in Portugal. There are different scenarios for a line between Lisbon and Porto, and additional plans for extension lines through Lisbon–Madrid or Porto–Vigo. PoNTraM can provide passenger forecasts for high speed rail, simulating traveler behavior on competitive transport markets. However, the effects of the introduction of such a new infrastructure on traveler behavior are not straightforward, so an additional assessment of the validity of the behavioral responses needs to be carried out. In this assessment, the current modeling system will be compared with empirical results from international literature, giving special attention to the demand responses of the introduction of high speed train.

Currently, IMTT has initiated the 2nd development phase of PoNTraM, with the purpose to improve the current model. The purpose of this project is to update the supply data in the model (highway and public transport networks) and it will review the construction of demand matrices and the calibration of parameters, which implies a new model calibration.

The objective of this paper is to compare the implicit demand elasticities from the current model with demand elasticities from international studies. The elasticities are calculated for different transport modes and express the aggregate change in demand due to changes in time or cost. The literature study includes sources that deal with empirical models for long distance travel, and/or provide relevant data for cross elasticities between the current conventional modes in Portugal (road, train, coach and air) and high speed train. The objective of this comparison is to see which responses of the model need to be revised, and forms an important input to the further development plan of the modeling system.

The paper first gives an overview of empirical studies with elasticity results for long distance travel. Then it briefly describes the current PoNTraM system and how the mode choice model was calibrated. Then it presents the results of an analysis of the behavioural responses of the model. The implicit demand elasticities of the model are compared to values reported in the empirical literature. This builds up to recommendations for improvements of the modeling system.

2 Empirical studies for long distance travel models

Long distance travel makes up a small proportion of travel demand, but accounts for a significant part of total distance travelled. In this section we will discuss a number of empirical studies on long distance travel, to collect representative elasticity and cross elasticities values for long distance travel. These values will be compared to the current behavioural responses in the Portuguese national model PoNTraM.

The review first of all discusses sources on elasticities and cross elasticities for long distance travel. The review is not intended to be exhaustive but contains the most relevant sources for our comparison to the implicit elasticities in. The elasticities for long distance travel we collected from:

- UK National Transport Model (DfT, 2005)
- Long Distance Travel Study & Dutch National Model (MVA, 1985)
- DATELINE deliverable 8: qualitative analysis for modelling (DATELINE consortium, 2003)
- Model for long distance travel in France (Cabanne, 2003)
- Italian National Model (De Jong and Gunn, 2001)

High speed rail is a particular segment in long distance travel that requires special attention. To collect information for assessment of the implicit elasticities for high speed rail in PoNTraM, the following projects are reviewed:

- High speed line study for TSA in UK (Atkins, 2002)
- High speed line study for RAVE in Portugal (RAVE, 2003)

Table 1 gives an overview of the elasticity values that were found in the empirical studies.

The implicit elasticities that are reported in the literature are context dependent: they are influenced by regional differences in socio economic context (value of time, level of fuel prices, GDP per capita), in quality of different transport modes, or in different definitions used for market segmentation (travel purpose, distance classes, transport modes). The research context of studies that are included varies so the reported elasticities can not be compared one on one. Important dimensions that affect elasticity values are the definition of long distance travel, and the level of competition between modes. In the interpretation of elasticities it is important to realise that elasticities are usually estimated (and therefore valid) for small changes of a system. If the system changes over time, the elasticity value is likely to change too. For instance, car fuel elasticities can increase under influence of increased fuel prices or decrease under increased fuel efficiency of cars (for detailed discussions of different types of elasticity and their variation with respect to different explanatory variables see Dargay and Hanly, 2002, Balcombe et al., 2004 and Wardman, 2004).

The elasticity to time or costs can also be influenced by changes in values of time. If the value of time increases, time is transferred into more cost units in the generalized cost, decreasing the relative importance of costs in this function, and this leads to a decrease of cost elasticity. If studies are analysing effects for a planning horizon that lies further in time (e.g. twenty years ahead) it is likely the value of times and elasticities will have changed with economic growth. For example, DfT (2005) reports different elasticity values in the UK National Model under high or low economic growth scenarios (for an up to date analysis of the change in values of time and elasticities over time and as a function of income please see the forthcoming paper by Abrantes et al.).

The DATELINE project provides relevant information that reveals structural differences in contexts for the transport market in different European countries (Gomes and Santos, 2004). This study shows significance structural differences in modal shares for long distance travel in different EU countries. In the UK, 61% of surveyed individuals use car for long distance travel compared to 77 % in Portugal (Gomes and Santos, 2004). This is important to realise, because the induced elasticities from logit models are sensitive to mode share. The cross elasticities of dominant modes are lower compared to inferior modes. For example the cross elasticities in the National Model in the UK are influenced heavily by differences in market shares: the cross elasticity of car trips to rail fares is +0.02, while the cross elasticity of rail trips to car costs is +0.12 (DfT, 2005). So, in our comparison we need to consider the relative high share of car use in Portugal, leading to relative higher cross elasticity between car prices and rail travel. Thus, for example, this cross elasticity in PoNTraM should be higher than the value of 0.12 found in the UK (DfT, 2005).

Table 1. Overview of reported elasticity values for long distance travel

Study	Description	Reported (cross) elasticity values			
MVA (1985)	Long Distance Travel Study,The Netherlands, year: ´82-´83, d>40km	*Commuting*		Rail	Car
		Rail Fare		-0.26	+0.14
		IVT Train		-0.29	+0.16
		Family Visit			
		Rail Fare		0.52 or -0.62	Range +0.06 to +0.16
		IVT Train		-0.69 or -0.79	
		Business Travel			
		IVT Train		-1.74	+0.31
DfT (2005)	UK National Model, year 2001		Car	Rail	Bus
		Fuel cost	-0.22 to -0.17		
		Rail fare	+0.02	-0.62 to -0.48	
		Bus fare			-0.68 to -0.57
			Rail short d	Rail med. d	Rail long d
		Rail fare	-0.28	-0.59	-0.88
Atkins (2002)	RP and SP survey among rail travellers on two corridors in UK, year: ´01-´02, d>48km)			(cross) Elasticities Rail demand	
				Business	Leisure
		Rail cost		-0.48 or -0.62	-0.86 or -0.72
		Rail IVT		-0.92 or -1.31	-0.78 or -0.88
		Car cost		0.20 or 0.28	0.33 or 0.40
		Car time		0.73 or 0.95	0.56 or 0.62
		Air cost		0.26 or 0.22	0.76 or 0.64
		Air time		0.12 or 0.12	0.13 or 0.11
		Rail Headway		-0.15 or -0.06	-0.18 or -0.25
RAVE (2003)	Survey among rail travellers in Portugal		High Speed Rail demand		
		HSR Price	-0.31 to -0.61		
		HSR Time	-0.12 to -0.44		
Cabanne (2003)	Demand data from period ´80 to ´00 in France, d>40 km		Car	Rail	Air
		Car Price	-0.60		
		Car accessibility	+0.74		
		Rail Fare		-2.00	+0.99
		Rail accessibility		+0.45	-0.16
		Air Fare			-0.77
De Jong and Gunn (2001)	Italian National model for long distance travel (d>30 km). Elasticities are presented in an article for a cross European comparison of elasticities (long term trip elasticities are presented)	Commuting		Car	Public transport
		Car fuel price		-0.55	0.22
		Car time		-0.56	0.23
		Other			
		Car fuel price		-0.16	0.50
		Car time		-0.09	0.30

Elasticities can be are sensitive to distance classes. This is shown for instance in the implicit passenger miles elasticities with respect to rail fares that were derived from the UK National model. These elasticities vary with distance: from -0.28 for short distances to -0.88 for long distances (DfT, 2005). The study by Atkins (2002) also revealed more competition (higher cross elasticities) between car and rail on longer distances. In the Portuguese National Model, long distance travel is defined as all trips greater than 75 km. The elasticities reported in the studies in this overview apply different definitions. The UK national model defines long distance travel for trip of at least 100 km, the former long distance travel model for The Netherlands regards trips of more than 40 km as long distance trips (MVA,1985). The study by Cabanne (2003) in France classified trips longer than 40 km as long distance travel, and the EU project DATELINE applied 100 km. (DATELINE consortium, 2003; Gomes and Santos, 2004). This is to emphasize that the elasticities cannot be compared one on one but are merely indicative, used to evaluate the size of an impact roughly.

High speed trains compete with all modes available on long distance travel and take market shares from each mode. But considering the current small market share of train use in Portugal (4%; compared to 10 % in The Netherlands and 11 % in the United Kingdom) a decrease in such a small market will lead to a change in elasticity values for this relatively small mode. We will test in the current model if the implicit cross elasticities for train travellers decrease after introduction of the high speed trains.The empirical studies furthermore show that business travellers have relatively high time elasticities and low cost elasticities, compared to leisure travellers (Atkins, 2002; MVA, 1985).

The results from the High speed line study in UK (Atkins, 2002) showed that the high speed rail behavioural parameters were very similar in scale to that of air; concluding that air is the closest comparative mode for travellers.

3 The Portuguese National Model

3.1 Overview of the model

The Portuguese National Transport Model (PoNTraM) represents the supply and demand of medium and long distance travel within the country. The model is designed for the evaluation of transport measures that have a regional or national impact (FEUP, 2007; Abrantes and Piementel, 2007). The model represents the following five modes relevant to long distance travel: car, coach, rail, taxi and high speed rail.

In addition to these main modes, the following access modes are included: taxi, metro and suburban rail services. When modelling long distances travel, these auxiliary modes of transport are necessary for modelling access to infrastructure networks from any location in the country.

The demand side of a national transport model consists of the choices that long distance travellers make in travelling from their origin to a specific destination. These choices can include a destination choice, a mode choice, a route choice and a time of day choice.

The model is implemented in the transport analysis package EMME. The mode choice model is run iteratively with the network assignment until convergence to reflect variations in road travel time (affecting coach and car travel) following from changes in mode choice. By doing so, travelers base their choices on the representative travel times taking into account congestion levels.

3.2 Mode choice model

The model follows the conventional sequential four-step model: trip generation, trip distribution, mode choice and route assignment. At the moment, the trip generation and trip distribution steps are carried out simultaneously on the basis of the trip matrix obtained from the household survey (FEUP, 2007b). Mode choice is the third step and is the crucial element that calculates the market shares of transport modes accounting for the preferences of travellers.

The mode choice model is based on a simple multinomial logit (MNL) formulation, whereby the choice between transport modes is organized at a single level (see Figure 1). High speed rail (HSR) is also represented in the model and available for forecasting.



Figure 1. Simple Multinomial Logit Model Structure.

The MNL mode choice model is applied separately for each of the captive and noncaptive demand segments to determine the choice probability by OD pair between bus, conventional rail, high speed rail (new mode) and car (for non-captive users). In the MNL model the probability of choosing a mode, e.g. car, between a specific origin i and destination j is given by:

$$P_{car;ij} = \frac{e^{V_{car;ij}}}{e^{V_{car;ij}} + e^{V_{bus;ij}} + e^{V_{train;ij}} + e^{V_{HSR;ij}}}$$

$V_{car;ij}$ represents the utility or generalized cost for the car mode, on the connection from i to j. The following expressions specify the utility for each transport mode in PoNTraM:

$$V_{car;ij} = \beta_{cost} \cdot (c_{fuel;ij} + c_{toll;ij}) + \beta_{time} \cdot (t_{car;ij})$$
$$V_{train;ij} = \beta_{cost} \cdot (c_{train;ij} + c_{accesstrain;ij}) + \beta_{time} \cdot (t_{IVTtrain;ij} + t_{waittrain;ij} + t_{accesstrain;ij})$$
$$V_{bus;ij} = \beta_{cost} \cdot (c_{bus;ij} + c_{busaccess;ij}) + \beta_{time} \cdot (t_{IVTbus;ij} + t_{waitbus;ij} + t_{busaccess;ij})$$
$$V_{HSR;ij} = \beta_{cost} \cdot (c_{HSR;ij} + c_{accessHSR;ij}) + \beta_{time} \cdot (t_{IVTHSR;ij} + t_{waitHSR;ij} + t_{accessHSR;ij})$$

The access mode for coach travel is assumed to be taxi to the nearest coach, metro or suburban railway station and then rail to the nearest coach station if necessary. For rail and high speed rail travel (HSR) the access mode is assumed to be taxi to the nearest metro, suburban or inter-city rail station and then suburban rail or metro to the nearest inter-city rail station if necessary. The utility function parameters β_{Cost} and β_{Time} vary by car availability and are calibrated separately for captive and non-captives.

3.3 Calibration

The key data source for developing the mode choice model was a household long distance travel survey (IMMLD) carried out in 2000 (INE, 2001). While the survey allows disaggregation of trips by purpose it proved impossible to derive meaningful disaggregate utility parameter estimates (as discussed below). Demand is therefore only segmented by time period and car availability (public transport captive and noncaptive users). The results discussed later on are based on the weekday morning period.

It was found during the estimation process that there was no need to include alternative specific constants in order for the model to reproduce observed mode shares. This is probably due to the fact that the explicit inclusion of an access mode with a significant fixed cost (taxi) performs this function well. The estimation process also found no significant difference between the time coefficients for in-vehicle time and wait time although it is not clear whether this is due to limitations in the data available, to errors in the travel time estimation (waiting time obtained from the model is likely to be an upper bound of real waiting time due to timetabling efficiencies) or whether it is indeed a reflection of true behavioural responses.

Table 2. Household survey mode shares for extra-municipal trips

Car	Train	Bus
79.7%	9.5%	10.8%

Attempts at estimating utility parameters using discrete choice methods (maximum likelihood estimation) applied to the household travel survey data proved unsuccessful, with many utility parameters coming out with unexpected signs and low significance. Therefore, a more robust but more rudimentary approach to model calibration was undertaken to try to reproduce the observed aggregate mode show in Table 2. This method assumes that the survey yields an adequate estimate of mode shares at an aggregate level even though there are insufficient observations to confidently understand individual behaviour. Due to computational constraints model estimation then needs to rely to some extent on expert judgment (for each set of parameter estimates, the whole mode choice model needs to be re-run to obtain new aggregate mode shares).

The implementation of this estimation heuristic started by assuming that values of time (ratio between time parameter and cost parameter) for any demand segment would be somewhere between 0.1 and 0.5 €/minute. Improved estimates were then gradually honed in by iterative trial and error. Once a good enough value of time was obtained the estimation process concentrated on determining the absolute scale of the parameters using the same trial and error process. The final results are shown in Table 3.

Table 3. Utility function coefficients

Captive Users		***Non – Captive Users***	
Time coefficient	**Cost coefficient**	**Time coefficient**	**Cost coefficient**
-0.027	-0.15	-0.09	-0.3
VT = 0.18 €/min = 10.8 €/h		VT = 0.3 €/min = 18 €/h	

4 Implicit demand elasticities in PoNTraM

Demand elasticities can be used to describe the aggregate change in demand for a given mode subject to a certain change in its cost or travel attributes. Cross elasticities measure the change in demand for a given mode subject to changes in the attributes of competing modes. Implicit elasticities can be calculated from transport demand models based on the number of trips or miles travelled. In the first case, trip elasticity describes the effect on mode choice and the resulting mode shares and, to a lesser extent to trip generation. The second case, elasticities of miles travelled, describes the combined effect on mode share, destination choice and route choice.

The implicit demand elasticities are calculated from elasticity scenarios that were analysed with PoNTraM. In each scenario one of the utility attributes (time or costs) of a specific transport mode is increased by 10%, with constant networks, tourgeneration, and no changes to the utility functions for the other modes. By comparing the number of travellers by transport mode to a base scenario, the elasticity can be obtained, as the ration of relative demand change and relative costs increase.

The purpose of each elasticity scenario is to test the demand elasticities to a specific utility component.

The elasticity scenarios analysed time or costs for each transport mode. In the analysis we focus on the impact of changes in travel time or costs on the number of tours by transport mode, since we are mostly interested in the effects on mode choice. This gives us the demand elasticity for the specific transport mode, and cross elasticities with the competing modes. The following elasticity scenarios are implemented:

- Fuel costs +10%
- Car costs (fuel + toll) +10%
- Car time +10%
- Bus time +10%
- Bus costs +10%
- Train time +10%
- Train costs +10%
- HSR costs +10%
- HSR time +10%

Table 4 presents the elasticities and cross elasticities from the scenarios that were run without the availability of high speed rail. Table 5 presents the elasticities and cross elasticities from the scenario run after introduction of high speed rail. Introduction of a new mode means additional competition

affecting the mode shares of the existing modes. Under this different context the elasticities and cross elasticities are affected slightly too, as reflected in the small changes in elasticity values in Table 4 and Table 5.

The elasticity for car fuel (-0.17 and -0.21 after introduction HSR) is similar to the implicit elasticity reported in the UK National model (-0.17;-0.22). They also correspond to the elasticities reported for the Italian National model, but these were distinguished by travel purpose (-0.55 for commuting and -0.16 for other). Car travel is by far the most important mode for long distance travel, so a comparable result (or in fact slightly lower) seems to confirm that the model has a plausible sensitivity to changes in fuel prices.

Table 4. elasticities (**bold**) and cross elasticities (*italic*)

		Car	Coach	Rail
1.	FUEL COST	**-0.17**	0.60	0.27
2.	CAR COST (fuel+toll)	**-0.26**	0.98	0.35
3.	CAR TRAVEL TIME	**-0.40**	1.37	0.74
4.	COACH TRAVEL TIME	0.25	**-2.02**	1.34
5.	COACH COST	0.07	**-0.44**	0.16
6.	RAIL TRAVEL TIME	0.12	0.53	**-1.66**
7.	RAIL COST	0.05	0.15	**-0.61**

Table 5. elasticities (**bold**) and cross elasticities (*italic*) of forecasts with HSR

		Car	Coach	Rail	HSR
1.	FUEL COST	**-0.21**	0.77	0.29	0.32
2.	CAR COST (fuel+toll)	**-0.29**	1.15	0.35	0.41
3.	CAR TRAVEL TIME	**-0.48**	1.63	0.84	0.88
4.	COACH TRAVEL TIME	0.19	**-2.02**	0.85	0.85
5.	COACH COST	0.00	**-0.28**	0.23	0.23
6.	RAIL TRAVEL TIME	0.04	0.37	**-1.84**	0.68
7.	RAIL COST	-0.02	0.34	**-0.80**	0.30
8.	HSR TRAVEL TIME	0.02	0.47	0.85	**-1.73**
9.	HSR COST	0.02	0.35	0.56	**-1.20**

The elasticities and cross elasticities for the total car costs are slightly higher than when only fuel prices are taken into account. The cross elasticity of rail travel to fuel 10 costs (0.27; 0.29) are considerable higher than those reported for the UK (0.12), but are comparable to the public transport cross elasticities for the Italian model (0.22 for commuting and 0.50 for other). Coach travel in Portugal has a much bigger share compared to the countries where the other empirical elasticities were derived. Consequently the reported studies did not provide (cross) elasticities for coach travel.

The cross elasticities between coach travel and car fuel costs are quite high (0.60; 0.77), but are attributed to the competitive coach market in Portugal (over 10% of all long distance travel).

The time elasticities for car travel are 2 to 3 times larger than the cost elasticities, a result that is similar to the values reported for the UK National Model.

The elasticities for rail travel time (-1.66 and -1.73 after introduction of HSR) are a bit higher but comparable to the results in the UK and Netherlands. The Long Distance travel study in The Netherlands reported elasticities of -0.29 for commuters and -1.74 for business travel. In the UK, Atkins (2002) reports rail travel time elasticities varying between -0.78, for leisure, and -1.31, for business travel. The differences in results can also be attributed to different segmentations by travel purpose, or other definitions of long distance travel. The cross elasticities of car use to rail travel time are low (0.12 and 0.04) and comparable to the cross elasticities found in the literature: 0.16 for commuters in The Netherlands and 0.02 in the UK National Model.

The elasticities for rail costs (-0.61 and -0.80 after introduction of HSR) lie in the range of the results in the UK and Netherlands. For the UK, Atkins (2002) reports rail cost elasticities varying between -0.48, for business travel, and -0.86, for leisure. The Long Distance Travel Study in The Netherlands reports elasticities between -0.26, for commuters, and -0.62, for leisure. The cross elasticity of car use to rail costs are minimal (0.05 and -0.02), compared to 0.14 for commuters in The Netherlands and no reported cross elasticities in the other sources. The low cross elasticity from rail costs to car use in Portugal is also the result of the relative small share of rail in Portugal (4% compared to 10 and 11 % in the Netherlands - Gomes and Santos, 2004).

For High Speed Rail the time elasticity is -1.73 and the cost elasticity -1.20. These elasticities are much higher than the ones reported in a previous study in Portugal (RAV, 2003), which gives a time elasticity between -0.12 and -0.44 and a price elasticity between -0.31 and -0.61 (dependent on travel distance). However, such low time and costs elasticities are doubtful. Cabanne (2003) reports a cost elasticity of -2 for rail travel in France (which includes HSR), supporting the higher elasticities that were found with PoNTraM. The rail elasticities from the study by Atkins (2002) are derived from an SP study that included high speed rail alternatives, so they can be assumed to be representative of high speed rail too. These time elasticities vary between -0.78 and -1.31; and cost elasticities between -0.48 and -0.86. The elasticities in PoNTraM are still a bit high in comparison. However, this could be linked to the very competitive base speeds of the proposed HSR project and the very dense travel corridor it travels along. Any increases in travel time are likely to make rail less attractive for a significant proportion of travelers (for example those who need one or more transfers to reach high speed rail stations).

In any case, these differences are important for the evaluation of high speed rail scenarios, and require further analysis. This should help to establish a proper range for the elasticity value for this transport mode.

5 Conclusions and recommendations

This paper presents an assessment of the behavioural responses of the Portuguese National Transport Model (PoNTraM) through a comparison of the implicit elasticities in the model with elasticities from empirical studies on long distance travel. Overall, the implicit elasticities and cross

elasticities are comparable to the examples found in the literature. This confirms the validity of the model, which shows that the calibration procedure has led to useful coefficients that give representative results. This finding is important given limitations in the estimation procedure stemming from the nature of the data available. However, some parts of the mode choice model are still very much open to improvement.

Given the current debate in Portugal on the construction of high speed rail, the parameters for transport mode should be revised. In the current model, HSR and conventional rail are evaluated with similar time and cost coefficients, and the choice model does not account for any difference in valuation for unobserved differences in service (e.g. quality of ride, level of crowding, general comfort) that may exist between these types of service. In addition there are likely to be significant nonlinearities in the valuation of HSR travel, in particular where the reduction in travel time is such that a trip that previously required an overnight stay could in the future take place over a single day. Addressing this type of issue would require some important changes to the tour generation model.

Based on the analysis it is suggested that the mode choice model can be revised in some ways. A first relevant change is the calibration of time and cost coefficients for different travel purposes. The international literature showed that the behavioural responses vary markedly by travel purpose, so such a segmentation should improve the responses in the mode choice model significantly. However, this change will only be possible if the Household Travel Survey contains enough observations for each purpose or if new data sets (for example, Stated Preference surveys) are made available.

In addition, the utility functions may be improved by inclusion of alternative specific constants to discriminate between unobserved differences that exist between the available transport modes. Another suggestion is to test a nested choice structure, since public transport modes (train, bus and high speed rail) are more likely to be each other´s substitute than car. To calibrate the utility functions representative targets for the demand elasticities for high speed rail can be based on results found in international examples of high speed rail studies.

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Operational performance of European metro systems: the Porto metro case

António Lobo, António Couto

Transport Infrastructures Division

Faculty of Engineering, University of Porto, lobo@fe.up.pt, fcouto@fe.up.pt

Phone/fax number: 00 351 225081902

Seeing that public services are usually explored by public entities (city councils, regional or central governments, etc.), metro systems do not regard financial profit as being their principal operational goal. Thus, providing each urban area with social and environmental benefits is considered to be their priority, which is achieved by providing adequate levels of mobility and accessibility in urban areas, in a rapid, safe and reliable manner. However, metro systems should optimize their resources and improve their operational performance in order to become less of a burden on public finances. This paper is concerned with the analysis of the operational performance of a number of European metro systems by adopting a production function approach. To establish this production function, data on diverse inputs is collected: capital and labour variables, as well as variables characterizing the social-economic context of the urban areas where these metro systems operate. Outputs collected include a service supplied characterizing indicator (place kilometres) and a service demand characterizing indicator (passengers). The analysis of the production is firstly focused on the estimate of the inputs elasticities of the optimal production function. Next, it is fixed on the efficiency and effectiveness levels of each company. For these two purposes, a stochastic production frontier model is carried out. Using Porto metro efficiency and effectiveness results, two analyses were made: the first establishes the relationship between these performance results and the network infrastructure time development and the second one compares Porto metro results and those of some European metro light systems.

Keywords: metro systems, production, stochastic model, efficiency, effectiveness

Introduction

Historical context

The steam engine was the most important symbol of innovation of the Industrial Revolution in the 17th century and its first application as the propulsion mode in a railway car occurred in the early 19th century. In fact, industrialization led to the growth of large urban areas, increasing the mobility needs of persons and goods.

The concept of metropolitan railway system was born as an attempt to reduce the accessibility problems to the city centres, at a time when the road networks were poorly developed and individual transportation was too exclusive and moved by animal traction. Thus, the main goal of a new metro system should be to make easier, faster and more efficient the travels between the residential suburbs and city centres, which is traditionally the location of the most workplaces.

The first underground line of urban passenger railway in the world opened in 1863, when it was inaugurated the Metropolitan Railway, in London. Today, this line is still a part of the current London Underground system. However, traffic conditions in this line were not the best. Poor ventilation of the tunnels did not allow the dissipation of the smoke released by trains, causing great discomfort to passengers, who were gradually abandoning the system. This problem would only be exceeded in 1890, with the opening of The City & South London Railway, the first electrified underground line, which is also still part of the current network. The electrification was proved to be a very effective solution and encouraged, at that time, the development of many subway systems around the world, such as Budapest, Glasgow, Paris, Boston, Berlin and Chicago.

Throughout the 20th century, many subway systems were built with varying characteristics, according to the mobility needs of each urban area, but all of those systems have the purpose of allowing to a large number of people to travel in a rapid and safe manner. After a period of some loss of importance for both individual and public road transport, railway systems have acquired a new role at the beginning of the 21st century, in line with the growing environmental concerns and sustainable development policies. The successive increase of road congestion and the continuous raising in the fuel prices make urban rail transport systems more attractive for the population. Therefore, many of the existing systems continue to expand their length, as well as new networks are built all over the world, even in medium-sized cities.

Scope of the study

Metro systems are conceived to provide urban areas with social and environmental benefits, increasing their levels of mobility and accessibility by offering a rapid, safe and reliable transport solution. As public service suppliers, metro systems do not regard financial profit as being their principal operational goal and they are usually explored by public entities (city councils, regional or central governments, etc.). Despite this fact, the systems should optimize their resources and improve their operational performance in order to become less of a burden on public finances (Dodgson, 1985; Nash, 2000).

This paper is concerned with the evaluation of the production of European metro systems rather than carrying out its cost analysis. Good reviews regarding studies about operational performance of transportation networks can be found in Dodgson (1985), Oum, Tretheway and Walters (1992) and De Borger, Kerstens, K., Costa et al (2002).

Our study includes an analysis of both heavy and light metros and takes into account data obtained in the operational period of 1990 to 2006.

For each system, the data is composed of internal variables (characterizing capital and labour), external variables (characterizing the urban area where the system operates), an service supplied characterizing indicator (place kilometres) in addition to a demand characterizing indicator (passengers)[210].

Two distinct analyses have been performed on the database in question[211]. Firstly, in the section entitled Estimation of production efficiency and effectiveness, a random coefficient stochastic frontier model has been used to process internal indicators and outputs in order to establish an optimal production function. This process has led to the following results:

1. Inputs elasticities of the optimal production function – represent the changing rate of the output caused by a 1% improvement of a given input, while the other inputs are maintained constant. This rate refers to an overview of all the systems.
2. Technical efficiency – represents the rate between the production achieved by each system and the optimal production for the available resources. In the case of the output being an

[210] Inputs and outputs data were collected either in the annual reports or in the available information in the web pages of the metro companies. External indicators were collected in the Eurostat (2008) web page, based on the European Large Urban Zones (LUZ) classification. The concept of LUZ has been created by the Eurostat and the National Statistics Offices of the different countries of the European Union at the occasion of the European Commission's Urban Audit of 2004, in an effort to harmonize definitions of urbanization in the European Union.
[211] Modelling estimation was made with the help of the econometric software *Limdep* (Greene, 2007).

service supplied characterizing indicator, technical efficiency has simply been referred to as efficiency. However, when the output was considered to be a demand characterizing indicator, it has been called effectiveness.

The production effectiveness is very influenced by social-economic environment of the urban areas on which metro systems operate. Therefore, in the following section, the influence of these external effects on effectiveness was evaluated by regressing the effectiveness results on external and internal companies' variables.

Estimation of production efficiency and effectiveness

Model description

Production function and technical efficiency

Production is, by definition, a process in which the available production resources (inputs) are used to obtain new products or services (outputs).

This transformation is represented by the production function, which shows the range of input/output combinations that lead to a technically efficient production process (Varian, 1992). In other words, the frontier production function $y=f(x)$ describes the minimum input quantities x required to obtain each quantity of output y.

Thus, any point (x,y) contained in curve $f(x)$ represents 100% technical efficient production processes. A company operating in a point (x_1,y_1) with $y_1<f(x_1)$ could become more efficient by approaching its production process with that optimal frontier $f(x)$, by either increasing its output using the same amount of input (x_1) or by producing the same amount of output (y_1) using less input ($x<x_1$). The points above the curve $f(x)$ represent production options which are technologically impossible to achieve.

The distance between points (x_1,y_1) and $(x_1,f(x_1))$ represents optimization flaws in the use of the available resources. Seeing that point $(x_1,f(x_1))$ is 100% efficient, technical efficiency (TE) in point (x_1,y_1) or in another generic point is obtained by Equation 1.

$$TE = \frac{y}{f(x)} \tag{1}$$

where y is the output produced by a company using x amount of input and $f(x)$ is the maximum output that can be obtained with the same amount of input. $f(x)$ is always greater than y and TE varies between 0 and 1, when the company achieves an optimal production process.

Cobb-Douglas production function

Equation 2 represents the general equation form of the single output production function.

$$y = f(x_1,\ldots,x_n) \tag{2}$$

where *x* and *y* are the amounts of inputs and output, respectively.

In this paper, the Cobb-Douglas function[212] has been used to establish the optimal frontier of the metro systems' operation. In the case of the single output, Cobb-Douglas takes the form of Equation 3 (Dodgson, 1985; Hooper, 1987).

$$y = \beta_0 \cdot x_1^{\beta_1} \cdot x_2^{\beta_2} \cdot x_3^{\beta_3} \cdot \ldots \cdot x_n^{\beta_n} \tag{3}$$

Linear form of Equation 3 is shown in Equation 4

$$\ln y = \beta_0 + \beta_1 \cdot \ln x_1 + \beta_2 \cdot \ln x_2 + \beta_3 \cdot \ln x_3 + \ldots + \beta_n \cdot \ln x_n \tag{4}$$

In the case, inputs elasticities (β_k for $1 \leq k \leq n$) are assumed to be constants.

Stochastic frontier model

The database collected in this study is a panel data sample, in which several producers (metro companies) provide the same type of public service (urban rail transportation), during a set of time of observations (annual). Subsequently, the panel data sample combines two classes of categories:

1. Cross section – Several producers acting in the same segment during a simultaneous observation.
2. Time Series – One producer acting in one segment for a particular set of time observations.

Due to the lack of information relating to production function, it is not possible to directly evaluate the efficiency of each company, thereby making it necessary to apply an econometric model, which may be deterministic or stochastic. Whilst in deterministic models, any deviation to the optimal frontier is attributed to the producer inefficiency, in stochastic models, that error is the sum of two components:

1. One side distribution error (u_i) – Encompasses the effects of technical inefficiency, hence it is always positive. u_i takes the form of an asymmetrical distribution.
2. Noise term (v_i) – Represents the portion of the error that is random from any one observation to the next, capturing the productivity effects which are not caused by the producer. These effects may, for example, be related to the environment in which a system operates (economy, strikes, etc.) or even to errors in data collection. A noise term may either increase or decrease the output and therefore may assume positive or negative values. As far as a random error is concerned, the probability of being favourable is assumed to be equal to the probability of being unfavourable to the production, so v_i takes the form of a normal and symmetrical distribution which is independent from u_i.

In this paper, a stochastic frontier model has been used due to the fact that it is most adequate for the analysis of the operational performance of transport networks, which largely depends on social and economical environment in which those systems operate (Greene, 2000). First stochastic models were introduced by Aigner, Lovell and Schmidt (1977) and by Meeusen and Van den Broeck (1977).

[212] The use of a more flexible production function such as the translog function was taken into consideration but it was subsequently rejected due to multicollinearity issues.

According to the deterministic models, the output y_i of the *ith* producer is provided by the production function multiplied by a coefficient of technical efficiency TE_i. Using the Cobb-Douglas function $f(x,\beta)$ (Equation 3) as a deterministic production frontier, it is possible to rewrite Equation 1 as it follows in Equation 5.

$$y_i = TE_i \cdot f(x_i, \beta) \tag{5}$$

where x_i is the vector of the inputs quantities strictly required to produce y_i amount of output and β is the vector of the function coefficients (β_0 is the constant and β_k for $1 \leq k \leq n$ are inputs elasticities).
The logarithmical transformation of Equation 5 is the result of Equation 6.

$$\ln y_i = \ln f(x_i, \beta) + \ln TE_i \Leftrightarrow \ln y_i = \ln f(x_i, \beta) - u_i \tag{6}$$

where $u_i = -\ln ET_i \geq 0$.

u_i is a measure of technical inefficiency, since $u_i \approx 1 - ET_i$. Therefore, technical efficiency of the *ith* producer is obtained by Equation 7.

$$TE_i = e^{-u_i} \tag{7}$$

As previously described, in stochastic models, a portion of inefficiency is attributed to a random error. Considering Equation 5 and Equation 7, the output of the *ith* producer estimated by stochastic modelling is provided by Equation 8.

$$y_i = TE_i \cdot f(x_i, \beta) \cdot e^{v_i} \Leftrightarrow y_i = f(x_i, \beta) \cdot e^{-u_i} \cdot e^{v_i} \Leftrightarrow y_i = f(x_i, \beta) \cdot e^{v_i - u_i} \tag{8}$$

where e^{vi} represents the noise term.
The technical efficiency of the *ith* producer, estimated by stochastic models, is then derived from Equation 9, in which the production deterministic frontier included in Equation 5 ($f(xi,\beta)$) is replaced by the stochastic frontier ($f(x_i,\beta)$. e^{vi}).

$$TE_i = \frac{y_i}{f(x_i, \beta) \cdot e^{v_i}} \tag{9}$$

Using the Cobb-Douglas function in addition to a logarithmical transformation in Equation 8 leads one to the stochastic model represented by Equation 10, in which the difference ε between the produced output y_i and the frontier $f(x_i,\beta)$ aggregates both errors terms (u_i and v_i).

$$\begin{aligned} &\ln y_i = \beta_0 + \beta_1 \cdot \ln x_1 + \beta_2 \cdot \ln x_2 + \beta_3 \cdot \ln x_3 + \ldots + \beta_n \cdot \ln x_n + v_i - u_i \Leftrightarrow \\ &\Leftrightarrow \ln y_i = \beta_0 + \beta_1 \cdot \ln x_1 + \beta_2 \cdot \ln x_2 + \beta_3 \cdot \ln x_3 + \ldots + \beta_n \cdot \ln x_n + \varepsilon_i \end{aligned} \tag{10}$$

where $\varepsilon = v_i - u_i$.

The total error ε takes the form of an asymmetric distribution. In this paper, a half-normal distribution for the error u_i has been adopted. These considerations are required to estimate technical efficiency, which is the efficiency fraction that directly depends on ability of producers to manage their resources, by stochastic models.

For each observation, the application of Equation 7 to estimate technical efficiency requires the previous evaluation of the error u_i. To estimate the value of $E(u_i|\varepsilon_i)$, which corresponds to the mean of its conditional distribution $f(u_i|\varepsilon_i)$, the approach proposed by Jondrow, Lovell, Materov, and Schmidt (1982) has been used. Therefore, it is possible to rewrite Equation 7 as:

$$TE_i = e^{-E(u_i|\varepsilon_i)} \tag{11}$$

As has been previously referred, technical efficiency may simple be called to as efficiency when it is related to service supplied characterizing indicators and as effectiveness when relating to demand characterizing indicators. Thus, being efficient does not necessarily means being effective and vice versa. So, it is possible to have a company that uses its resources effectively but which is not effective in attracting the public or, alternatively, a system that wastes resources and which is always overcrowded.

Data processing

In the estimation of the efficiency and effectiveness of European metro systems, the variables which have been considered are:

Inputs:

- Operational year (*YR*);
- Network length in km (*NL*);
- Number of stations (*NS*);
- Number of carriages (*NC*);
- Number of employees (*NE*);
- The existence of fare gates (*FG*);
- Dummy for number of employees (*DE*);
- Dummy for output (*DO*).

Outputs:

- Number of place kilometres;
- Number of passengers.

A stochastic frontier model has been applied to each output. The collection of data provided less available data for output place kilometres than for output passengers. Whilst in the latter case, 154 observations were available, in the former, only 121 observations were obtained.

In a number of observations, in particular when a company operates more than one transport system in the same urban area (metro, tram, bus, etc.), the number of employees (NE) as well as both output variables are only available for all of the systems as a whole. In order to obtain the influence of these over measured values in the output of the metro systems, two dummies (DE and DO) were created.

Thus, in the case of the number of employees or the output including other systems besides metro, the value 1 was considered, respectively. Should this not be the case, these values were considered to be null.

The operational year (variable time trend YR) has been considered as input in the model, in order to capture the effect of productive experience throughout time.

Despite the simultaneous inclusion in the model of the extension length and the number of stations could have introduced collinearity issues between these two variables, due to the fact that observed average distance between stations varies over a wide range, from 0.60 km to 1.45 km, both variables have been considered.

In addition to the variables already defined, FG is a dummy variable which was considered to be 1 when fare gate devices are used to control station entrances and 0 if this is not the case. It is expected that the inclusion of this effect will provide some control for the degree of automation of the system.

Unobserved firm-specific database heterogeneity is a direct consequence of the possible use of different variables measurement methods by each company, which may in turn influence productivity results. This is the case of the output and employees statistics which, as previously mentioned, in certain cases include the figures of more than one transport system operated by the company. Thus, a random parameter stochastic frontier model (Alvarez, Arias and Greene, 2004) that considers productivity floats which are not completely observable has been applied. The individual random coefficients are based on a single standard normal distribution and are only applied to DE and to the constant β0, in order to attenuate the main problem in data heterogeneity, namely, the over measurement of employees and outputs of some metro systems.

Results and discussion

Input elasticities

In Table 1 and in Table 2, respectively, input elasticities on the production of the output place kilometres and passengers are presented.

Table 1. Input elasticities on the production of place kilometres

Input	β	P[|Z|>z]
CONST	17.50	0.0%
YR	0.02	6.9%
NL	0.68	0.1%
NS	-1.31	0.0%
NC	1.00	0.0%
NE	0.18	0.7%
FG	0.61	0.0%

Table 2. Input elasticities on the production of passengers

Input	β	P[|Z|>z]
CONST	12.68	0.0%
YR	0.02	0.2%
NL	0.24	2.9%
NS	-0.69	0.0%
NC	0.61	0.0%
NE	0.60	0.0%
FG	0.11	8.7%

P[|Z|>z] or P-value is associated with the confidence interval of the coefficients, which is the measure generally used to represent the statistical significance level of the influence of inputs on the output produced. Most coefficients are statistically significant at a 5% level and none of them is above 10%. It is now possible to drawn some conclusions about each input influences on final outputs.

YR – Time increases the production of both outputs, reflecting positive technological changes. By maintaining all production resources constant, firms tend to produce more, because this allows them to gain experience in the production process. The influence of *YR* on outputs is very low, although it has been considered as being positive.

NL and *NS* – Infrastructural variables have a strong influence on the outputs produced. However, they do so in opposite directions. Whilst increasing network length tends to increase outputs, more stations means less production. The influence of *NL* on place kilometres is about three times greater than on passengers. In fact, hypothetical network expansion, with the number of stations and trains remaining fixed, implies metro systems to lower frequencies of passing trains. Consequently, in the output passengers, this influence is less marked. Although new network extensions could serve more population, the higher distances between stations persuade these users to resist altering their transportation habits. The increase in the number of stations implies strong breaks in the production of place kilometres and passengers. More stopping times mean less fluidity in the system and a greater difficulty in adjusting train schedules. Besides, the increase of travel times could make metro systems less competitive in comparison to other transportation facilities, particularly as far as longer journeys are concerned.

NC – The increase of the rolling stock increases to a large extent the production, with elasticities of 1.00 and 0.61 for output service supplied level and passenger, respectively. Being favourable to place kilometres, this means that, from a global perspective, European metro companies could put more trains on tracks without major congestion risks. In addition, with more rolling stock available, each firm would be capable of reducing frequencies and using more carriages per train. By reducing waiting times and offering the general public more space and comfort on board, companies become more appealing to the public thereby increasing passenger output.

NE – The increase of the number of employees raises the outputs produced. The elasticities are around of 0.18 and 0.60 respectively for output service supplied and passenger. This means that companies may be operating with some lack of labour force due to financial constraints. It seems as well that users may feel more attracted by more humanized systems, which generally achieve superior results in areas such as security or user support.

FG – The existence of fare gates benefits the production, but at a low impact levels. Although, this may cause some congestion at the station entrances, barriers tend to reduce unpaid travels thus increasing passenger numbers. However, the direction of causality is not clear: it may well be that it is the busiest and most heavily used systems that most require fare gates. The data did not allow us to explore this issue in greater detail.

Efficiency and effectiveness

For each observation of the outputs in the current study (place kilometres and passengers), efficiency and effectiveness are estimated through the use of Equation 11. However, in Figure 1, the averages of the achieved values for the last three available operational years[213] are presented for each system.

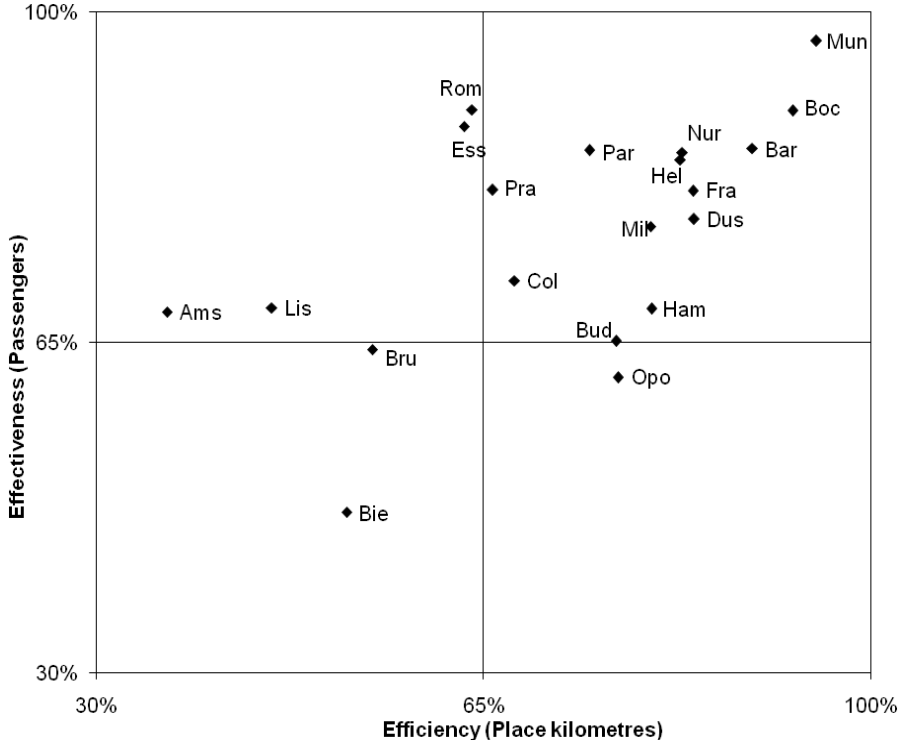


Figure 1. Efficiency and effectiveness of metro systems.

Efficiency and effectiveness values obtained by metro companies are consequence of two main factors:

1. Management policies.
2. Influence of external variables.

Management policies mainly influence the efficiency of the service supplied characterizing output (place kilometres). These practices are carried out by the administrators who determine input types

[213] Parisian results refer to the period dating from 1996 to 1998. From then on, only the output number of passengers was available.
Oporto results only refer to the last available year (2006). The system began in 2003 and was subject to a period of gradual expansion until 2006. Thus, technical efficiency in the early years is not comparable to the values obtained in the full operation years.
Results in Turin refer to the opening year of 2006, which is the only available data.

and quantities, as well as the technological level of the production process. In most metro systems, management policies are determined by financial constraints imposed by other public or private organisms.

The effectiveness of the demand characterizing output (passengers) is largely influenced by external variables, such as the demographic, economic and social features of the urban area served by the system in question, in addition to the competition presented by other transportation systems operating in the same area (other railway systems, bus, etc.). In fact, building a new metro network or expanding an already existing one is only justified in the case of the current transportation systems being overcrowded, or alternatively, if there is a lack of public transportation in the urban areas. Besides these factors, it is necessary to assure that a sufficient number of people served by the new tracks are receptive to using the system. Should these requirements be met, a non explored market share will have been created, which represents a possibility of achieving satisfactory effectiveness results.

However, there are a number of examples in which management policies have influence on effectiveness or external variables affect efficacy.

In the former case, good advertising campaigns and clean and secure stations are some of the many possible administration strategies oriented towards capturing more users for the systems in question. On the contrary, management practices that lead to inefficiency and poor providing services can bring about an indirect reduction of passengers and, consequently, effectiveness.

In the latter case, one may consider the example of the social-economic changes that lead to less demand. After a certain period, firms can try to adjust their business to the new circumstances by reducing the service they provide. Due to the fact that in the short term and from a technical viewpoint, it is very complex to reduce the inputs on infrastructure, rolling stock and labour, the cuts in the output service supplied will lead to an increase of inefficiency. Decisions regarding input cuts may be a sensitive issue that may raise some opposition amongst workers, who are afraid of losing their jobs, and amongst the actual community, who is concerned with reductions in the quantity or quality of the service provided by the metro company.

Contrary to these examples, the main effects of management policies are felt on efficiency, whilst effectiveness is affected by external dynamics. As a result, it is easier for the companies to improve their efficiency, seeing that they only need to rely on themselves to adopt the most effective management strategies possible.

The chart in Figure provides an overview on the efficiency and effectiveness of the metro systems which have been studied by presenting the available data in relation to both of the above mentioned outputs.

Results are displayed in quadrants, in order to facilitate comparisons amongst systems.

1st quadrant (efficiency and effectiveness above 65%) – The firms in this quadrant have achieved the best compromise between efficiency and effectiveness. They have managed their resources well and are simultaneously attractive to the general public.

2nd quadrant (efficiency from 30% to 65% and effectiveness above 65%) – The companies in this quadrant are those who depend more on themselves to achieve better results. As they have

obtained good effectiveness scores, they only have to improve their management strategies to move up into the first quadrant.

3rd quadrant (efficiency and effectiveness from 30% to 65%) – The firms in this quadrant presented the worse results of the group. Therefore, they need to simultaneously improve their management practices and policies, as well as to await more favourable changes in the socio-economic dynamics of the urban areas, so as to be capable of moving into the first quadrant.

4th quadrant (efficiency above 65% and effectiveness from 30% to 65%) – Metro systems in this quadrant are efficient. However, they need to attract a larger number of users. Consequently, companies are dependent on external dynamics to improve their effectiveness. Despite this, they should put in practice more aggressive market competitiveness policies, make more advertising campaigns, as well as improve security conditions and cleanliness in order to attract more passengers.

In terms of firms comparative analysis, Munich shows to be the best performing system, with the highest efficiency and effectiveness levels. On the contrary, Amsterdam has the least efficient system and Bielefeld has the least effective network. It is thus possible to conclude that most systems follow good management policies and are simultaneously attractive to the public. Consequently, they are placed in the first quadrant.

In this paper, obtained average efficiencies vary from 36% to 95% and effectiveness is placed between 19% and 97%. Technical efficiency of urban transportation systems varies over a very wide range. This is patent in the overview performed by De Borger et al (2002), where diverse authors' results vary from 24% to 100%[214]. From that study, it is highlighted the results obtained by Gathon (1989), who have performed a parametric frontier model (translog production function) and found technical efficiencies between 58% and 100%.

The results obtained in the current paper are also consistent with the results of the non-parametric frontier models performed in Wunsch (1994 and 1996) studies for urban bus and rail transportation systems. This author found average technical efficiency between 43% and 100%, using a FDH model, and between 26% and 100%, using a DEA model.

Influence of external indicators on production effectiveness

Methodology

External variables have been considered to have a significant influence on the effectiveness of metro systems. However, the effectiveness is also partially explained by the companies' resources in terms of capital and labour.

In order to estimate the influence of each indicator on effectiveness, a linear regression expressed by the following equation has been carried out:

$$\ln(EE) = \alpha_0 + \alpha_1 \cdot \ln x_1 + \alpha_2 \cdot \ln x_2 + \alpha_3 \cdot \ln x_3 + ... + \alpha_n \cdot \ln x_n + \varepsilon \quad (12)$$

[214] Studies included in De Borger *et al* (2002) have adopted distinct methodologies. Moreover, in some of those references, authors have considered other types of transportation systems in addition to metro networks. Despite this fact, the results obtained in the present study are consistent with the other authors' analysis.

where *EE* is the total effectiveness estimated in the previous part of the current analysis.
Coefficients β_k were replaced by α_k, in order to distinguish between external influences (α_k for $1 \leq k \leq n$) and input elasticities (β_k for $1 \leq k \leq n$).

Data processing

In the estimation of the influence of external indicators on the effectiveness of the European metro systems, the variables that have been used are:

Independent variables:

- Network length in km (*NL*);
- Number of carriages / Network length (*NC/NL*);
- Number of employees / Network length (*NE/NL*);
- Population density of the urban area in nr/m^2 (*PD*);
- Percentage of single person households (*SPH*);
- Gross Domestic Product *per capita* in EUR[215] (*GDP*);
- Number of registered cars per 1000 inhabitants (*RC*);
- Dummy for output (*DO*);
- The existence of tramway systems (*TR*).

Dependent variable:

- Total effectiveness (*EE*).

The internal indicators *NL*, *NC/NL* and *NE/NL* intend to capture the effects on effectiveness of possible relative growths of extension, rolling stock and labour force.

DO reflects the influence on effectiveness due to the fact of reported output include figures of other transportation systems run by the same company. Being this the case, *DO* assumed the value 1. Should this not be the case, the value in question was considered to be null.

TR was considered to be the value 1 when there are trams operating in the same urban area and the value 0 if this was not the case[216].

Results and discussion

Table 3 presents the influence of each internal and external variable on effectiveness.
Effectiveness is related to the distance from the operational point to the stochastic production frontier and expresses the optimization level of the available resources in the production of output passengers. In fact, effectiveness depends not only on the number of people transported, but also on the adaptation of the use of inputs to the amount of output produced. Thus, a system could transport more passengers and be considered to be less effective than another which uses quantities of inputs which are more suitable for the output produced. In this case, the latter company would be considered as being closer to the optimal production frontier, even if transporting an inferior amount of passengers.

[215] Converted at 2000 constant prices.
[216] The competition represented by the bus sector has not been considered, the existence of bus networks was a constant in all of the cities under analysis.

Table 3. Influence of internal and external variables on effectiveness

Indicator	α	P[|Z|>z]
CONST	-0.49	46.0%
NL	0.32	0.0%
NC/NL	-0.25	0.0%
NE/NL	0.06	0.7%
PD	-0.18	0.0%
SPH	-0.45	0.0%
GDP	0.10	7.1%
RC	-0.24	0.7%
DO	0.12	2.9%
TR	0.46	0.0%

Most of statistical significance levels for the results in Table 3 are situated below the maximum value of 5%, with the exception of the constant and the *GDP*. The significance level of the *GDP* remains under 10%.

Therefore, a number of conclusions relating to results may be drawn:

NL – Increasing the extension of metro systems has positive effects on effectiveness, which means that it is possible to expand metro networks and, at the same time, perform better on managing resources.

NC/NL and *NE/NL* – The increase of the rolling stock per kilometre of network extension reduces effectiveness. This result could mean that companies own more carriages than necessary for the service they provide, being some of those cars out of operation. If this is not the case, and the carriages are operating, a higher relationship between the rolling stock and the extension could mean higher frequencies of passing trains, which could lead to saturation of the networks, reducing effectiveness. On the contrary, the increase in 1% of the number of employees per kilometre of network extension seems to have a positive, but very small effect (0.06%) on effectiveness. Therefore, the excess of rolling stock is the internal factor that limits companies' effectiveness. In fact, metro systems are supposed to assure high frequencies of passing trains, and reducing the rolling stock as a mean of reducing service frequencies could have some opposition by the population served by the systems.

PD – The increase of population density seems to reduce effectiveness. In fact, in a city that is growing rapidly in terms of population, there is always the risk of overcrowding transportation systems if the expansion of the already existing networks or the creation of new ones has not been duly anticipated.

SPH – The increase of single person households reduces effectiveness. In the case of the European population, which is considered to be old and on the increase, many single person households are formed by elderly people, which generally have fewer mobility needs and more difficult in doing so.

GDP – The *GDP per capita* growth has positive effects on effectiveness. This is a natural result since *GDP* measures the wealth of urban areas. A prosperous economic environment

intensifies mobility needs. In such cases, firms have more financial conditions to invest in upgrading their productive process.

RC – As expected, increasing the use of private transportation has the opposite effect on public transports thereby decreasing their effectiveness.

DO – The operation of other transportation systems by the same company is favourable to the output. In such cases, it is easier to implement efficiently intermodality management measures. Also companies could adopt better practices to manage greater quantities of resources.

TR – Despite the risk of losing passengers to other transportation systems, the existence of internal competitors encourage firms to become more effective, through the management of their resources so as to approach the optimal production frontier.

The Porto metro case

Network characteristics

The Porto metro is a light rail system which serves six municipalities of the Porto Metropolitan Área (AMP): Maia, Matosinhos, Porto, Póvoa do Varzim, Vila do Conde e Vila Nova de Gaia.

Since the beginning of the commercial operation (on January 1st 2003) until the end of 2006, several network extensions have been built:

- 2003-01-01 – Trindade – Senhor de Matosinhos;
- 2004-06-05 – Trindade – Estádio do Dragão;
- 2005-06-13 – Senhora da Hora – Pedras Rubras;
- 2005-07-30 – Fonte do Cuco – Fórum da Maia;
- 2005-09-17 – Pólo Universitário – Câmara de Gaia;
- 2005-12-10 – Câmara de Gaia – João de Deus;
- 2006-03-18 – Pedras Rubras – Póvoa de Varzim;
- 2006-03-31 – Pólo Universitário – Hospital de São João;
- 2006-03-31 – Fórum da Maia – ISMAI;
- 2006-05-27 – Verdes – Aeroporto.

By December 31st 2006, the network had an extension of 58.9 km, being 6.8 km built underground within Porto city centre. All the vehicles in operation had three carriages.

The main characteristics of the Porto metro system (from 2003 to 2006) are presented in Table 4.

Table 4. Characteristics of Porto metro system

Year	Network Length (km)	Nr. of Lines	Nr. of Stations	Nr. of Vehicles	Nr. of effective Employees
2003	11.8	1	18	18	301
2004	15.6	1	23	26	314
2005	34.5	4	45	34	390
2006	58.9	5	69	66	432

Effects of the network expansion on the quantities of produced outputs

For the period between 2003 and 2006, we have analysed the effects of the experienced network expansions on the quantities of produced outputs. Figure 2 represents the production quantities of Porto Metro system.

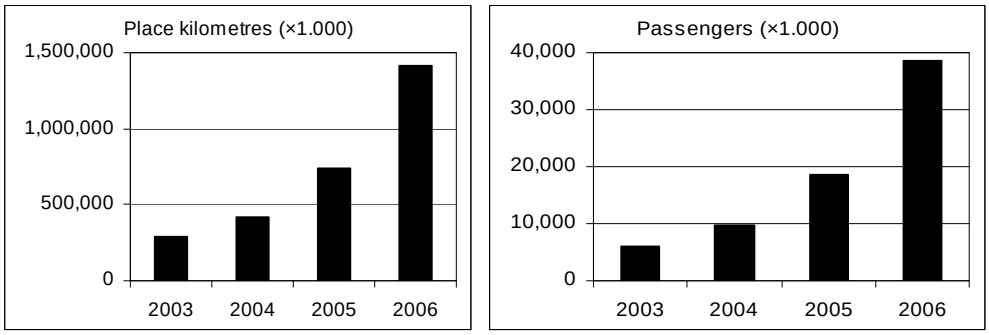


Figure 2. Quantities of outputs produced from 2003 to 2006.

Data contained in Figure 2 show strong annual production growths for both outputs. These successive increases have been related with the gradual change of habits and adoption of the new transport system by the population, but they are mainly caused by the extension of the network towards some important residential, commercial/services and industrial zones of AMP. Observing the different periods, some conclusions may be drawn:

o Annual growth between 2003 and 2004 – Production increases were 45% for place kilometres and 65% for output passengers. These are impressive values, attending to the fact that the network length was increased in just 3.8 km in 2004. However, the metro reached the Campanhã train station, the most important in Porto, where the metro is the fastest way to get to the city centre. In addition, the network began to serve Antas, a zone with high density of population and many public services at Loja do Cidadão. The biggest football stadium in northern Portugal is also located in Antas, being the metro very used by soccer fans, for example during the Euro 2004, in which Porto was a host city with two stadiums. Despite being occasional, sports events usually attract a large amount of users to public transport.

o Annual growth between 2004 and 2005 – Production increases were 75% for place kilometres and 88% for output passengers. The network was expanded in 18.9 km in 2005, doubling its length. The metro reached Maia with two lines, one of them going to the city centre. But the most important expansion occurred only in the last quarter of the year, when a new line connected the city centre of Vila Nova de Gaia to Asprela, across Porto city centre. This line serves, at the same time, the centres of the two most populated cities in northern Portugal and the Asprela zone, where are located most of the faculties of the University of Porto and other higher education schools.

o Annual growth between 2005 and 2006 **–** Production increases were 93% for place kilometres and 109% for output passengers. The network length was increased in 24.4 km in 2006. An old train line was converted to metro, which started to serve two other municipalities: Vila do Conde and Póvoa do Varzim. However, this line have been revealed to be unattractive for a

significant number of passengers of the old train, gathering complaints about the higher ticket prices, when compared with the old train, and , when compared with bus, the longer travel time to Porto city centre. Since 2006 it is also possible to get to the airport of Porto by metro, but it is a transport avoided by passengers carrying luggage. The extension to S. João Hospital, the most important in northern Portugal, was also not very important in attracting new users to the metro system, due to the fact that the metro already stops a few hundreds of metres from the hospital. The metro was also expanded within Maia, towards its industrial zone, which is one of the largest industrial areas in Portugal. Despite the positive effects of all those expansions in production numbers, the main cause of the large production growth observed in 2006 was probably the fact that was the first complete operational year of the line between Vila Nova de Gaia and Asprela, which the metro company recognizes as the line with more registered travels.

Effects of the network expansion on the efficiency and effectiveness

The relationships between the network expansion and the efficiency and effectiveness results are now analysed. In Figure , it is presented the evolution of production efficiency and effectiveness of Porto metro system.

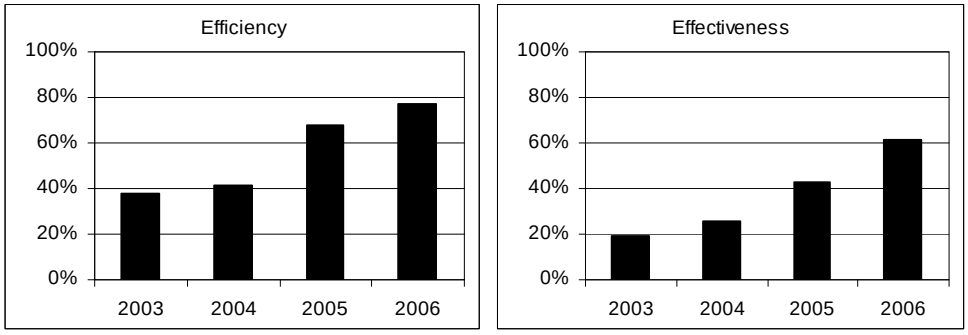


Figure 3. Efficiency and effectiveness from 2003 to 2006.

The successive annual increases in the quantities of outputs produced have positive effects on the efficiency and the effectiveness levels of Porto metro system. Comparing Figure 2 and Figure 3, the extensions experienced by the network which have been increasing the production from 2003 to 2006 are probably the main cause of successive increases in efficiency and effectiveness in the same period. Also the experience acquired over the operation years could help to improve management policies, increasing efficiency and effectiveness.

Overview of the operation of Porto metro system

Porto metro system presents efficiency levels of about 80%, which is a good score and reflects that the company manages well its resources. However, the effectiveness levels are lower (about 60%), which means that the system needs to attract more users.

One way of achieving this goal could involve expanding the network to the higher densely populated areas which are not too far away from the existing network. This policy could create a

significant increase in the number of passengers carried, with a smaller increase in the production resources, upgrading the effectiveness levels.

The lower effectiveness scores reflect the effects of the network expansion through rural and low density urban areas, far away from the city core. Although it is possible to travel longer distances in the same train, long lines across rural areas tend to have lower frequencies of passing trains, in order to reduce the operational costs of a line with low demanding levels. This could disappoint the users which expect high frequencies of passing trains in a metro system. In the Porto metro, the line between Porto and Póvoa de Varzim is the best example of a long rural line. This line has also the problem of most of its users are from Vila do Conde and Póvoa do Varzim, cities located at the end of the line. Thus, many inhabitants of these cities prefer to use direct buses to Porto, avoiding the many stoppages along the metro line.

However, the management policies of Porto metro company are not in the origin of these problems, since that the most of the extension of the current network was converted from old train lines to metro operation, according to financial restrictions and political issues.

Efficiency and effectiveness: comparing Porto with other European light metro systems

We now compare the performance of Porto metro system with other light metros. With the exception of Porto, the available data collected for the current study only encompass light metro systems in Germany. In Figure 4 are presented the efficiency and effectiveness levels[217] of light metros considered in this study.

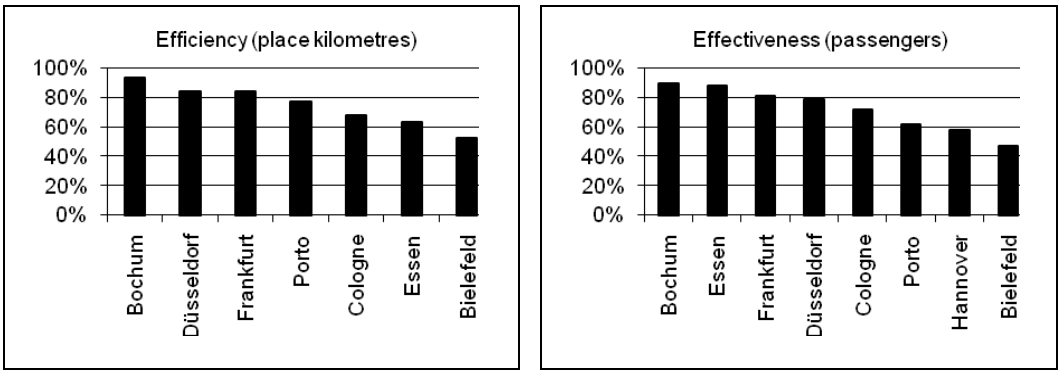


Figure 4. Efficiency and effectiveness of European Light metro systems.

Efficiency levels range from 53% of Bielefeld and 93% of Bochum. Porto registers a value of 77%, which is 2% above the average of all systems, meaning that Porto company adopts good practices in managing its productive resources. Effectiveness levels are placed between 47% of Bielefeld and 90% of Bochum, while Porto is 12% beneath the average value. This confirms the fact that Porto metro needs to attract more passengers in order to approach to the average of European light metro systems.

[217] German metros results refer to the mean of the achieved values for the last three available operational years. Oporto results only refer to the last available year (2006).

Bochum is the metro with better levels of efficiency and effectiveness, but the network consists in a 15 km single in a high densely populated area. On the opposite side is Bielefeld, whose lines go through some rural areas. In fact, the four worse performing networks in terms of effectiveness results (Bielefeld, Hannover, Porto and Cologne) have lines serving areas with low population density.

Conclusions

In this paper, an analysis of the operational performance of European metro systems has been carried out.

A stochastic frontier model, based in the Cobb-Douglas function, to evaluate inputs elasticities and systems technical efficiency of the production process of two outputs (place kilometres and passengers) has been used in the first section of this study.

Consequently, the variables which have positive elasticities on both outputs are: operational year, network length, number of carriages, number of employees and the existence of fare gates.
On the other hand, increasing the number of stations, i.e. decreasing average distance between stations, has been found to reduce outputs.

With regards to the registered levels of efficiency and effectiveness, one may assume that most of the systems have a good operational performance as far as these parameters are concerned.

In the second part of this study, the effectiveness has been regressed on external variables.

As such, the indicators most favourable to effectiveness results are: network length, number of employees per kilometre of network length, existence of tramway systems and Gross Domestic Product per capita. The companies which operate simultaneously other transportation systems than metro in the same urban area tend to be more effective.

The external variables whose expansion has negative effects on effectiveness are: number of employees per kilometre of network length, population density of the urban area, percentage of single person households and number of registered cars per 1000 inhabitants.

The third part of this study was focused on the Porto metro case. In the period between 2003 and 2006, the system registered successive increases both in the quantities of outputs produced and the efficiency/effectiveness of the production process. These growths were related to major network expansions built in the same period. This study does not consider data after 2006. The current network extension have been maintained practically constant since 2006, thus it is likely that large increases in the quantities of outputs and in the efficiency and effectiveness have no longer been observed in the latter operational years.

The efficiency of Porto metro is placed near the average value of other European light metros, while the effectiveness is 12% below. The main cause of Porto's lower performance in the effectiveness level could stand on a certain oversize of the network, namely the expansions through rural or low densely populated areas located far away from the core of the urban area. Lines with these characteristics are common among the networks with the lower effectiveness levels.

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Internal and external costs of transport in Portugal

Pedro Gomes*, Myriam Lopes, Helena Martins**, Jorge Carvalho***

* GOVCOPP, Unit of Social, Legal and Political Sciences

** CESAM, Department of Environment and Planning

University of Aveiro, serranogomes@ua.pt

Phone/fax numbers: 00 351 234372484 - 00 351 234372500

Urban dispersion (sprawl) is a reality, however unplanned it may be. Its supporters advocate contact with nature, space and intimacy; however, alleged disadvantages include land consumption, public infrastructure and mobility costs, and housing prices. The Research Project "Costs and Benefits of Urban Dispersion on a local scale" seeks to contribute to the debate with an objective approach based on the quantification of costs, externalities and benefits of different urban settlement patterns, thus "bringing urban form back to planning". This paper presents one of the Project's tasks, the one concerning mobility costs, both internal and external. Quantified internal costs include investment, inspection, insurance, energy and maintenance; external ones include accident and environmental costs, calculated for road and rail transport. Different methods are combined depending on available data sources in order to achieve figures for each of the cost components per vehicle-km, ton-km and passenger-km for 2005, at 2009 prices. Results show that internal costs are larger than external ones for the majority of motorized transport, except two-wheelers, and for rail. External costs are larger than internal ones for soft modes, mainly due to high accident costs. Cost components, both internal and external, related to fuel consumption are the most relevant in heavy modes' cost structures. Investment costs are the most important category for the majority of the remaining modes. Results also stress that current occupancy rates, load factors and vehicle mileages hinder the economic efficiency of collective and two-wheeled modes of transportation and may contribute to the pervasiveness of cars in Portugal.

Keywords: mobility costs, externalities, transport modes, urban dispersion

1 Introduction

The world's population is increasingly urbanized, yet today's city is quite different from the traditional, continuous and compact one. In the emergent city, social and spatial *rapports* have been transformed by mobility, while construction is intertwined with increasingly abandoned green spaces and land use patterns are fragmented and dispersed. This *city-territory* thus encompasses not only old compact and continuous cores but also fragments and dispersed development which, thanks to the spread of infrastructure and to an increasing mobility allowed by the car, have expanded to increasing vaster areas.

This phenomenon of urban dispersion[218] has not been supported by many key urban theorists - F. L. Wright's *Broadacre* is the most well-known exception (Wright, 1958) -, yet it is practised and consented, and increasingly so.

Urban dispersion has rightfully become the subject of several publications and research (e.g. Bauer and Roux, 1976; Indovina, 1990; Burchell, Lowesntein, Dolphin, Galley, Downs, Seskin. Still and Moore, 2002; Font, 2004; Portas, Domingues and Cabral, 2003) that acknowledge and describe it, but do so mainly on a regional or metropolitan scale. And there are not almost any studies on a local scale that, regarding dispersion as an urban form, compare it with other (compact) ones or that draw recommendations on how to plan it.

[218] The phenomenon is worldwide, but it carries its local idiosyncrasies, including in Portugal. We refrain from using the more pervasive term in Anglophone literature "sprawl", because it often has implicit morphologies when employed; "urban dispersion", on the contrary, gives room for Portugal's several morpho-tipologies of dispersed areas.

Still, and even if not particularly rigorous or based on solid evidence, arguments for and against dispersion have long been put forward in a debate that Breheny (1996) has summarised as opposing centrists to decentrists (Carvalho and Gomes, 2009; Martins, Lopes, Silva and Gomes, 2008):

- Apologists of dispersion claim contact with nature, spaciousness and intimacy as quality of life improvements, and lower real estate prices and congestion in roads as more objective advantages.
- Its detractors see dispersed environments as simulacra of nature, isolation and anonymity and as implying greater land consumption, infrastructure costs and a bigger number of trips and an increase in the use of private vehicles.

If dispersion is real and needs planning and regulation, then an opinion as precise as possible should be sought. That is the purpose of the project «Costs and Benefits of Urban Dispersion on a local scale»[219]: to contribute to the debate with an objective approach based on the quantification of costs, externalities and benefits of different urban settlement patterns on a local scale. It considers mobility costs (both internal and external) as well as local infrastructure costs; on the benefits vector, it will assess people's valuation of distinct settlement patterns.

This paper will present the results of one of the Project's tasks, that of the quantification of internal and external costs of transport in Portugal. These costs will subsequently be confronted with results from a large scale survey undertaken in two mid-sized Portuguese cities on residents' mobility patterns thus achieving mobility costs associated with different settlement patterns.

Mobility planning and management has become one of the most relevant issues in efforts towards urban sustainability: notwithstanding a myriad of mitigation efforts, namely in technology efficiency, transport's environmental impacts are yet to be curtailed, as increases in transport use offset gains in vehicle efficiency (Martins *et al.*, 2008).

One of the most pressing challenges mobility planning faces thus resides in changing people's mobility patterns. Studies on the relationship between land use and mobility patterns are one of the means by which answers have been sought. Another strand of research has focused on markets' functioning instead: transport users do not pay for all the costs caused by their trips, causing suboptimal prices and traffic volumes, where too low a price generally causes too high a traffic volume (Sirikijpanichkul, Iyengar and Ferreira, 2006). This strand of research seeks quantification of external costs (those not paid for by users) so that price internalization policies and mechanisms may be accordingly devised.

This Research Project will therefore contribute to both the aforementioned debates. On the one hand, presenting internal and external costs (per vehicle-, passenger- and ton-km) will allow comparisons among themselves that will shed light on the current transport system's alleged inefficiency. This data allows comparisons between the transport modes under scrutiny, which may prove useful for urban mobility scenario building and policy making. On the other hand, subsequent confrontation with data from the survey will address the debate on the relationship between settlement patterns and mobility.

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[219] «Costs and Benefits of urban dispersion on a local scale» is a Research Project funded by the Portuguese Science and Technology Foundation (FCT), coordinated by Jorge Carvalho. Project Reference: PTDC/AUR/64086/2006.

This paper is structured as follows: after the definition of concepts and research scope, a few remarks on data and methods employed will follow. Results for internal, external and integrated costs will then be presented. Concluding remarks will shed light on further developments and policy implications of the achieved results.

2 Definitions and methodology

2.1 Definitions and scope

Despite the consensus on definitions of internal and external costs – internal are those directly borne by transport users, whilst external are so by others than the users causing them – there are disagreements on the classification of certain components. Controversy, usually over accident and delay costs due to congestion, derives mostly from differing interpretations on the extent of cost internalization mechanisms' coverage of externalities (Baum, Geiβler, Schneider and Bühne, 2008) as well as distinct conceptual and methodological assumptions.

Internal costs may be divided into investment and operation costs. Investment ones are related to vehicle purchase, including its price, taxes and interest. Operation costs, in their turn, derive from vehicle operation and are dividable in fixed and variable ones; fixed costs are independent of intensity of use, such as legally imposed (in Portugal) circulation taxes and vehicle inspections while variable ones depend on the intensity of vehicle usage, including maintenance, tolls, parking and energy consumption, among others. There are other direct costs of transport such as those deriving from infrastructure development and maintenance, freight handling, labour, management, administration and organisation (e.g. Ricci and Black, 2005).

Among external costs, the most relevant ones are environmental (pollution, climate change, noise, nature and landscape depredation, and other impacts up- and downstream the transport), additional costs in urban areas (barrier effects and space shortage), accidents (medical care, production losses, pain and sorrow) and congestion (time wastes and increasing operation costs). (EEA, 2001)

Not all of the cost components listed for both internal and external costs will, however, be taken into account in this work, as the Project's goals, structure and methodology enforce certain decisions, even if they may go against mainstream research on mobility costs.

As the Project's purpose is not to establish users' expenses with transport (at market prices), rather mobility costs associable to different settlement patterns, per transport mode, (i.e. from a systemic/territorial standpoint), all cost components which are a consequence of internalization mechanisms were excluded from calculation as well as those aiming at financing the system's operation. Consequently, all taxes, tariffs and capital costs were subtracted from said market prices. Moreover, all costs concerning infrastructural development and maintenance have also been discarded, as these are the subject of another of the Project's tasks (see above). This exclusion also applies to external costs deriving from infrastructure, for the same set of reasons.

Another issue influencing choice of cost components is the type of cost studied, usually average and/or marginal costs. In this study, as its purpose is to compare costs between different urban settlement forms, average costs were chosen. The objective is not to calculate costs of

additional vehicles in the system, but that that of the average mobility pattern associable to a given land use pattern (Carvalho and Gomes, 2009).

Therefore, external costs will not take into account congestion costs either, as «parts of the congestion costs are 'paid' by waiting and delay costs of the users, others, namely those imposed on other users, are not. The measurement of the external part has to consider congestion dynamics. Since marginal costs are above average costs with increasing congestion, the difference between these two levels are considered as [the] external part, since average costs are paid by the user» (Maibach, Schreyer, Sutter, van Essen, Boon, Smokers, Schroten, Doll, Pawlowska and Bak, 2008: 14). As this Project deals exclusively with average costs and these are internalised within transport users, then they should not be taken into account in this context.

Consequently, the following cost components were analysed: in internal costs, investment, insurance, inspection, energy and maintenance costs; in external costs, accident, air pollution, climate change and noise costs.

Choice of transport modes was influenced by the case studies' characteristics (namely by dictating that some, such as metro, trams and fluvial transport, needed not be included). Road, including non-motorized modes, and rail transport were analysed. Some modes, like heavy duty vehicles and freight rail, despite not being relevant for the survey, were still included, in order to give a fuller picture of the Portuguese transport system. In the end, the following transport modes were considered: passenger cars, light duty vehicles, buses and coaches, heavy duty vehicles, mopeds, motorcycles, bicycles, pedestrians and passenger and freight rail transport[220].

2.2 Methodology

The purpose of this study is, then, to achieve average integrated (or social) costs per transport mode, encompassing both internal and external ones, so that costs of mobility patterns associable to different settlement patterns may be calculated and compared with other costs and benefits.

Average costs (€/vehicle-km, €/passenger-km, €/ton-km) were sought for each transport mode, taking into account each one's different average lifetimes, mileages and occupancy rates or load factors.

The costs' reference year is 2005, except when stated otherwise. However, monetary values were inflated to 2009 prices via Eurostat's Consumer Price Index, so that comparability with data on benefits derived from the survey is possible.

Whenever available, secondary data was used, sometimes combining distinct sources; otherwise, primary data was gathered via several enquiries to local stakeholders and agents. Depending on available sources, approaches for cost calculation were either top-down (departing from aggregate values for the whole of the vehicle fleet) or bottom-up (identifying costs for one single average vehicle). Table 1 summarizes the diversity of data sources and methods used in calculating internal costs. "N/A" stands for "Not Applicable", meaning the cost component in question was not calculated for that transport mode. A note should be made on pedestrians, for whom no internal costs were calculated. As all costs are referenced to a vehicle, the pedestrian, as a "vehicle", is assumed in all transport modes. Accordingly, arguments, such as Litman's (2009), on the higher caloric needs of

[220] Results for rail are still provisional.

pedestrians and cyclists and estimates on shoes' cost and average lifetime were not taken into account either.

Studies on external costs are more abundant, yet results reached are varied, depending both on differing conceptual and methodological options (including type of cost) and on the «specifics of the situations» (Quinet, 2004), namely countries' distinct settlements patterns and vehicle fleets. Therefore, only sources dealing with average costs were considered and, within these, those relating specifically to Portugal were privileged. Three sources fulfilling these prerequisites were found: INFRAS/IWW (2000; 2004) and Macário, Carmona, Caiado, Rodrigues, Martins, Link, Stewart, Bickel and Doll (2003).

Having compared these three sources, data from INFRAS/IWW (2004) were chosen. However, some adjustments had to be made so that these data would answer research goals laid out, because, unlike the 2000 version of the study (INFRAS/IWW, 2000), this report does not present national data disaggregated per cost component. Such disaggregation was needed, as some of the cost components stem from infrastructure (nature and landscape, additional costs in urban areas and upstream and downstream effects) and had, therefore, to be excluded. To do so, the Portuguese cost structure from the 2000 study, referring back to 1995, was used, for there are substantial differences between the Portuguese and European situations, as their cost structures portray.

Moreover, the report does not contemplate soft transport modes (bicycles and pedestrians). It was assumed that these modes do not have any environmental costs, but accident costs still had to be determined. This was done by crossing data on accident victims per transport mode and type of casualty in 2005 in Portugal (INE, 2006) with external accident costs per victim and casualty type according to INFRAS/IWW (2000; 2004). This method was then applied to the remaining transport modes, because they not only relate directly to the Portuguese reality, but also refer back to data from the original source of the remaining cost components. Accidents costs calculated with this method are generally higher than those achieved by simply applying the national cost structure from 1995 to average total external costs in 2000.

3 Results

3.1 Internal costs

Table 2 presents vehicle fleet characteristics in Portugal in 2005. Tables 3, 4 and 5 display results for internal costs in Portugal in 2005, in €/vehicle-km, €/passenger-km and €/ton-km, respectively, and Figure 1 shows each transport mode's cost structure. When interpreting the results, it is important to bear in mind that the figures do not include capital costs nor taxes, which may mean, in some of the cost components, costs much lower than market prices. One should also keep in mind that, generally, figures describe the Portuguese situation and fleet use, which is determining when explaining some of the results.

Table 1. Data sources and methods for vehicle fleet characteristics and internal costs calculation

	Transport Mode								
Variable	Passenger Cars	Light Duty Vehicles.	Buses and Coaches	Heavy Duty Vehicles	Mopeds	Motorcycles	Bicycles	Pedestrians	Rail
Nb, of Vehicles	Pereira *et al.* (2009)[221]	Pereira *et al.* (2009)	Pereira *et al.* (2009)	Pereira *et al.* (2009)	Pereira *et al.* (2009)	Pereira *et al.* (2009)	From The Gallup Organization (2007) e INE (2009)	From INE (2002; 2009)	Enquiry to CP (National Railway Service)
Vehicle fleet: age structure	ACAP (2006)	ACAP (2006)	ACAP (2006)	ACAP (2006)	Due to absence of specific data, assumed to be equal to motorcycles	ACAP (2006)	N/A	INE (2009)	N/A
Average lifetime	Enquiry to VALORCAR	From VALORCAR e ACAP (2006), analogy with passenger cars.	Enquiry to 6 service providers.	From ACAP (2006), analogy with buses and coaches	Due to absence of specific data, assumed to be equal to motorcycles.	From ACAP (2006), analogy with passenger cars.	From literature and enquiry to 2 repair shops.	INE (2007)	Enquiry to CP
Vehicle mileage	Parlamento Europeu (2008)	Parlamento Europeu (2008)	Enquiry to 6 service providers.	From Parlamento Europeu (2008), analogy with buses and coaches	Pereira *et al.* (2009)	Pereira *et al.* (2009)	From Alonso (2009)	Transportation Research Board (2000)	Enquiry to CP
Load factor / Occupancy rate	From INFRAS/IWW (2004)	From INFRAS/IWW (2004)	From INFRAS/IWW (2004)	From INFRAS/IWW (2004)	Due to absence of specific data, assumed to be equal to motorcycles	From INFRAS/IWW (2004)	Litman (2009)	N/A	From enquiry to CP and CP (2006)
Investment costs	Bottom-up; from AutoFoco n.º 292	Bottom-up; from AutoFoco n.º 292	Bottom-up; enquiry to 8 service providers and manufacturers	Bottom-up; enquiry to 7 service providers and manufacturers	Bottom-up; from Motociclismo n.º 174	Bottom-up; from Motociclismo n.º 174	Bottom-up; from literature and enquiry to 4 establishments.	N/A	Top-Down; from enquiry to CP and CP (2007)
Inspection costs	Bottom-up; from applicable legislation: DL 55/99, Portaria 1468/2004	Bottom-up; from applicable legislation: DL 55/99, Portaria 1468/2004	Bottom-up; from applicable legislation: DL 55/99, Portaria 1468/2004	Bottom-up; from applicable legislation: DL 55/99, Portaria 1468/2004	N/A	N/A	N/A	N/A	N/A

[221] Full reference: Pereira, T. C., Seabra, T., Maciel, H., Torres, P. (2009), Portuguese National Inventory Report on Greenhouse Gases, 1990-2007. Submitted under the United Nations Framework Convention on Climate Change and the Kyoto Protocol, Agência Portuguesa do Ambiente. Amadora.

	Transport Mode								
Variable	Passenger Cars	Light Duty Vehicles.	Buses and Coaches	Heavy Duty Vehicles	Mopeds	Motorcycles	Bicycles	Pedestrians	Rail
Insurance costs	Bottom-up; from enquiry to 2 insurance companies.	Bottom-up; from enquiry to 2 insurance companies.	Bottom-up; from enquiry to 2 insurance companies.	Bottom-up; from enquiry to 2 insurance companies.	Bottom-up; from enquiry to 2 insurance companies.	Bottom-up; from enquiry to 2 insurance companies.	Bottom-up; FPCUB (2010)	N/A	N/A
Energy costs	Bottom-up; combining several sources from fuel consumption	Bottom-up; combining several sources from fuel consumption	Bottom-up; combining several sources from fuel consumption	Bottom-up; combining several sources from fuel consumption	Bottom-up; combining several sources from fuel consumption, inc. enquiry to 4 repair shops.	Bottom-up; combining several sources from fuel consumption, inc. enquiry to 5 repair shops.	N/A	N/A	Top-Down; from enquiry to CP
Maintenance costs	Santos, Santos and Cavaleiro (2008)	Due to absence of specific data, same figures as passenger cars' were used.	Bottom-up; Enquiry to 6 service providers and manufacturers.	Bottom-up; Enquiry to 6 service providers and manufacturers.	Bottom-up; survey to 4 authorized repair shops.	Bottom-up; enquiry to 5 authorized repair shops.	Bottom-up; from literature and enquiry to 2 establishments	N/A	Top-Down; from enquiry CP

Table 2. Vehicle fleet characteristics per transport mode in Portugal, 2005[222]

Transport mode	Number of vehicles	Average lifetime (years)	Average mileage throughout lifetime (km)	Average annual mileage (km)	Occupancy rate (passenger/vehicle) or Load factor (tons/vehicle)
Passenger cars	4.795.147	17,9	200.000	11.187	2,28
Light duty vehicles	788.018	15,1	250.000	16.544	0,75
Buses and coaches	12.558	16,8	1.102.778	65.642	17,1
Heavy duty vehicles	157.586	16,1	1.378.472	85.651	5,1
Mopeds	330.538	12,3	57.033	4.620	1,12
Motorcycles	157.040	12,3	46.145	3.738	1,12
Bicycles	105.696	7	11.038	1.577	1
Pedestrians	10.018.980	78,2	34.408	440	N/A
Passenger rail[223]	350	32,5	2.789.151	85.820	114
Freight rail	89	32,5	2.789.151	85.820	316

Table 3. Internal costs per transport mode in Portugal, 2005 (€/vehicle-km)

Transport mode	Investment costs	Inspection costs	Insurance costs	Energy costs	Maintenance costs	Total (internal costs)
Passenger cars	0,089	0,002	0,023	0,045	0,016	0,229
Light duty vehicles	0,061	0,002	0,016	0,039	0,016	0,142
Buses and coaches	0,165	0,001	0,018	0,227	0,144	0,643
Heavy duty vehicles	0,070	0,001	0,009	0,197	0,050	0,329
Mopeds	0,033	0,000	0,032	0,014	0,015	0,094
Motorcycles	0,149	0,000	0,066	0,024	0,037	0,288
Bicycles	0,019	0,000	(0,027)	0,000	0,013	0,032[224]
Pedestrians	0,000	0,000	0,000	0,000	0,000	0,000
Rail	1,791	0,000	0,000	0,879	1,377	4,048

In €/vehicle-km (Table 3), rail transport is undoubtedly the most costly of all, but this should be relativized given trains' carrying capacity, In motorized road transport, buses and coaches and heavy duty vehicles have the highest costs, namely the former, due to high fuel consumption and maintenance costs. Maintenance is significantly more expensive for buses and coaches, probably due to intense use and tighter safety and maintenance requirements given the type of service provided. Motorcycle costs are quite costly, more so than passenger cars; this occurs because the proportion of big-engined and more expensive motorcycles is quite high and vehicle mileage is quite

[222] Figures in this and following tables have been rounded a posteriori, hence the apparent mismatches that may appear on occasion.

[223] Calculation of number of vehicles (motor units) for rail transport were only possible by assuming equal mileages for every train, as data on number of vehicles was aggregate, not distinguishing between vehicles providing passenger and freight transport.

[224] As insurance is not compulsory for cyclists, this cost component was not included in the totals for this transport mode: insured cyclists were assumed to be marginal in the overall population.

low. Enquiries to repair shops have suggested that for many users, use is quite seasonal or restricted leisurely use on week-ends and holidays. Mopeds are, by far, the least costly of all motorized modes. Bicycles are the cheapest of all modes, besides pedestrians for whom no internal costs were calculated, as previously stated.

Figure 1 shows that investment costs are the most important component for all modes, besides heavy duty vehicles and buses and coaches, where energy costs prevail. Insurance costs are the second most expensive component for motorcycles and mopeds, and almost as relevant as investment ones. Energy costs rank second for passenger cars and light duty vehicles. Inspection costs, when applicable, are negligible.

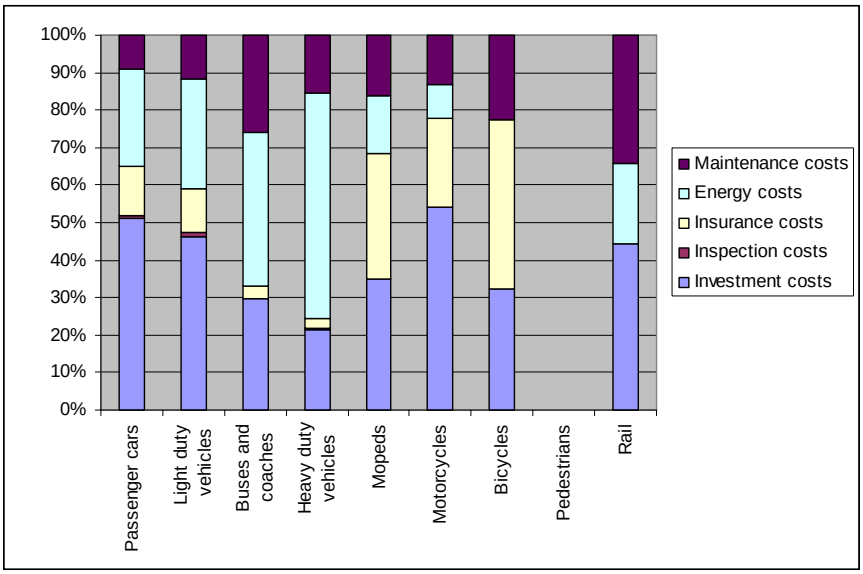


Figure 1. Internal cost structure per transport mode.

Costs per passenger-km (Table 4) and ton-km (Table 5) show how important intensity of use (mileages and occupancy rates/load factors) is for the transport system's rationality. Accordingly, motorcycles and mopeds are the most expensive transport modes and passenger cars are only about 2,5 times more expensive than buses and bicycles, contradicting much of the common sense and widespread opinions. From a strictly financial standpoint, it does seem that the passenger car is not an overly irrational choice; even more so if one bears in mind that transit systems have high management and organization costs which have not been accounted for in this piece of research. For example, Carris' fleet's operation costs (excluding fuel and vehicle components' substitution) mounted to 1,272 €/vehicle-km and 0,069 €/passenger-km in 2008.

Table 4. Internal costs per transport mode in Portugal, 2005 (€/passenger-km)

Transport mode	Investment costs	Inspection costs	Insurance costs	Energy costs	Maintenance costs	Total (internal costs)
Passenger cars	0,039	0,001	0,010	0,020	0,007	0,078
Buses and coaches	0,010	0,00006	0,001	0,013	0,008	0,032
Mopeds	0,029	0,000	0,028	0,013	0,014	0,084
Motorcycles	0,133	0,000	0,059	0,021	0,033	0,246
Bicycles	0,019	0,000	(0,027)	0,000	0,013	0,032
Pedestrians	0,000	0,000	0,000	0,000	0,000	0,000
Passenger rail	0,016	0,000	0,000	0,008	0,012	0,036

Table 5. Internal costs per transport mode in Portugal, 2005 (€/ton-km)

Transport mode	Investment costs	Inspection costs	Insurance costs	Energy costs	Maintenance costs	Total (internal costs)
Light duty vehicles	0,082	0,002	0,021	0,052	0,021	0,180
Heavy duty vehicles	0,014	0,0002	0,002	0,039	0,010	0,064
Freight rail	0,006	0,000	0,000	0,003	0,004	0,013

3.2 External costs

Tables 6 to 8 present external costs of transport in Portugal, at 2009 prices, in €/vehicle-km, €/passenger-km and €/ton-km, respectively. Figure 2 portrays external cost structure per transport mode.

Table 6. Average external costs per transport mode in Portugal, 2000 (€/vehicle-km)

Transport mode	Accidents[225]	Noise	Air pollution	Climate change	Total (external costs)
Passenger cars	0,017	0,005	0,017	0,021	0,061
Light duty vehicles	0,017	0,010	0,041	0,061	0,129
Buses and coaches	0,012	0,017	0,199	0,147	0,374
Heavy duty vehicles	0,002	0,026	0,137	0,093	0,258
Mopeds	0,157	0,009	0,004	0,012	0,182
Motorcycles	0,524	0,009	0,004	0,012	0,549
Bicycles	0,558	0,000	0,000	0,000	0,558
Pedestrians	0,094	0,000	0,000	0,000	0,094
Passenger rail	0,598	0,644	0,732	0,925	2,899
Freight rail	0,000	1,970	2,332	2,890	7,192

[225] Referring to 2005, except for rail transport, for whom data derived from INFRAS/IWW (2000; 2004) was maintained.

Table 7. Average external costs per transport mode in Portugal, 2000 (€/passenger-km)

Transport mode	Accidents	Noise	Air pollution	Climate change	Total (external costs)
Passenger cars	0,008	0,002	0,008	0,009	0,027
Buses and coaches	0,001	0,001	0,012	0,009	0,022
Mopeds	0,140	0,008	0,004	0,011	0,162
Motorcycles	0,468	0,008	0,004	0,011	0,491
Bicycles	0,558	0,000	0,000	0,000	0,558
Pedestrians	0,094	0,000	0,000	0,000	0,094
Passenger rail	0,006	0,007	0,008	0,010	0,030

Table 8. Average external costs per transport mode in Portugal, 2000 (€/ton-km)

Transport mode	Accidents	Noise	Air pollution	Climate change	Total (external costs)
Light duty vehicles	0,023	0,014	0,055	0,081	0,173
Heavy duty vehicles	0,000	0,005	0,027	0,018	0,051
Freight rail	0,000	0,008	0,010	0,012	0,030

In €/vehicle-km (Table 6), rail transport has the highest external costs, especially freight transport, due to its greater environmental impact. In road transport, bicycles and motorcycles come first, mostly because of accident costs. Heavy modes (duty vehicles and buses) come next, mopeds, light duty vehicles, pedestrians and, finally, passenger cars. Soft modes and two-wheelers are often thought to have lower external costs, but low vehicle mileage and high accident rates lead to results that suggest otherwise.

Analysing environmental costs (i.e. excluding accident costs) of road transport, heavy vehicles cause the highest costs, followed by light ones; motorized two-wheelers' are considerably lower. As previously stated, soft modes were assumed not to have any environmental costs.

In €/passenger-km (Table 7), the situation is different. Two-wheelers bear the highest external costs, bicycles coming first. Two-wheelers are followed by pedestrians, rail transport and passenger cars. Buses and coaches have the lowest costs. Environmental costs are somewhat similar for all motorized transport modes.

In freight transport (€/ton-km, see Table 8), external costs are lowest for rail and light duty vehicles are the most costly. The same applies to environmental costs.

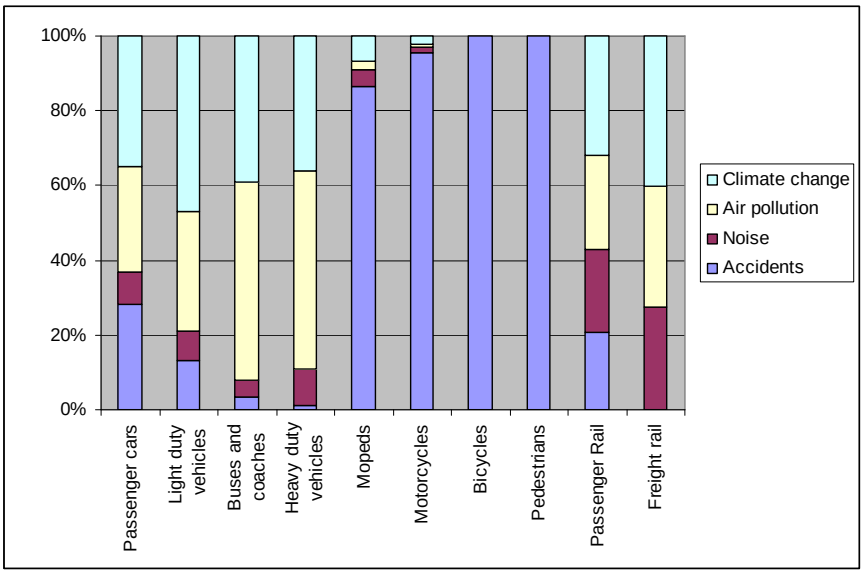


Figure 2. External cost structure per transport mode.

The analysis of each transport mode's cost structure (Figure 2) highlights the prevalence of accident costs in soft modes and in motorized two-wheelers. Even in absolute terms, cost figures for this component are quite high, stressing the necessity of measures aiming at the reduction of accident rates and that take into account these transport modes' specificities, more liable to severe injury and fatality.

Conversely, environmental costs are more relevant in the remaining transport modes, particularly in heavy modes. Among these, costs stemming from fuel consumption (air pollution and climate change, consequent of polluting gases and particles emissions, including GHG) are most important. Considering vehicle fleets' characteristics, stimulating their renewal, adopting more efficient technology and less polluting fuel, may be one way to reduce their environmental impact.

Occupancy rates and load factors arise, once again, as a very relevant factor for introducing rationality and efficiency into the system, as results challenge many established ideas. Road accidents are most definitely a pressing issue to be dealt with when acting upon the transport system.

3.3 Integrated costs

Integrated costs are the sum of internal and external ones. Figures 3 to 5 present them in €/vehicle-km, €/passenger-km and €/ton-km, respectively.

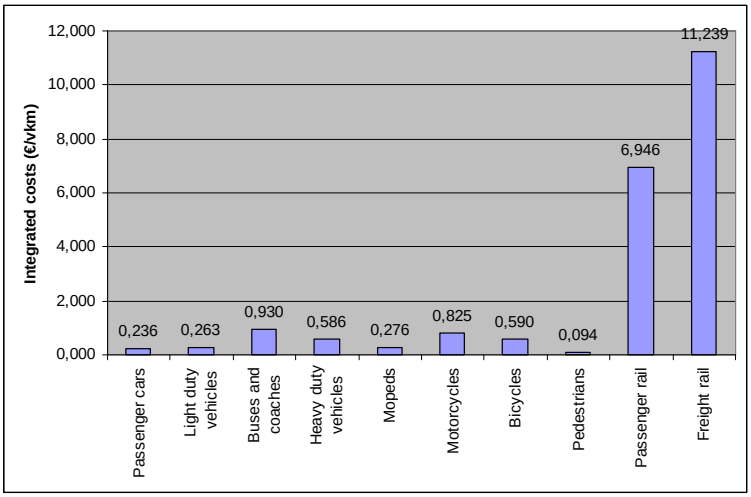


Figure 3. Integrated costs per transport mode (€/vehicle-km).

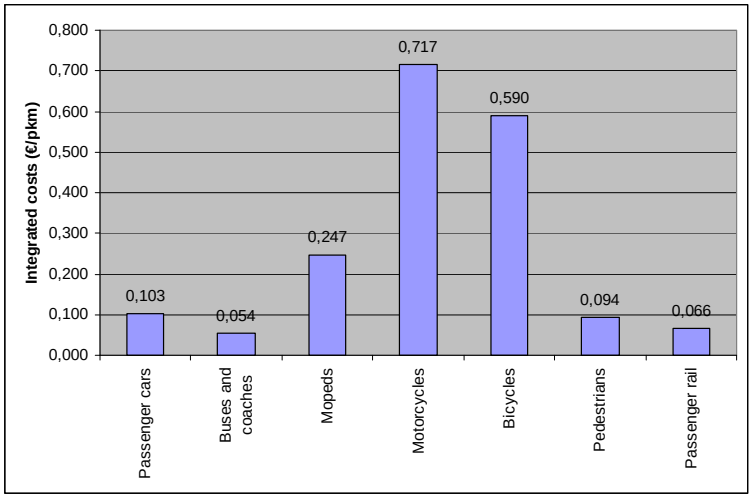


Figure 4. Integrated costs per transport mode (€/passenger-km).

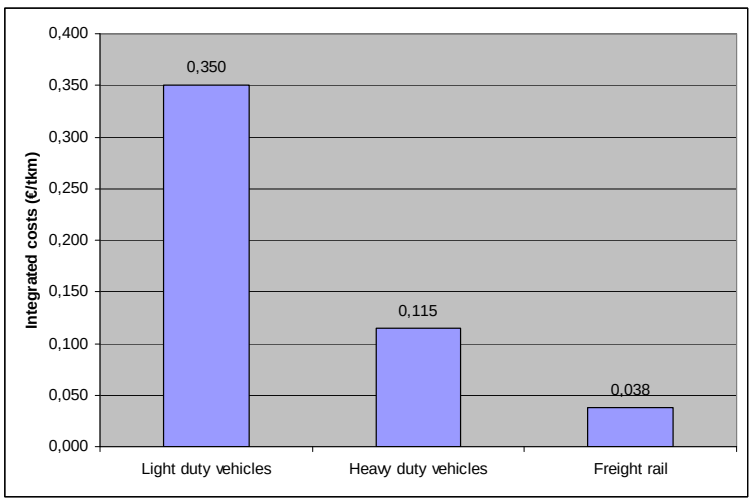


Figure 5. Integrated costs per transport mode (€/ton-km).

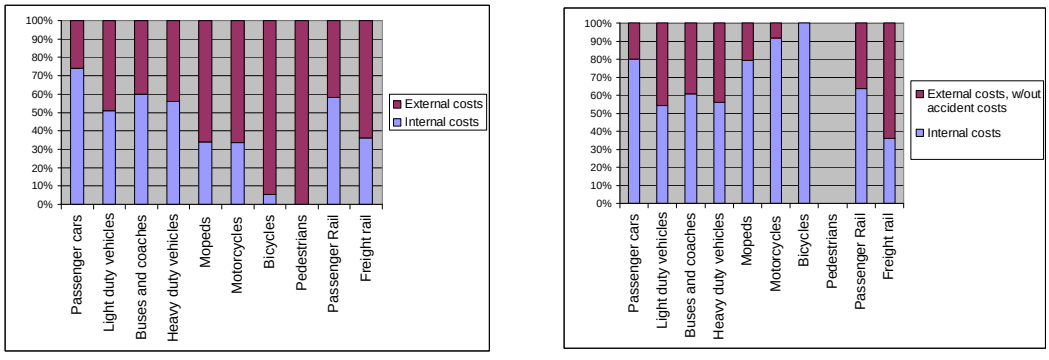
Final results challenge, once again, some of the preconceptions on the transport system. Mostly due to their low mileages and high accident costs (and, naturally, due to necessarily low occupancy rates), motorcycles and bicycles undoubtedly have the highest costs per passenger-km. Mopeds' integrated costs come third, but are quite lower than the previous two's. Yet, they almost double the following mode's costs, passenger cars, which, in turn, are only slightly higher than pedestrians', who only present accident costs. Collective transport modes have the least costs, but these are "only" half of passenger cars', which may lead to questioning, once again, whether massive use of private cars is as irrational as some claim.

In freight transport, heavy duty vehicles and freight rail are clearly less costly than light duty transport. Cost differentials between the three modes stress the need to plan and implement freight transport by articulating them.

Internal and external costs' relative weights (see Figure 6) vary between transport modes, between 74%/26% for passenger cats and 0%/100% for pedestrians. External costs are particularly relevant in soft modes and motorized two-wheelers, mostly due to high accident costs. Freight rail also presents external costs higher than internal ones, but due to its environmental impact.

As accident costs are often determinant in final results and given that a lot of the research on the external costs of transport derives from environmental concerns, we present the relative weights of internal and external costs without accident costs (Figure 6).

By excluding accident costs from calculations, external costs' relevance in integrated ones changes; internal costs become more relevant in practically every transport mode, ranging from about 60% (passenger rail and light duty vehicles) and 100% (bicycles). Freight rail remains the exception, as it has no external accident costs. External costs' absence of soft modes thus underlines their proclaimed environmental sanity.



a) b)

Figure 6. Share of Internal and external costs of transport in Portugal (%): a) in average integrated costs b) excluding accident costs.

4 Conclusions

Results put under discussion two widespread ideas about the transport system that apparently deserve more cautious treatment and further study: public transport's efficiency vis-à-vis the passenger car and bicycles' statute of a quasi-panacea for urban mobility.

Results showed that the cost differentials between buses and coaches and passenger cars are not as common sense has it. This is naturally contingent of the Portuguese reality that the data describe; for public transport's efficiency, increasing occupancy rates is fundamental, so that high costs per vehicle-km are offset. Yet, it remains unclear whether the increased costs that efforts to improve service levels that compete with the private car and therefore boost occupancy rates entail would imply would actually lead to a decrease in costs per passenger-km. Transport modelling along with cost-benefit analysis could shed some light on these matters.

However, public transport's efficiency may also be increased by decreasing its costs per vehicle-km. Results confirmed energy/fuel as one of the major issues in urban transport, including buses and coaches: not only do energy costs play a relevant role in direct costs, but external costs caused by emissions are still relevant. Considering buses and coaches' vehicle fleets' characteristics, its renewal for more recent, energy efficient vehicles and adoption of cleaner fuels could contribute to decreasing their costs per vehicle.

These results do not include organization, operation and administrative costs for public transport systems; these have to be taken into account when planning for mobility.

Perhaps more unexpected is bicycles ranking first in integrated costs per passenger-km. This is mostly due to extremely high accident costs which clearly indicate that road safety for cyclists has to be a priority if cycling is to be encouraged by policy makers. Yet, and perhaps more importantly, these results have to be questioned: it is possible that cycling is particularly unsafe in Portugal and, consequently, there is a greater incidence of accidents and casualties. It is, then, important to undertake a comparative analysis with countries, such as the Netherlands, where bicycle use is much more prevalent than in Portugal and where there are better conditions for doing so. Such analysis will shed light on whether so high an accident cost is something contingent of the Portuguese situation or if it is somewhat intrinsic to bicycle use.

What these results show clearly is that different transport modes have different vocations and mobility planning should take advantage of said vocations in order to ensure the highest cost-effectiveness possible. But any strategy aiming at sustainable mobility must clearly understand and address people's behaviour and mobility patterns. Results from the survey to the case studies' residents will give greater insight into the specifics of their behaviour, allowing greater rigour and detail in analysis, scenario building and policy making.

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Mobility in daily life – two case studies in Lisbon Metropolitan Area

Eduarda Costa, Ana Louro

Centre of Geographical Studies – Institute of Geography and Spacial Planning (CEG – IGOT)

eduardamcosta@netcabo.pt; analouro@campus.ul.pt

Phone/fax numbers: + 351 21 794 02 18 / +351 21 793 86 90

Mobility is one of the most important aspects to consider in sustainable urban planning. At the same time, the personal choice of transportation mode by families and their routes for daily moves can configure a more or less sustainable city. The paper[226] presents an analysis of travel behavior in context of two neighborhood of Lisbon Metropolitan Area (LMA). This line of thought leads to the objective of the work: understand, in context of Lisbon Metropolitan Area, on the one hand, the level of accessibility within the neighborhoods studied and their link to other points on LMA, on the other hand, a focus to the real travel time and modal choice of families (data survey). The main focus is on how travel behavior is affected by the location of homes (trip origin), the location of trip destinations, the accessibility with car and public transport. In fact, it`s true that the geographical localization of neighborhoods influences the families behaviors on their daily routine. It will be tested if the physical characteristics of the neighborhood and city referring to transports and mobility, especially on public transports network, may affect the families decisions. The case studies are two neighborhoods localized on two different municipalities: one in inner city of Lisbon – Telheiras, and the other in south metropolitan area of LMA – Quinta do Conde, Sesimbra.

Keywords: mobility, accessibility, geographical localisation, family daily life

1 Introduction

The mobility of the communities and the accessibility of the neighborhoods are important aspects to consider to the transports planning. Between them there must be a strong connection. The higher the compatibility between the two aspects, the largest is the urban sustainability.

This paper want to test a methodology to relate the mobility and accessibility in accordance with the theoretical background presented in the concept of "sustainable community". For that, it will be focus two major parts. The first is about the neighborhoods, their accessibility, especially the public transport networks, as well as the distribution of goods and services. The second is referred to the community and their trends of travel, relating the location of homes (origin trip) to the location of trip destination to work or find some kind of goods and services, to the time spent and the transport mode chosen.

Although this article was done in academic context, with the major goal of testing methodologies to link the survey results of the communities to a territorial analysis, the link to the urban planning can be very strong. This analysis to the real families time use and their daily mobility intend to be an added value to operationalize the strategic guidelines to reach a sustainable community and a sustainable city, referred by state governments or for other organizations like United Nations.

This paper is structured into five parts. After the introduction, it will refer the theoretical background about urban sustainability, focusing the concepts of Sustainable City and Sustainable Community, and stressing particularly the role of mobility (part 1). After that, we present the methodology applied in this analysis associating the results of data survey realized with an analysis to some physical characteristics of the neighborhoods within Lisbon Metropolitan Area (part 2). The

[226] Paper done in context of Investigation Project – FURBS (PTDC/GEO/69109/2006)

presentation and characterisation of the case studies (part 3) gives the context to explain the family behaviour relating to mobility (part 4). This knowledge proves to be fundamental to operate on urban planning and understand the individual choices relating to daily travels and according to the residence localization within LMA. The last part refers the principal conclusions.

2 Theoretical backgrounds – Urban sustainability and daily mobility

In this paper, the theoretical background has two strands: the first focus the theme of urban sustainability at two scales: the city and the neighbourhood. After that, we propose a reflection on mobility and accessibility, relating with the urban sustainability.

2.1 Urban Sustainability

The emergence of the concept of Sustainability takes place in the 1980`s, promoted by a Commission and culminates in the production of reports and declarations. But before that, in the Stockholm Conference, in 1972, (United Nations Conference on the Human Environment), focusing the relationship between economic development and environmental degradation the subject of the environment had discussed already, for example, in the ecodevelopment model by Sachs, a model supported strongly in the environment with the objective of a socially desirable, economically viable and environmentally prudent development.

In 1983, the United Nations convened a World Commission on Environment and Development (WCED), named Brundtland Commission and chaired by Gro Harlem Brundtland (prime minister of Norway, 1986-1989). With the major goal to develop the political concept of sustainable development and establish policies, the concern was in the human environment and the waste of natural resources that affects the economic and social development. Four years later, the Brundtland Commission published a Report named “Our common future” or “Brundtland Report”. In this report, the definition of Sustainable Development is the “development that meets the needs of the present without compromising the ability of future generations to meet without compromising the ability of future generations to meet their own needs.

From the documents and discussions, we detach Agenda 21. The Agenda 21 have 40 chapters, divided in four main sections:

I. Social and Economic Dimensions – poverty, consumption patterns, population and demographic dynamics, health, sustainable settlement patters, environment and decision-making;
II. Conservation and management of resources for development – atmospheric protection, deforestation, fragile environments, biological diversity, pollution;
III. Strengthening the role of major groups – children and youth, women, NGO, local authorities, business and workers;
IV. Means of implementation – science, technology transfer, education, international institutions and financial mechanisms.

Some state governments implementing the Agenda 21 at a national, regional and local level as a recommendation in the 28th chapter.

In 2002, occurred the Earth Summit 2002 - World Summit on Sustainable Development in Johannesburg, South Africa.

Despite all these years of work on sustainable development, the concept is not totally established. Since the 1980`s, there are three major pillars referred by Brundtland: environmental, economic and social. But other dimensions are evoked: cultural (e.g. Meadowns, 1998), politics, institutional and governmental (e.g. Bursztyn et al, 1999), ethics (e.g. Herrero, 1997), spatial dimension and infrastructures or individual development (e.g. Bossel`s Model, 1998). Some authors defined the concept of Sustainable Development as a "constant dynamic balance" between the various dimensions (Dominsky, 1992) or like an "evolutive process".

The definitions of sustainable cities aren't fixed or unified, despite the concept is more and more present in various governmental programs and documents during the recent years.

It was in the 1990`s, as in Europe as in USA, that the concept was arise, in response to the Modern Urbanism and the urban sprawl that caused social, environmental, economical and urbanistics problems in the existent urban centres. The urban monofunctionalism, the overdependence on the automobile and the lack of feeling of belonging to the residence places are some of the major problems found.

As a strategy to solve these problems, some documents representing a new urban planning model (post-modern): in Europe, we found the Aalborg Charter (1994). From it came the document "The European Sustainable Cities and Towns Campaign". In USA we find the Charter of the New Urbanism (1996), highlight the Smart Growth movement (focusing in the mix of functions, pedonal travels, friendly-urbanism according to the history and culture of the community). From the United Nations Conference on Environment and Development in Rio de Janeiro (1992), resulted the 27 principles that based the Agenda 21.

According to the Division for Sustainable Development of United Nations, Agenda 21 is "a comprehensive plan of action to be taken globally, nationally and locally by organizations of the United Nations System, Governments, and Major Groups in every area in which human impacts on the environment." However, after these years, the results of the implementation of Agenda 21 and Local Agenda 21 are very different depending of the national and local governments. There isn`t a unique approach to sustainability at the local level in all the State Members and the only common thread is the Thematic Strategy on the Urban Environment. We highlight two examples: UK and Portugal. In UK the revision of Local Agenda 21 has made the Government oblige the Local Governments to create the "Community Strategies", with the goal of unify the processes, taking in consideration the differences of each community. This strategy covers the social inclusion, housing, employment, services, infrastructures and environment and overlapped the Local Agenda 21. In Portugal, the Local Agenda 21 was strongly released when the Guide of Portuguese Environment Agency was published. It was consider as a tool of the National Strategy for Sustainable Development 2015, without any objective methodology.

The second European conference in Lisbon (1996) presented the document "The Lisbon Action Plan: Charter to action" to operationalize the concept of sustainability and, four years after, occurs "The Hannover call of municipal leaders at the turn of the XXI century".

In 2004, in the Aalborg +10 conference were reaffirmed the Urban sustainability principles: governance, local management towards sustainability, natural common goods, responsible consumption and lifestyle choices, planning and design, better mobility and less traffic, local action for health, vibrant and sustainable local economy, social equity and justice, local to global.

2.2 The Sustainable Communities and their importance for local planning

To center the analysis in a minor scale, we chose examine the concept of Sustainable Community, that meets the assumptions about urban sustainability in general, giving to the social and community approach. This is one more concept that haven`t a unique definition, but one of the most applied is: "(…) Sustainable communities are places where people want to live and work, now and in the future. They meet the diverse needs of existing and future residents, are sensitive to their environment, and contribute to a high quality of life. They are safe and inclusive, well planned, built and run, and offer equality of opportunity and good services for all. (The Government of the United Kingdom, Sustainable Communities Plan, 2003).

In the context of governmental reports, it`s possible to enumerate several axes where it appears: in academic context with focus on the theoretical concept, with an approach to the tools (studies about methodologies and indicators), in case-studies, coordinated by national, regional and local governments and sometimes in association with NGO`s and the community itself, blogs from the communities work, and many others.

For a better comprehension, we will focus (in a summarized way), some topics of the "The Egan Review: skills for Sustainable Communities" (ODPM, 2004) that permits apply some ideas in the empirical component of this article. This report, online available, presents three major objectives: clarify what the term 'sustainable community' means, identify who is responsible for leading the delivery of sustainable communities, and recognize the skills necessary to achieve sustainable communities.

Relatively to the definition of Sustainable Community, it was referred before (2.1.2 Sustainable Communities). In this report were defined seven components with several principles that, all together, constitutes the "common goal" (fig.1). They are: Governance, Transport and Connectivity, Services, Environmental, Economy, Housing and the Building Environment, Social and Cultural.

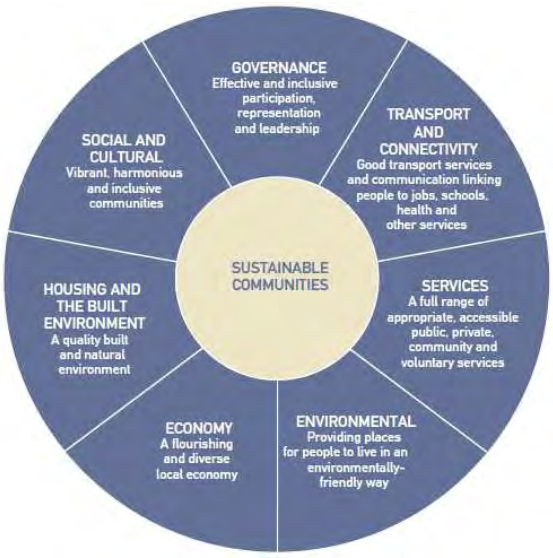


Figure1. Components of Sustainable Communities. Source: The Egan Review, 2004, p. 18.

For this paper, not all the components will be in evidence. The components of Transports and Connectivity, Services and Economy have major importance in this study (Table 1).

Table 1. Components of Sustainable Communities

Components of Sustainable Communities
TRANSPORT AND CONNECTIVITY
• Transport facilities, including public transport, that help people travel within and between communities • Facilities to encourage safe local walking and cycling • Accessible and appropriate local parking facilities • Widely available and effective telecommunications and Internet access
ECONOMY
• A wide range of jobs and training opportunities • Sufficient land and buildings to support economic prosperity and change • Dynamic job and business creation • A strong business community with links into the wider economy
SERVICES
• Well-educated people from well-performing local schools, further and higher education and training for lifelong learning • High quality, local health care and social services • Provision of range of accessible, affordable public, community, voluntary and private services (e.g. retail, food, commercial, utilities) • Service providers who think and act long term and beyond their own immediate geographical and interest boundaries

Relatively to the shape of the communities, Egan refers that there isn`t two equal communities, varying the size and topography of the neighborhood, aspirations, social, economic, environmental and population policies, among others).

Egan also identifies some bibliography to consolidate the definition of Sustainable Community, like the “Sustainable Communities: Building for the Future Report”, which presents 12 key requirements (ODPM, 2003) or the “Sustainable Communities: Dimensions and Challenges Report”, which identifies components Key Sustainable Communities (Kearns, A., Turok, I., 2003). These sources will be important in the search for measurable indicators that characterize the communities.

In the report are presented a set of 50 subjective and objective indicators to help the measurement of sustainability to monitoring and evaluation. Is highlighted that the indicators have to be appropriate for each urban scale (E.g. economic indicators are more relevant at the regional or sub-regional level, as indicators of urban safety or public space are more relevant to the scale of the neighborhood / community). It also stressed that the choice of indicators depends on local circumstances, needs and priorities of communities.

In the field of quantitative indicators, beyond the Egan Report, theoretical research has been extended. Apart from the scientific articles (e.g. Innes and Booher, 2000; Baule, 2007; Scipioni et al, 2009) and documents of government bodies (e.g. ODPM, 2004), there are other sources, particularly European and North American (Sustainable Measures website - Sustainable Community Indicators Trainer's Workshop, Hart, 1998-2000, Guide to Sustainable Community Indicators, 2nd Edition, Hart, 1999, Canada Mortgage and Housing Corporation; The Community Indicators Handbook: Measuring Progress Toward Healthy Communities and Sustainable , By Redefining Progress, Tyler Norris Associates and Sustainable Seattle (1997)). These sources are studying, selecting and implementing indicators as a way of "measuring" and monitoring the Communities and promote the dissemination of their own methodologies.

2.3. Accessibility and Mobility – a key element for urban planning

Accessibility and mobility are two concepts that are interrelated and there are central in this paper. From their definitions we can understand that while the accessibility is associated to the locations, in this particular case to the neighborhoods, the mobility is referring to the people.

According to Costa (2007), the accessibility “is a characteristic that describes a location, enhancing the ease of reaching certain points. As the movement becomes easier, cheaper or/and less time consuming, it increases the accessibility and with it the propensity to travel, increasing the potential for interaction between places.” (2007, p.22) The accessibility analysis can have several approaches: displacement approach (which is the ease of travel in the network according to the use of time or cost?), approach from the place (which the ease of a given place be achieved?), approach from the individual (which is the number of choices of destination at a certain distance from the point of locating of an individual?), like others.

The concept of mobility, for the same author, is “the capacity that each person has to move between two points, using the different modes of transport available.” (2007, p.23) The mobility depending of various factors: personal factors (age, sex, technical competences like driving license, economic capacity, possession of vehicle), geographical factors (distance, hydrographical system,

relief) and technical factors (existence of a public transports network, costs and time-schedule, and others).

The European Policies Research Centre (2001, cited in Report "Gender, Territory and Environment – Diagnostic and creation of gender indicators", 2009, p. 32-33), identify the four dimensions more studied about the mobility:

- The access to private motorized transport – the number of private vehicle has been growing as their use in daily life;
- The mobility patters associates to labor mobility or familiar and social responsibilities – the more or less proximity of home to the labor place and to the quotidian activities, like schools, shopping, health care, etc. These situations should influence the mobility planning;
- Infrastructures and highways (with focus in the cost-benefit analysis relating to the public transports network) – is relating with the time spend essentially for labor travelling and rarely about others daily movements (relating to daily needs – schools, health care, leisure, etc.)
- The main constrains to the mobility – security, comfort, time-schedule, cost, available information.

In Portugal, we can find several studies about the mobility in LMA or in a specific municipality, like The Transport Study of Lisbon Region (DGTT, 1977), Mobility Survey of Lisbon Region (DGTT/INE, 1999), "Contributions to PROTAML" (DGTT/DLT, 2000). Nunes da Silva (2006) and Marques da Costa (2007), taking about the sustainable mobility, presents a diagnosis of mobility and accessibility in the region of Lisbon. Relating to the mobility, the author refers five trends: stabilization of the number of trips per day; increased use of private transport and less use of public transport; decreased flows center-periphery and increased flows periphery-periphery; higher intensity flows off-peak and the greater distances traveled and time spent. Nunes da Silva (2006) analyzes the accessibility in Lisbon divided on road accessibility and railway and river accessibility. The first one have a radio-concentric configuration in the region, with a structure and hierarchies almost complete, reveals an insufficient coordination between the functions "transport" and "accessibility", usually present a congestion in peak hours and has a low efficiency between the occupied space and the ability. The second, referring to the railway and river accessibility has others characteristics: it presents a radial configuration in the region, with incomplete structures and hierarchies but presents a high level of service in peak hours and a high efficiency between occupied space and the ability.

To conclude, despite the theme discussed in this article isn`t recent, the attempt to combine the operationalization of the concepts of accessibility and mobility, using various tools, and also associate the differences in urban form of each neighborhood, will be the next step.

3 Methodology

We applied a methodology composed for four steps. In the first step were defined the case studies - Telheiras (Lisbon) and Quinta do Conde (Sesimbra). Due to the size of the neighborhoods, were selected a part of the neighborhood where are incorporated the historic core, shopping and schools (the last were the key element to the definition of the areas). After this methodological delimitation of the areas and their characterizing, the second step is divided into two parts: the first one was to hold a collection of functions in the neighborhood (economic, social, leisure and green spaces, etc.) and georeference them. We also characterized the neighborhood according to their accessibility. The

second part deals with the implementation of surveys to the resident community. We have done 60 surveys in each neighborhood, wondered about the movement of all elements of the household. The paper focus on the daily routines and time spent in travel for various items (work, school, food, hairdressers, services, sports, etc.), as well as their respective location (within the neighborhood, near the workplace, others).

4 Lisbon Metropolitan Area and the two case studies – Telheiras and Quinta do Conde

The Lisbon Metropolitan Area is the functional center of the Lisbon metropolitan region, divided in two units: Greater Lisbon (north side) and Setubal Peninsula (south side). The LMA concentrates 25% of resident population and almost 40% of the economy in less of 3% of country surface.

In the PNPOT Annex Report (2007, p. 106), the major politic program for national urban planning in Portugal, are focused some actual territorial trends: urban fragmentation due to the news road infrastructures and the increasing of the car use and the enterprises relocation, location of news activities (shopping, I&D activities) in the Lisbon-Cascais-Sintra triangle, the restructuration of the south riverside, consolidation of Lisbon-Palmela-Setubal axe supported by the rail accessibility, and so on.

The two municipalities where are included the two case studies are very different, not only in their geographical location within the LMA but in basic data (table 2). Whilst Lisbon municipality, on north side of LMA, is divided in 53 urban neighborhoods in a small area (85 Km2) and with a great population and building density, Sesimbra, on south side of LMA, have most of twice of Lisbon area (196 Km2) and, according to their majority rural area, the municipality presents a low human and constructed density, but still above the average of LMA.

Table 2. Indicators of LMA, Lisbon and Sesimbra

Indicators	LMA	Lisbon	Sesimbra
Area (Km2)	29.623	85	196
Municipalities	18	_	_
Neighborhoods	_	53	3
Population (2001)	2.661.850	564.657	37.567
Population density	90	6.643	192
Nº buildings (2001)	394.520	53.387	15.760
Buildings density	13	628	80

Source: INE, 2001

The case studies are two neighborhoods located in different areas within Lisbon Metropolitan Area. Telheiras is situated in LMA north border (Lisbon municipally) while Quinta do Conde is in Sesimbra municipally, on south border of the river (fig. 2). Their urban context within LMA, the urban genesis or population and build density are some explanation factors for the possible differences in the community everyday life.

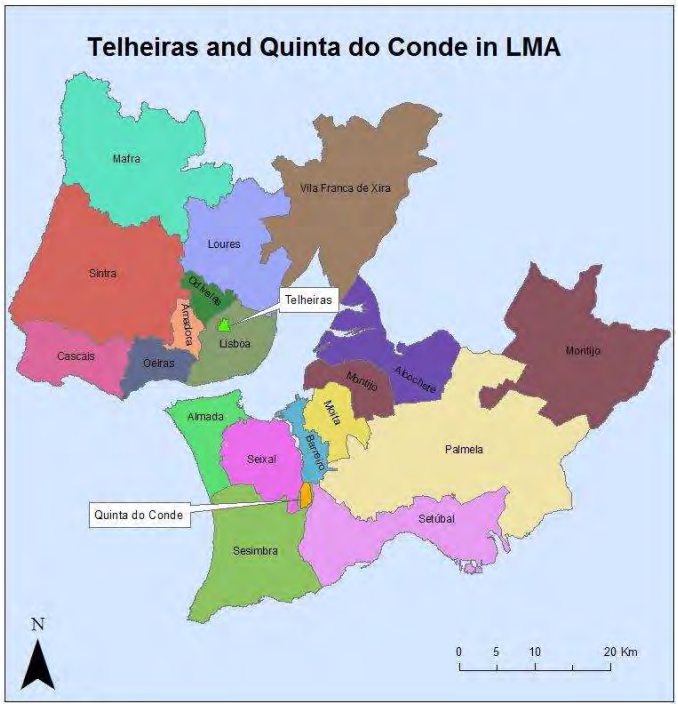


Figure 2. Geographical location of the case studies: Telheiras (Lisbon) and Quinta do Conde (Sesimbra). Source: own.

4.1 Telheiras – Lisbon

The neighborhood of Telheiras isn`t an institutional or statistical unit, without a concrete delimitation, but have a strong identity within the city, especially for their residents. This neighborhood is splitted between two neighborhoods (Carnide and Lumiar), and the respective historical centre's. This situation hinders the existence, in the scientific area, of quantitative material coming from Census (or others resources) and complicates the comparison between investigation works. In the political action and urban planning, this situation turns the implementation of plans for this undefined unit more difficult.

The urban grow of Telheiras started in 1970`s. Before that only exists a village, with particularly morphologic characteristics (urban sprawl of unifamiliar housing). Since 1970`s, an intervention done by EPUL (Public Company for Lisbon Urbanization) for the south Telheiras (1975) led the neighborhood to grow. Telheiras was known as a "neighborhood of doctors" essentially because the proximity to the University Campus and the attraction of young couples with university frequency (Matos, 2009:11-12).

This neighborhood aggregates four distinct areas: 1. South Telheiras, 2. Alto da Faia, 3. Paço do Lumiar, 4. Parque dos Príncipes. However, our case study is focused in two areas: South Telheiras and Parque dos Príncipes, where are concentrated the most of goods and services (fig. 3).

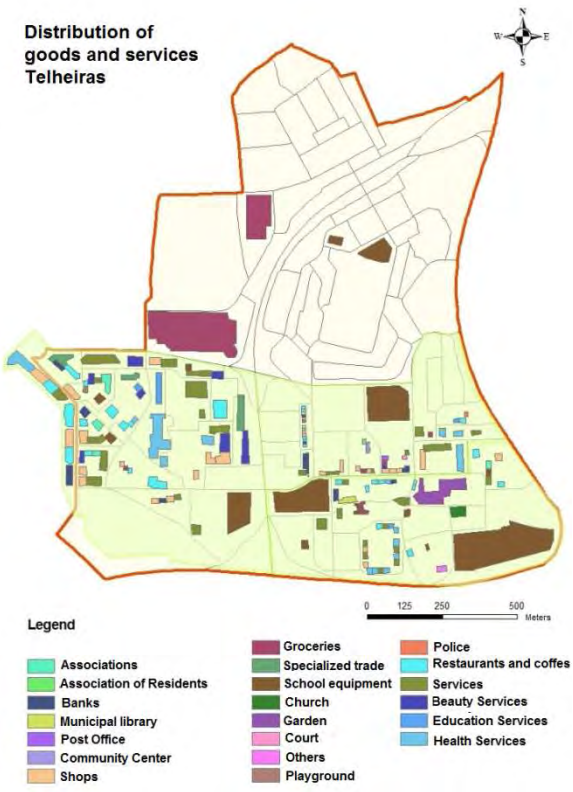


Figure 3. Distribution of goods and services in Telheiras (Lisbon). Source: own collection.

The historical centre and the first urban expansion areas in Telheiras were planned with large and arborized streets and harmonious housing, mostly with residential function, both unifamiliar houses and apartments. In the surroundings of the historical centre there is a pedestrian area with green spaces for leisure as some public equipments and services. But, in the expansion areas, like Paço do Lumiar, there wasn`t a good urban planning intervention, revealed in the lack of public spaces and equipments.

In general, the housing is in buildings with apartments, and the ground floors have stores or services. Despite the urban density, there are spaces to the automobile and pedestrian circulation.

4.2 Quinta do Conde – Sesimbra

The second case study is Quinta do Conde, a neighborhood within a neighborhood with the same name, in Sesimbra municipality, in the south merge of the river, about 20 quilometers from Lisbon. Sesimbra is characterizes by several settlements like Sesimbra historic centre, but is a municipally mostly rural. Quinta do Conde is a peripherical settlement that is closer to Seixal municipality than Sesimbra, presenting the same urban morphology that the nearest municipality.

Unlike the neighborhood of Telheiras, the neighborhood of Quinta do Conde is a settlement identified on portuguese Census like a territorial unit as the other two settlements that compounds the Quinta do Conde neighborhood (Casal do Sapo and Fontaínhas). Due to the big area, for this study we

defined only a part of the neighborhood, where are concentrated the most of equipments, stores and services.

The urban growing of Quinta do Conde began at 70`s of last century (like Telheiras) with a splitting of a rustic area, sold in illegal lots. So, being Quinta do Conde an Urban Area of Illegal Origin, their urban morphology and the sprawl verified don't reveal an urban planning strategy: streets unfinished or the lack of equipments and public and open spaces are some of consequences.

In this neighborhood, we can find mostly unifamiliar houses with one or two floors and yards. There are buildings with apartments too but in a minor number and localized in a new urbanized area near the shopping centers. Here we can find some unoccupied spaces between the residences and inclusive some infrastructures are unfinished (e.g. roads).

Just in 2006 was elaborated the Quinta do Conde Urbanization Plan, actualized in 2008.

In this neighborhood, the commerce and services are concentrated in a major avenue (Avenida Principal), presenting some economic and employment dynamic. In the rest of the area these functions are residual, like we can see in figure relative of distribution of goods and services in Quinta do Conde. (Fig.4)

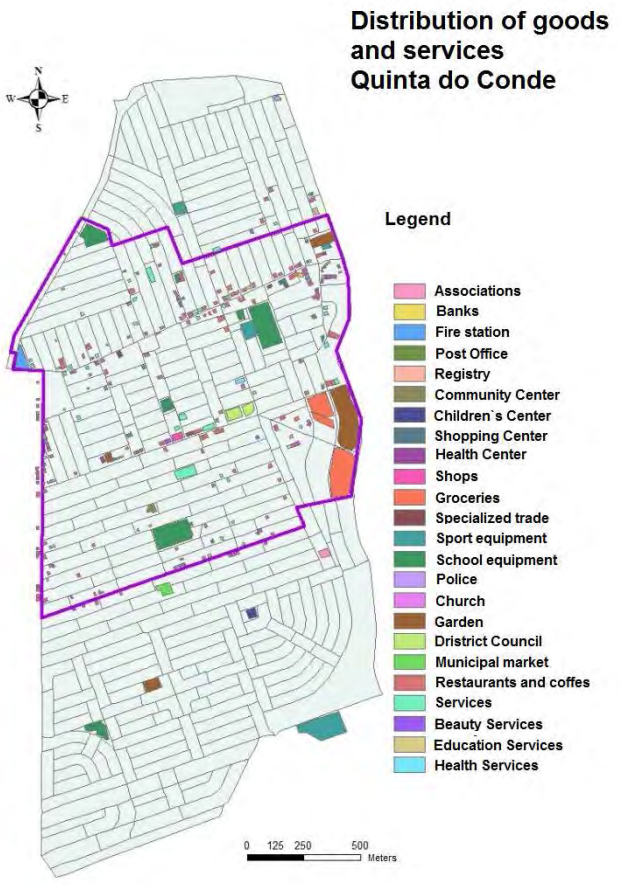


Figure 4. Distribution of goods and services in Quinta do Conde (Sesimbra). Source: own collection.

5 Analysis of the accessibility and mobility of the case studies

The empirical analysis of this paper is divided in two parts. The first one is centered on an analysis of accessibility infrastructures in the Lisbon Metropolitan Area (LMA), in the cities of Lisbon and Sesimbra, but mostly in the neighborhoods. The second part is referring to the results of data survey done in June of 2009. In this second part is highlighted the daily labor movement and to several services according to the trip destination, the transportation mode and the time spent on travel.

5.1 Accessibility and mobility within an for the municipalities and neighborhoods

To analyze the accessibility of each neighborhood it`s important to see a major scale to understand the connection of neighborhood with their geographical context. This location associated, on one hand, with the role play of these urban centers in the regional hierarchy (capital *versus* periphery) or, on the other hand, with the urban context (integration on an urban continuous, populational and functional dense tissue versus an isolated and decentralized neighborhood within his municipally).
Both of case studies are within the LMA but presents different levels of accessibility according to their location and the available transport infrastructures (fig.5).

Focusing now on the accessibility of Telheiras, this area is definitely central. Just highlighting the road accessibility, the location of the neighborhood is close to three principal high flow roads in Lisbon (Segunda Circular, Av. Padre Cruz and Eixo Norte-Sul). The area have a varied public transports network: it presents a metro station with a network sprawl to the city and several Carris bus routes (8 routes).

Quinta do Conde is relatively near (7Km) to a principal train station (Coina) and have 14 bus routes of two public transports operators (TST and SulFertagus). There are 35 bus station both the periphery and inside the neighborhood. The neighborhood has in the proximities a high-speed road (A2) and a national road (N10). The fact of the neighborhood be located on the south merge of the river promotes a difficulty in daily mobility (it`s mandatory to pass the bridge or take the boat to go to north).

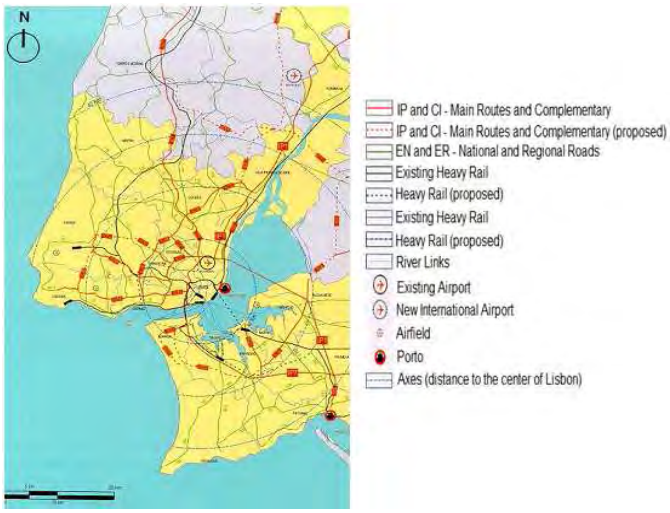


Figure 5. Transport infrastructure in AML. Source: Nunes da Silva, 2006.

We can see similarities and differences in the public transports in each neighborhood (table 3). Despite the difference of the number of bus stops in each neighborhood, the density is similar: one station for every 10 ha. The geographic location influences: while in Quinta do Conde exists 8 in 14 lines that start / end in the neighborhood, highlighting the central housing function; in Telheiras all lines just crossing the neighborhood. The main destinations of the lines also vary: in Quinta do Conde, the origin or destination points are intermodal stations (e.g. Coina with trains and buses, Cacilhas with boats and buses, Praça de Espanha - bus and metro and near Sete Rios with trains). Telheiras has a limited road public transports network in the neighborhood, with arrival/departure in peripheral centers of Lisbon (e.g. Damaia, Pontinha), to transportation hubs in the vicinity (Campo Grande - metro and bus).

Table 3. Indicators of the public transports networks

Neighborhoods Accessibility	Q. Conde	Telheiras
N.º stops of Public Transport Network	35	14
N.º stops of Public Transport Network per acre	0,085	0,071
N.º routes of Public Transport Network	14	8
N.º routes of Public Transport Network with origin or destination in the neighborhood	8	0

Souce: Carris, TST, 2010

According to INE data, since 1981 until 2001, it`s visible some mobility trends within LMA (table 4). The labor traveling within Lisbon municipally was decreasing (31% for 17%). The causes, among others, are the travels of the residents to peripherical municipalies and due to the dislocation of jobs for new peripherical centers, as Tagus Park). Consequently, within the north side and within south side of LMA there was an increase of daily movements.

Table 4. Daily travel to home-work or home-school

1981				**1991**				**2001**			
	N- LMA	S-LMA	Lx		N- LMA	S-LMA	Lx		N- LMA	S-LMA	Lx
N-LMA	25,4%	0,5%	19,5%	N-LMA	31%	0,5%	19,5%	N-LMA	36,1%	0,7%	17,9%
S-LMA	0,3%	16,8%	4,2%	S-LMA	0,5%	18,5%	5,2%	S-LMA	0,9%	19,7%	5,4%
Lx	1,9%	0,4%	31%	Lx	1,7%	0,3%	22,8%	Lx	1,8%	0,3%	17,2%
N-LMA – North LMA (without Lisbon), S-LMA – South LMA, Lx – Lisbon											

Source: Marques da Costa 2007

Concerning to the evolution of the transportation mode for the labor movements (table 5), within the LMA in general, the private vehicle as gain importance (from 13% to 42%), while the public transport lost the majority presented in 1981 (from 62% to 34%).

Comparing the municipalities in study with their side of LMA, it`s visible that Lisbon presents the same pattern of the north merge and close to the LMA average. Sesimbra reveals an important evolution in the use of car (from 8% to 50% moves) and the percentage of moves done using the public transportation are decreasing (from 37% to 20%) and below the LMA average.

Table 5. Main transportation mode used to the route home-work or home-school

	1981				1991				2001			
	Car	PT	None	Others	Car	PT	None	Others	Car	PT	None	Others
AML	13%	62%	19%	6%	22%	47%	24%	7%	42%	34%	20%	4%
N-LMA	14%	62%	19%	6%	23%	47%	23%	7%	44%	34%	19%	3%
Lisbon	14%	67%	17%	2%	23%	50%	24%	3%	39%	38%	21%	2%
S-LMA	9%	56%	23%	12%	21%	47%	25%	7%	41%	31%	22%	6%
Sesimbra	8%	37%	38%	16%	21%	32%	31%	16%	50%	20%	22%	7%
N-LMA – North LMA (without Lisbon), S-LMA – South LMA, PT – Public Transportation												

Source: Marques da Costa 2007

5.2 Analysis of the household's mobility of the case studies

This part is referring to the results of data survey done in June of 2009, done for the academic seminar for master`s degree in IGOT-UL[227] Before focus the daily life routine, we can present others secondary issues that can help to understand the families behavior.

The first analysed question it`s about hypothetical reasons to move to a new house nowadays to understand if the mobility issue are important in that choice. It`s noted that both communities studied did not attach great importance to this issue. Only in Quinta do Conde, the location of employment was mentioned in a prominent factor (22%), being exceeded only by the proximity to family (32%) and the neighborhood environment (27%).

It`s evident some satisfaction with the place of the actual residence in both of neighborhoods because over 50% of respondents would like to stay in the same neighborhood.

The number of cars per household is an important variable. Although Telheiras be at the heart of Lisbon, with a good network of public transport accessibility, only 8% of households have no car and more than half (55%) have at least two cars. Already in Quinta do Conde, 55% of the households surveyed own a car and nearly 20% of the sample has no car.

The perception of respondents is also relevant to understand their behaviour on the daily mobility. Telheiras is seen as a neighborhood well served by public transport (75%), contrary to the other neighborhood, where 43% of respondents consider that the Quinta Do Conde is not well served by public transport. The perception of this respect should then be confronted with the actual behaviour of the community, since greater use of public transport is a key strategy towards greater urban sustainability. Over 40% of respondents in each neighborhood agree that the home location

[227]This survey as the functional cartography of the neighborhoods was done in the context of academic masters of Urban Planning and Urbanism (2008-2009) in IGOT-UL, by a large team: Louro, A.; Camoêsas, A. Martins, S., Silva, S.; for the seminar of territorial planning and development Indicators, coordinated by Prof. Eduarda Marques da Costa.

has enough parking, but for 27% of respondents in the Quinta do Conde disagrees. It`s missed a similar issue but regarding parking at the workplace to strengthen this subject.

One of the issues involved in the act of moving is the cost of travel. It was questioned the percentage of household budgets spent on transportation. The majority of respondents from Telheiras spend less than 10% of the budget (public and private) (67%) and only 4% spent between 26% to 50% of the household budget. In Quinta do Conde, the proportion of spending on transport is higher: 50% of the sample spends between 10% to 25% and 6% spend between 26% to 50% of the budget. Recall that these values are due to several variables: the household budget, type of family, number of individuals per household, workplace, transport modes selected, among others.

5.2.1. Daily routine in the labor movement and in the travels to school

It is important to analyze the mobility of individuals at two daily movements: the daily travel home-work, the daily travel home-school.

The first aspect that is important but also to understand the day-to-day lives of individuals with regard to frequency of purchase or other services and activities, including the patterns of mobility to travel beyond the home-work-home.

The second aspect - the movement to children`s school - have some importance. Whereas the educational facilities are central to the life of the community, and on the other hand, the mobility of children, according with their age, may be more or less dependent on the mobility of parents.

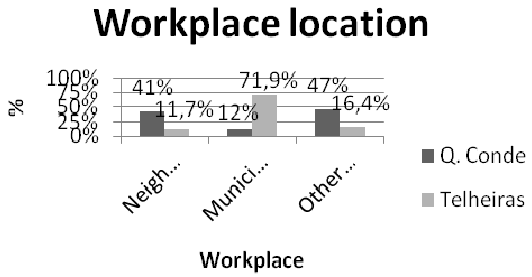


Figure 6. Workplace location of the sample. Source: survey, 2009.

Analyzing the labor movements there are large differences between the two neighborhoods: Quinta do Conde respondents divided their work essentially within the neighborhood (41%) or in another municipality of LMA than Sesimbra (47%), 29% of those who have to travel to another municipality to go north to AML. The residents of Telheiras, despite a lower number of respondents who work in the neighborhood of residence (widespread due to high qualification of people), 72% of those working in the municipality of Lisbon, confirming the centrality of capital functions that employer makes a great pole. In much smaller scale, there were 16% of respondents who have to leave Lisbon daily and 14% are moving to north municipalities of LMA.

Regarding the choice of mode of travel, the behavior of both communities is very similar: the car itself is the 1st choice (64% in QUINTA DO CONDE and 67% in Telheiras), while 15% goes to public transport and shows up a slight difference in walking (18% and 14% in QUINTA DO CONDE in Telheiras).

According to the movement of children under 15 years to school, we found big differences, too dependent by the existing equipment in the neighborhoods and the context in which the municipality is in, taking advantage or not of educational facilities in other nearby neighborhoods:
In Quinta do Conde, 90% of the students have their school in the neighborhood of residence and almost 8% have left the municipality of residence (this data has a high correlation with the location of the parents workplace). 28% of children take less than five minutes, and 62% takes between 6-15 minutes to get to school. Of these 90%, 46% will walk and 39% going by car (taking advantage of the daily routine of parents). The use of public transport for this trip is residual.

The neighborhood of Telheiras presents some differences. Since 70% of students in studying in the neighborhood, there are 26% studying in Lisbon. This value makes sense because Telheiras is located in a municipality with a network of equipment that has a higher offer in the vicinity. In these 96%, 35% moves on foot and take up to 15 minutes and 17% use the public transport.

5.2.2. Daily routine in consumption of goods and services
It was questioned where the individuals usually seek some type of good or service: in the neighborhood, in the municipality of residence or another municipality of AML, and if not acquire or not attend.

Since the labor movement is a daily and formal regularity, it becomes an easier aspect to investigate. However, all other movements provide an important component of mobility. While the location of employment is rarely an individual decision, the choice of where to make all purchases or services are completely free (with some restrictions e.g. the hours of opening and closing, the location of the establishment, the mode of transport available, among others).

It is therefore important to analyze the mobility associated with the daily needs of families who may be more or less sustainable for families (with saving money, resources or time) and the communities (with more or less local social and economic dynamics).

The dynamics of the two communities appears to be different, with several facts cited above are consistent with the behavior of households. In the neighborhood of Quinta do Conde, for the most of services, it`s a high demand within the neighborhood. Only sports and cinema aren`t sought within the neighborhood: while the cinema is wanted in another municipality of AML (68%), just because in Sesimbra municipality there aren`t any cinemas and the people have to search it far away from home location; sports is one of the items with lower adherence (60% do not practice), getting to know if people do not attend because there are or aren`t the equipment most appropriate or desired, or if they don`t practice for convenience or lack of time.

Noted that the demand for groceries takes place almost entirely in the neighborhood (97%) since the Quinta do Conde are from small grocery stores to large supermarkets, and could even be achieved and pedestrian shortly.

Besides the importance of the neighborhood, it is noted that since the municipality of Sesimbra essentially rural with few and little urban centers, is not in the municipality that individuals supply their needs but in other municipalities in the LMA, especially for health services (37%) and cinema (68%)

Already in Telheiras, the phenomenon observed is quite different: as in the Quinta do Conde, there is great demand for goods and services within the neighborhood, especially for food, cafes, services (banks, post offices) and hairdresser (all above 67%). But, according to their geographical location and its integration into the city, there is some demand for goods and services in Lisbon. It`s in health and in the movies that other places of Lisbon are sought. At the level of demand for health services is an explanation: there is no health center in the neighborhood, with two in districts where it is integrated, but far from Telheiras. The demand for goods and services in other municipalities in the AML is almost null.

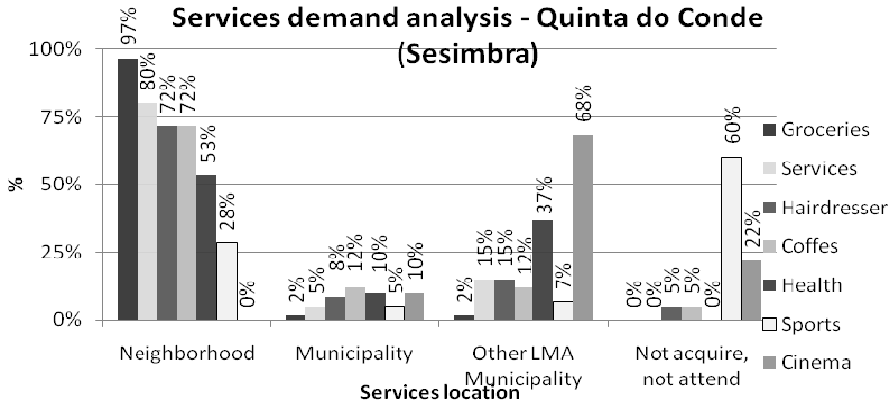


Figure 7. Services demand analysis – Quinta do Conde (Sesimbra). Source: survey, 2009.

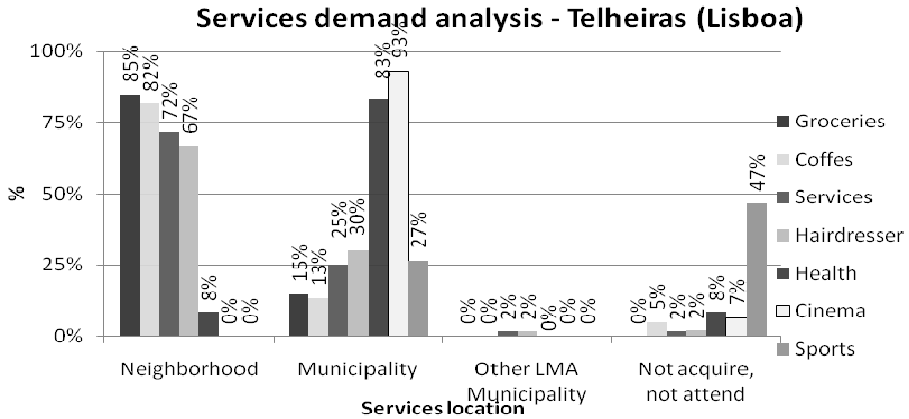


Figure 8. Services demand analysis – Telheiras (Lisbon). Source: survey, 2009.

Time is an important resource, especially on daily life of families and influences their quality of life.

The travel times of the respondents also show some differences depending on the relevant neighborhood of residence. The analysis divides the travel times in three classes: up to 15 minutes, from 16 to 30, more than 30 minutes (table 6).

In both areas, the demand for all goods and services takes place mostly less than 15 minutes (regardless of mode of transport used). Only the demand for cinema in Quinta do Conde

takes longer because there isn`t nothing near the neighborhood. In Telheiras the existence of the Alvaláxia Mall nears the neighborhood easy to get to it.

Another topic that demonstrates a need for more time is the demand for health services. This phenomenon takes place for different reasons: while in Telheiras there is a public health center who`s serving the area located a great distance, in Quinta do Conde despite the existence of health center, there is a large percentage of the population seeking these services in place of previous residence near the workplace (and becomes a sought service integrated with the mobility of labor) or associated with health insurance based on a particular site. These phenomena explain the 41.7% and 45.5% of respondents in Quinta do Conde and Telheiras, respectively, who took more than 15 minutes to reach the health service.

We cannot forget that the times for travels are influenced for the services available in the proximities of the houses (or the workplaces).

Table 6. Time used to travel to consumption spaces

Quinta do Conde			
	Until 15 min	**From 16 to 30 min**	**More than 30 min**
services	96,7%	3,3%	0,0%
Groceries	95,0%	5,0%	0,0%
Hairdresser	89,5%	7,0%	3,5%
Coffes	86,0%	12,3%	1,8%
Sports	78,3%	17,4%	4,3%
Health care	58,3%	30,0%	11,7%
cinema	4,3%	85,1%	10,6%
Telheiras			
	Until 15 min	**From 16 to 30 min**	**More than 30 min**
services	96,6%	3,4%	0,0%
coffes	94,7%	3,5%	1,8%
groceries	91,7%	8,3%	0,0%
hairdresser	91,5%	5,1%	3,4%
sports	87,5%	12,5%	0,0%
cinema	80,4%	17,9%	1,8%
health care	54,5%	40,0%	5,5%

Source: survey, 2009

The transport modes chosen are an important piece to the sustainability at any urban scale. The consumption of resources: gas, money, time, or others, are important items to take in consideration.

For modes of travel we note three different modes of transport: walking, public transport (bus, subway, train and boat). On the modes of transport chosen by individuals, rather than on the location of the neighborhood and services or about the time travel, there is a greater variation depending on the product or service to be achieved (table 7). This variation depends therefore on

other variables: the existence of dependent children and number of children, age of individuals, possession of vehicle, time available and the distance traveled, days / times and locations where the service is available. From the survey, there is a range of services that are sought in a pedestrian in both neighborhoods for more than 50% of respondents, revealing an indicator of sustainability of community and neighborhood: general services (banks, post offices, etc.), hairdressers and coffees, and in Telheiras, sports equipment (table 7). It is visible that is in the neighborhood of Telheiras that more respondents to walk in the items above, but the remaining values decline enough, unlike what happens in Quinta do Conde, where there is still a significant percentage of individuals who on foot to health care or groceries. Despite the similarity, is the comparison between the use of public transport and car where there is a large difference: while in Quinta do Conde car usage by respondents is always above 25%, whatever the objective travel. There are three services in more than 70% of respondents use the car: health services (70%), groceries (83%) and cinema (92%). This phenomenon is explained by the location of these services for the neighborhood or the behavior of households. First example, if there is only cinema near a large distance, in a secluded shopping mall, there is a greater tendency to seek the mode of transport faster and more comfortable, in this case the car. Second example, if a family with small children goes to the supermarket is only natural that you need some comfort to transport both people and goods purchased.

Table 7. Transport mode to travel to consumption spaces

Quinta do Conde			
	By foot	**Public Transports**	**Car**
Services	71,7%	1,7%	26,7%
Hairdresser	59,6%	1,8%	38,6%
Coffes	54,4%	1,8%	43,9%
Sports	37,5%	16,7%	45,8%
Health care	26,7%	3,3%	70,0%
Groceries	16,7%	0,0%	83,3%
Cinema	4,3%	4,3%	91,5%
Telheiras			
	By foot	**Public Transports**	**Car**
Services	83,1%	1,7%	15,3%
Coffes	80,7%	3,5%	15,8%
Hairdresser	58,3%	5,0%	36,7%
Sports	53,1%	0,0%	46,9%
Groceries	28,3%	0,0%	71,7%
Health care	3,6%	12,7%	83,6%
Cinema	3,6%	8,9%	87,5%

Source: survey, 2009

6 Conclusions

This paper presents a starting methodology for studying the theme of mobility and accessibility at a local scale (neighborhood) in a specific community. This methodology has the objective of understand how travel behavior is affected by the location of homes, location of trip destination and the accessibility by car and by public transports to travels to work and to others services. Our hypothesis is that the physical characteristics of the neighborhoods and the cities referring to the transports and mobility influence the family`s behavior.

Based on the theoretical principles of urban sustainability throughout the community, attempted to operationalize and discuss some of the items listed on the pillars of transport (mainly concerning the need to transport facilities, especially public transport in order to allow the movement within and between districts), economics (with verification of the local business community) and services (through the determination of major equipment such as schools, health centers or other).

The first conclusion is that not only is the characterization of the accessibility of case studies, both in terms of road infrastructure such as access to public transport, which is explaining the behaviour of individuals because, despite the different mobility opportunities in each neighborhood, conduct community turns out to be very similar. Associated with the characterization of accessibility, is the characterization of urban form district-level services and infrastructure available that promotes behaviour more or less sustainable. Throughout the demand for the individuals examined showed a greater tendency to look for the points near the residence (or near the workplace). It is necessary to further this work, explore the features of the neighborhoods and its potential, for example through GIS network analysis both mobility infrastructure (e.g. public transport routes) and the available services.

The second conclusion of the paper is that the values found by investigation at local follow the trends of investigation at the regional and municipal level in decades. Trends in each case study are quite similar to the dynamics of municipalities in which they are integrated.

The third conclusion is observed that, in spite of the locations of the jobs are quite varied but concentrated in the major employment areas of LMA, the demand for other services, property or infrastructure is made mostly in the municipality. It is true that the fate of demand depends once again of the services available near the residence. In the event of no particular service on a local scale, the demand diverges: Telheiras residents come to us in the municipality of Lisbon, since the residents of Quinta do Conde seek other municipalities that not Sesimbra (Seixal, Almada and Lisbon). Concluded that characterization of surroundings neighborhoods is also important to this analysis.

The last conclusion is on the travel time and mode of transport in demand for various goods and services. Despite the travel times are very similar in the two case studies, with less expenditure of time in the neighborhood of Telheiras, the modes are quite different. In both areas, there are high chose for pedestrian mode, but it is in the neighborhood of Quinta do Conde that there is a greater use of cars for the various services questioned.

For a next work, it`s interesting to attend another methodological question in the survey. To a better understanding of the daily routine of the families, it should insert an option that will reveal to us when someone`s looking for some good or service makes it near to the workplace and whether it is during the journey home-work-home or in time lunch, trying to reproduce the daily time of the survey. This paper not only can open some clues for transports planning but also for urban planning (and it`s sustainability) at the local level, according to the daily life of the families and the potentiality of the neighborhoods and municipalities.

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The mobility patterns of FEUP's students

Catarina Cadima, Paulo Pinho

CITTA – Research Centre for Territory, Transports and Environment

Faculty of Engineering, University of Oporto, pcpinho@fe.up.pt

Phone/fax numbers: 00 351 225081903 - 00 351 225081486

This paper presents the results of a research on the mobility patterns of the students of Faculdade de Engenharia da Universidade do Porto (FEUP). We intended to characterize the mobility patterns of FEUP students and to identify key factors that can influence those patterns. To accomplish the referred objectives, a questionnaire was elaborated and applied to a representative sample of the students (N = 394) from the Department of Engineering of Porto University. The results showed that there was a propensity for the use of private automobile and, consequently, the mobility patterns of FEUP's students tended to be unsustainable. The results revealed that home-college proximity and an extensive public transport network with low fares are conditions capable of promoting more sustainable mobility behaviours. Consequently, it seems pertinent to adopt incentives like the ones previously described if one wants to improve the sustainability of the mobility patterns of the Portuguese students. Those incentives should occur at the planning level and imply the articulation of the involved authorities to more efficiently respond to the demands of mobility and to provide a sustainable development.

Keywords: Travel patterns; transport demand; university students; private, collective transport and non-motorized modes; mode choice

Introduction

Sustainable mobility requires the provision of means and opportunities in an efficient and equitable manner, with few adverse impacts and lower costs. According to the literature (Cervero, 1994; Black, Nijkamp, 2002; UITP, 2001), currently, societies are facing mobility patterns that are not sustainable, due to excessive use of private transport. The individual transport is negative to the environment, not only due to high fossil fuel consumption per passenger, as to the noise and consumption of soil it implies (Sanz, 1996; UITP, 2001, WBCSD, 2001; Sanches & Arruda, 2002). There are several possible measures to combat this problem. The Portuguese Direcção Geral de Transportes Terrestres (DGTT) pointed four: (i) control of land use and its occupancy, (ii) delimitation and timing of construction areas, and (iii) appropriate location of equipment and employment, and finally (iv) increasing Quality of Public Transport. Only the latest deals effectively on transport, while the remaining three focuses clearly on issues relate with land use (DGTT, 1986).

Various measures have been proposed to influence mobility patterns, modal split, the energy use and emissions from transport. However, these are far from being consensual. A more efficient energy use for the vehicles is an example of such (use of less polluting energy sources - electricity), which could prove beneficial in reducing emissions in this sector, but unfortunately the significant increase in both private vehicles and characteristics (faster vehicles and therefore more polluting) has stifled the energy savings (Naess, 2003). Other measures, such as increasing fuel costs, the establishment of a maximum for its consumption, or the introduction of tolls, could potentially change patterns of mobility within a short period (Naess, 2003). However, these measures, aimed at reducing motorized mobility, are not easily accepted (UITP, 2001), since mobility is now seen as a prerequisite for improving the quality of life standards (Naess, 2001). Consequently, it remains unclear which steps to take to pursue a more sustainable future in this area (Kennedy et al., 2005).

This paper intends to contribute to a better understanding of the mobility patterns of college students of the Faculty of Engineering of Porto University (FEUP), taking into account that they represent at the city level, a large number of movements, at an approximate time, for the same location. The investigation of the student population represents an opportunity to meet a group that for its characteristics and age, represents potential users of private car (Cullinane, 2002). It also aims to analyze the degree of sustainability of current mobility patterns and identify their main constraints, with special emphasis on identifying attributes of the physical environment. This study aims therefore to discuss possible future actions and incentives that can be taken at the level of planning to address more effectively to the mobility demands of the students population providing a sustainable development.

Theoretical point of departure

Mobility Patterns and their influences

According to the literature (Ewing & Cervero, 2001; Cervero, 2002; Rodríguez & Joo, 2004, Naess, 2006) the first empirical studies were mainly focused on the theme of mobility choice of transport mode, trying to ascertain the preferential mode of transport and understand why this choice. These studies had as starting point the notion that to influence the modal choice, it was necessary to know the factors that justify this choice. They were mostly analyzed through the theory of consumption, which is based on the belief that people make rational choices facing different alternatives, choosing one that has greater utility or personal benefit (Cervero, 2002). According to this theory, travellers weigh and compare the travel times, costs and other characteristics of the ways to decide how to go from point A to point B, opting for the way that brings the least inconvenience possible. As a measure of the total disadvantages that implies a particular trip, was introduced (by economists), the concept of *generalized travel costs.* As Naess (2004) explains the shorter the distance, the cheaper the trip, more comfortable the means of transport available, the lower the generalized costs of travel and greater accessibility.

Other aspects generally included in explanatory models relate to the traveller characteristics, including gender, age, income and car ownership (Cervero, 2002). Not all studies embody the characteristics of the traveller in their analytical models. However, in studies that include the characteristics of the traveller we can identify differences between studies in the United States or Europe. Sanches and Arruda (2002) found that the propensity to ride a car was significantly associated with the number of existing vehicles in the household. Also the study of Ewing et al. (2005) obtained similar results, showing that more than synonymous with socio-economic power, the number of vehicles reflects behaviour or a lifestyle. However, Ubillos and Sainz (2004) in his research identified major socio-economic factors the educational level of parents and the value of housing per household. Naess (2006), in turn, addresses great importance to the annual income of the household, number of household members, the recent changes (last 5 years) of housing and educational level. One possible reason for the dissonance of these results may be related to the socio-cultural context of different studies: the former are Americans, while the latter are Europeans. Nevertheless it remains clear that modal choice is influenced by individual and socio-economic factors. Another key aspect is related to modes incorporated in the studies. According to literature the

exclusion of transport modes in the model analysis can produce false results (Cervero, 2002; Sanches and Arruda, 2004). Sanches and Arruda (2004) call additionally attention to the fact that most models of transportation planning does not include the modes of non-motorized transport (walking and cycling). These are the modes of transport more environmentally friendly (in terms of noise, consumption of fossil fuels, either in their consumption of ground infrastructure). And in addition, bring major health benefits as a good workout (Ewing et al., 2004).

In the last two decades various empirical studies proliferated, this studies focus on the relationship between the built environment and individual travel behavior in order to identify ways to influence this behavior (Ewing & Cervero, 2001; Cervero, 2002; Rodríguez & Joo, 2004; Naess, 2006). Different behaviours of travel, such as mode choice, travel frequency, travel distance and time were studied in different neighbourhoods and built-up areas (Ewing et al. 1994), networks of streets (Boarnet & Sarmiento, 1998) , characteristics of urban design (Cervero, 1994) and patterns of land use (Cervero & Kockelman, 1997). In general, these studies conclude that urban development can significantly influence the ways that people choose to travel (Cervero, 2002) and the amount of travel by car is significantly higher in suburbs than in city centres (Naess , 2006). However, despite the empirical literature is voluminous, most studies have failed to adequately specify these interrelationships in order to be able to infer which environmental factors matter in modal choice (Cervero, 2002; Naess, 2006). These studies played a key role in guiding future studies.

Studies on the behavior of student mobility

Other studies focused more specifically on the student population and mobility behaviour. While the discussion continues, differing mainly on the factors to be considered in each study, there are small changes in their theoretical models that we consider important to mention.

Ewing et al. (2005) studied in a group of young American students, the relationship between the mode of travel to school, taking into account the impacts of emissions caused by these trips, and the factors that may affect this choice, as the location of the school and built environment around it. The authors wanted to see if equipping walking and bicycle trails in the surrounding areas of the school would influence the choice of transport modes or not. The study results indicated that the larger the schools and if they are located in remote locations, the greater the negative effects on emissions of gaseous pollutants from transportation (Ewing et al. 2004; Ewing et al. 2005), showing, among other factors, the importance of school location.

Previously, some studies had shown that schools located in urban centres with good infrastructure and with good pedestrian and public transport services, had the necessary conditions to use alternative modes to the car and thus reducing significantly the emissions of vehicles.

A study of Rodriguez and Joo (2004) seems to confirm this idea while concluding that the choice of mode of transport is influenced by four attributes of the local physical environment: topography, features of sidewalks, residential density and shortest routes to non-motorized modes. The slope of the terrain seems to diminish the attractiveness of non-motorized modes. Conversely, the greater the percentage of trips on the route (shortest route) to the School / University or the closer the bus stop is, the greater the probability of use of non-motorized modes and public transport.

However, the propensity to use these modes is not affected by the existence of shortest routes or by population density.

The fact that students who travel in areas with high coverage levels of walks are more likely to walk is an important figure of these studies. It was also concluded that students who live within walking distance of the school tend to go on foot or by bicycle. The growing trend to locate new schools in remote areas, probably because they had more space and the land may be less expensive, however it signifies that students will no longer live in comfortable distance to travel on foot. As Ewing et al. (2004) mentioned there is consequently a tendency for students to move less on non-motorized modes and public transport.

The location of the school as well as the characteristics of the environment can influence more sustainable mobility behaviours so when the site of a new educational establishment is considered, it is crucial the decision is closely linked to the idea of growth and development, both in terms of urban form, as at the level of public health (Barjas, 2003, Ewing et al., 2005).

Naess (2004), as Ewing et al. (2005), considers the size of school equipment as a factor to take into account, explaining that the larger the school most likely will have to serve students from further afield, Naess (2004) adds that the more specialized the activity implement, greater will be the propensity for students (college students in our study), to move from places further away, making longer trips. These two factors the size of the equipment and specificities of the activities carried out there, differing primary schools (areas of education more generally) in special schools, or universities (more specific areas of instruction) help to understand the distance and time that some students are willing to go in their day to day.

Sanches and Arruda (2002) in his study on the University Campus of São Carlos, concluded that the distance had great influence on the choice of mode of transport used. It should be noted that in this study were counted only two modes: motorized modes and non-motorized modes. In the end concluded that the study would have reached the best results if the motorized transport had been divided into individual and collective transportation. At distances greater than 4km the possibility of people moving on foot is practically zero. In relation to the physical environment factors analyzed: accessibility (mixed uses), population density and quality of the pedestrian environment, achieved significant results in the mix of uses concluding that this was positive for travel on foot.

Ubillos and Sainz (2004) considered that the main variables that influence the demand for transportation of students from the University of Bilbao are, firstly, the variables of generalised cost and some general characteristics of individual travellers. When they proceeded to the analysis of the possible effects of changing the public transport with the aim of reducing traffic congestion and pollution from the intensive use of private vehicles, the results revealed that a higher frequency of subway and train, along with a reduction in the prices of the buses effectively contributes to the attractiveness of public transport. These authors argue that small changes along these lines (subway, train) would cause a transition in the number of car users to public transportation provided they meet the travel needs of this specific group.

However Cullinane (2002) in his study on the attitudes of university students in Hong Kong, seeks to establish whether the provision of good public transportation system can arrest people from the possession and desire to use the private car. Hong Kong is unlike Bilbao and most European

cities, characterized by having one of the best public transportation systems and where the population mainly uses it. Likewise, the vast majority of respondents (students) move to public transport and the car ownership itself in this target group is almost nonexistent. The results showed that even the whish to move in and possess a car (prominent in the male group) is not sufficient to change behaviour. A good and cheap public transport system can actually change behaviours. Cullinane (2002) gives as an example the cities of Oxford, Zurich and Freiburg, though it seems reticent about the costs that were required for such change, while leaving the question open, considers it necessary to rethink the matter by giving the example of Hong Kong where there was no need of any kind of subsidy or effort for an effective use of public transport (Cullinane, 2002).

A major study on the movements of students was developed by Aláez et al (1996). The purpose of this study was to estimate the demand for university transport in the Autonomous Community of the Basque Country (CAPV). Accordingly, the 43 800 surveys that were used allowed us to know how the respondents (approximately 56% of the universe under study) solve their need to travel to universities located in CAPV. Out of the analysis of the results we can see that public transport is the transport of choice for most students (bus - 67.7%, Train - 23.8%), while the private car is used only for 18.9% of respondents. This study revealed that most students during their studies, being able to choose, seek to reside in CAPV. They also give greater preference to rental and university residences, which were more sought after by students from other communities outside the CAPV. The usual time of university travels concentrates during the morning, and they mostly last between 15 'to 45' minutes. Most respondents reported being dissatisfied with public transport. Students who incurred a shorter duration and cost per mission were those who were showing more dissatisfied. For the specific purpose of the study a set of origin-destination flows was identified, in which were concentrated the most acute problems of transport (Aláez et al., 1996).

Analysis objectives

The purpose of this study is to identify the mobility patterns of the student population at the Campus of Asprela and analyze their degree of sustainability, by achieving the following objectives:

- Identify the dominant modes of transport, the time and average cost of the home-school journey;
- Identify the provision of public transport and check the accessibility of the areas under study
- Determine the main mobility obstacles that students encounter on their way to college
- Find the main reasons for students' travel mode choice
- Knowing the degree of satisfaction with the transport used
- In the perspective of the students find the favourite measures to combat the problems of mobility in order to make it more sustainable,
- Explore if some of the attributes of the physical environment of the area of residence (origin) and the University (target) may or may not condition the mobility patterns,
- Lastly, analyze the possible factors influencing the transport mode choice.

Method

SURVEY: Students. 394 students that in the year 05/06 attended a graduation degree at the Faculty of Engineering of Porto University (FEUP) were surveyed in this study. Of these students, 130 (33%) were female and 264 (67%) are male, with an average age of 22 years (minimum age: 18 years, maximum age: 46 years). To obtain a representative sample of FEUP's students, the method of random selection of sampling was resorted, initially selecting 400 students out of 5177 students who attend FEUP. This number was provided in accordance with the proposed by Krejici and Morgan (1970, in Almeida & Freire, 2003), in which, for a probability of error less than 5% and has a population (N = 5000) the sample should include at least 360 subjects.

APPROACH**:** In this study, in order to achieve greater uniformity of the sample were taken into account the specific characteristics of the population. Accordingly, we opted for a selection of participants from two different strata - degree course and year. The classes included in the randomly selected sample, across disciplines, so that the whole subject had equal chance to integrate into the sample and the selection of a subject not interfering or influencing the selection of the next individual. The sample size and the random process of selection of students for classes, led to 18 classes at the responsibility of 15 different teachers, to whom a first e-mail was sent requesting 10 minutes (initial or final) of the class time so that the questionnaire could be distributed and filled. There were no refusals by teachers, so it was sent a second e-mail to arrange convenient time. It was also taken into account the hours application of the questionnaire maximum diversification, 8h00 to 20h00, and on different days of the week. The process of data collection took place during the month of May 2006. The questionnaire was introduced in each lesson for two people to distribute and collect the questionnaire as soon as possible. In each class, we made a brief introduction and explanation of how to complete and what was intended with each question, with two people available to answer any questions that arise. We explained that the collaboration of the students was voluntary. None of the students declined to fill it. However, contrary to expectations, the classes of practical classes had large variations in the number of students. As classes were composed of only seven students (especially the 4th and 5th year), there was the need to incorporate more classes in the analysis. We applied a total of 400 questionnaires out of which were excluded six questionnaires, either for not responding to key issues or for doing it not so consistently.

INSTRUMENT: Questionnaire. In order to achieve the proposed objectives - explore the mobility patterns of the students and understand the reasons for their choice - a questionnaire was elaborated. This instrument was based on the questionnaire of Aláez et al (1996), about college students from Bilbao, due to the specificities of the study group. With regard to questions of opinion, the work of Cullinane (2002) provided a better understanding of the study population and how questions should be directed. Referring to the literature on the main factors influencing mobility patterns (Ewing & Cervero, 2001; Cervero, 2002; Naess, 2003; Rodriguez & Joo, 2004; Ubillos & Sainz, 2004; Sousa, Schmidt and Nave, 2004; Naess, 2006), we selected a set of questions, organized into three groups:

Table 1.

Individual factors traveler characteristics	• Age (Cervero, 2002) • Gender (Cullinane et al, 2002) • Status / Occupation STUDENTS (Ewing et al, 2006). • Car onwership (Sanches and Arruda, 2004; Ewing et al, 2005). • Driver's license for car (Naess, 2006) • Arrangements for accommodation (Aláez et al, 1996) • Opinion on measures to be taken for environmental protection /greater sustainability • Review on public transport • Reason for transport choice
modal factors trip characteristics	• Travel time • Frequency • Costs
factors related to the local physical environment characteristics of the physical location	• Obstacles on the way home-school • Accessibility of the area of residence (home-school route) - Distance (Naess, 2006) - Population density (number of inhabitants per km2, Rodriguez and Joo, 2004). - public transport service (Naess, 2003) - alternative routes (Fujii et al, 2001) - parking condition (Ewing e Cervero, 2001) - Mixture of land use / diversity / distribution activities - Pedestrian infrastructure and cycle paths (Crane and Crepau, 1997) - Quality of sidewalk environment (Cervero, 2002) - traffic jam

In the carrying out of this questionnaire it was regarded the software (SPSS) that would be used in order to have greater ease in entering and processing data. The aim was to construct a short questionnaire that allows a rapid collection of relevant information, whose average response time did not exceed 5 minutes. The questionnaire was based on several versions and has been tested four times, in order to ascertain the clarity of the issues, possible problems, the time spent in its completion and possible suggestions. We tested a first version of the questionnaire with students of FEUP, the 10th of March, having 14 questionnaires applied. At the end of its completion, some questions were made to clarify any doubts and elucidate what was intended.

Analysis of general results

MODAL ANALYSIS: As it has been observed in other studies, the automobile is the main transport, 48% of students of FEUP, of which 30% do so individually and 18% tracked. Surprising is the percentage (32%) of respondents who said that travel on foot (all movements of more than five minutes), although only three fifths do so as sole mode of transport and about two fifths do it in combination with other transport modes (bus, subway or other). The remaining modes are the bus that is used by about 26%, the Subway for about 16%, the train for about 3% and the bike for about 2% of participants. Whenever it was indicated of another mode of transport it was referring to use of motorcycles. These results are discordant with the mobility patterns of the university students from the Autonomous Community of the Basque Country, as in the study of Aláez et al. (1996), where the main mode of transport is bus, 67.7%, followed by train, 23.8%, finally the car, 18.9% (Aláez et al.,

1996). However, these results are consistent with results obtained by the INE (2001), for the population living in the North of Portugal.

TIME TRAVEL AND MONTHLY COST: The average time to travel home-college is 30 minutes, but the high standard deviation (20.8) suggests a wide dispersion around this reference value. Students traveling by car are those who claim to spend more money on travel, on average spend 60 euros per month. Students traveling by bus spend an average of 31 euros per month. Those who use two wheelers motor spend on average 53 euros per month and the moving subway spend 32 euros (20 to 42 euros) per month. Regarding the cost-per-motorized mode of transport we found that, on average, the fastest are the most expensive.

TIME OF DEPARTURE AND HOMECOMING: The usual time of travel, for the journey home-college, focuses in the morning, 76.9% of respondents leave their home between 7:30 and 8:30, this corresponds to one of periods of high traffic intensity. However, on returning home the movements will take place gradually throughout the afternoon.

ACCESSIBILITY OF AREA OF RESIDENCE: The bus is the most accessible transport mean to most students, about 70% of respondents have a bus stop less than 400 meters away or five minutes of their home, one third of these have direct buses to College which seems quite positive. However, if we think that the sidewalks are a way of arriving at a bus stop or subway we realize that most students have poor conditions either to move on foot or drive to a bus stop, which as we previously saw are fundamental to the encouragement of these two modes (Cervero, 2002; Sanches and Arruda, 2004; Rodriguez and Joo, 2004, Ewing et al, 2006). Only 37% of respondents claimed to benefit from wide and comfortable sidewalks. On the other hand the same percentage of the population under study claims to have at its disposal arterial highways nearby. As high levels of accessibility, derived from the highways, promote the use of private transport (Cervero, 2002), there is a greater incentive to use motorized vehicles. Although the Subway in Porto is relatively recent, since 2004, 23.9% of the students live in a place with a subway station less than 400 meters away.

JOURNEY MAJOR OBSTACLES: From the results, the *traffic jams* are the main obstacle faced by the students (64.2%) in its daily journey. This obstacle is targeted both by those moving in their own car and those using public transportation (buses). The difficulty of parking (29.4%) is the second obstacle cited by the respondents. Although the car park of FEUP is quite reasonable with 900 exterior parking spaces and 53 interior, even if distributed among staff, faculty and students, almost one third of the students revealed to have trouble finding place to park. The justification that seems most plausible as the cause of the problem is the large number of students who move by car alone. The pollution (27.9%) is particularly felt by moving on foot and have to cross and walk along the roads. The lack or deterioration of sidewalks and walkways is the fourth most referred obstacle (24.4%). Walk through sidewalks that are degraded, which have been taken as parking lots or which do not have extension out of the Asprela core (contributing for this area to function as an isolated fragment of the city) seems to be the scene of daily pedestrians. Weak regularity and punctuality of the buses are another obstacle for 23.4% of respondents. The remaining problems are shared by: transshipments (8.1%), security issues (5.8%) and other factors (6.3%).

MODE CHOICE AND DEGREE OF SATISFACTION WITH PUBLIC TRANSPORT: Fastness is the main reason given for choice of transport mode (46%) and the second the convenience (28%). The

cost factor is the third choice (16%), then follow up: those who claim (16%) to have no other option, which depend on the schedules (11%) and, finally, other reasons (5%) such as live near the college. We observed in our study that people who do not use public transport seem to have a worse opinion of them from those who use them. In order to verify the degree of satisfaction differed in both groups (public transport users and non users), we used the nonparametric Mann-Whitney, a .05 level of significance, given the scale used is ordinal. We found that the differences between the two groups were statistically significant, with the group who do not attend public transport worse opinion ($z = -2.2006$, $p = 0.03$).

MEASURES TO BE TAKEN FOR A MORE SUSTAINABLE MOBILITY: In response to what to do to make mobility more sustainable (Figure 18), respondents highlighted three measures related to public transportation: increasing the frequency and quality (21.2%), enlargement of the network (21%) and reduction price (20.6%). The most punitive or unpopular seem to excite the student population that prefers to design changes for greater investment in public transport. These data are consistent with the study of Ubillos and Sainz (2004) where the reduction in prices of public transport services and increased public transport measures were the most voted by the students and where the penalties directly to the use of private vehicles, parking restrictions, tolls were not well accepted. Naess (2003) justifies these measures are extremely difficult to implement, in part because mobility in modern society is tantamount to a greater freedom to obtain a wide variety of destinations and activities, corresponding, increasingly, as already mentioned, the perception of a need. When analyzing the three main steps that should be taken in relation to the modal group, the results show that the groups appear to be fairly uniform in the first steps to take. However as a second measure, the users of private transport prefer either the reduction of tariffs as the extension of public transport, whereas in non-motorized modes, the data show that these are more sensitive as the creation of bike lanes and pedestrian circuits.

DISCUSSION OF RESULTS

After the general results obtained with the questionnaire, they are now trying to meet the final objective: To analyze the possible factors influencing the choice of mode of transport. For this analysis, we face up to the literature and summarized the data obtained through the survey of some issues that we consider relevant. For purposes of analysis, the different transport modes were grouped into three categories: 1) private transport, 2) public transportation (subway, train or bus) and 3) non-motorized modes of transport (walking or cycling). In order to be able to compare the various modes of transport, for this analysis included only the sample of students using only a single mode of transport not to overlap modes of transport and for representing the situation of most students (80%, 313 of 394).

INDIVIDUAL FACTORS

Genre: 44.9% (40 of 89) students were females and 54.0% (114 of 211) males use the car on their way to college. To investigate whether there were differences between the two groups, we applied the χ^2 test at a significance level of 0.05. The results showed no differences (χ 2 (1) = 2 068, ns). Thus, in both genders, there is the same trend: around half the pupils of each sex uses the car. However, when we examined the percentage of students of each sex who goes to college by car alone, we found statistically significant differences: while only 22.5% of girls (20 of 89) travel alone by

car for the boys the value is 40.8% (86 of 211) (χ 2 (1) = 9161, p =. 002). There is an inverse trend with regard to sharing the car: the male students tend to share the car less (13.3% versus 22.5% of female students; χ 2 (1) = 3944, p =. 047). These results are in line with data obtained in other studies. Cullinane (2002) in his study on the attitudes of students from Hong Kong over the private car, found that male students had a greater propensity to use the car than the female students would, if given the opportunity. In our study, although about half of the pupils of both sexes use the car, there is a greater tendency for male students using cars alone. For other modes of transport, there is no differences of gender: 28.1% of girls (25, 89) and 19.4% (41 of 211) of boys using public transport (bus or subway) (χ 2 (1) = 2735, ns) and 26.9% (24 of 89) and 24.2% (51 of 211) (χ 2 (1) =. 261, ns). However, it appears that girls have a higher propensity to use more than one mode of transport: 27.0% (33 of 122) use more than one way, while only 16.9% of boys do (χ 2 (1) = 5.234, p =. 02).

Age: In order to verify whether age differed according to mode of transport used (in private, collective or non-motorized), we used a nonparametric test, Kruskal-Wallis test at a significance level of .05 since preliminary analysis showed that the data did not meet the prerequisites for the use of parametric tests. The results showed that students who use private transport are on average 23 years old (SD = 3.92), those using public transport have an average of 21 years (SD = 2.45), the same average for that use non-motorized modes (SD = 2.65). Results showed that there are differences among the three groups in terms of age (χ 2 (2) = 18.79, p =. 000). To find out which groups differ, we used the nonparametric Mann-Whitney test, comparing the groups two by two. In order to control the type I error, became the Bonferroni correction, using as statistical significance level .016 instead of .05. The results showed that students who move from private transport are older than those using public transportation (z = -4.125, p =. 000) and are also using the older non-motorized modes (z = - 2.555, p =. 011) and there were no differences in ages among the students who move from public transport and those using non-motorized modes (z = -1.316, p =. 188). Despite the fact of the analysed population having similar age, it appears that those moving by private transportation are older. Literature review found similar results. The age, according to Cervero (2002), is directly associated with variables that reduce the chance of walking, being directly associated with physical activity that usually involves an effort. Ewing et al. (2004) states that, as students get older became able to choose the preferred mode of transport, while younger students are dependent on the decisions of their families, although the behavior, the number of household cars family and the distance you live from school equipment influence this relationship.

Driver's license for car and car ownership: The overwhelming majority of the surveyed students (87% of 394) have a driving license. In fact, out of the 68 students who use public transport, 49 students (72.1%) have a license, as well as 56 students (80.0%) of the 70 pupils who usually travel on foot or by bicycle has driving licence, which means that the vast majority of students who do not regularly use private transport has a driving license. Therefore, we conclude that the possession of the license is not direct indicator of a given travel behavior, appearing before us this is rather something culturally valued. In relation to possession of the vehicle itself, about half of students (50.3% 149 in 296) responded positively. The tendency for owners of personal vehicle to use it is statistically significant (χ 2 (2) = 80.612, p =. 000). The literature seems to be in agreement on this issue: the

possession of the vehicle itself is an important input for the travel behavior, who tend to have own car will enjoy this (Cervero, 2002; Naess, 2003; Sanches and Arruda, 2004; Ewing et al., 2005).

students' residence: We intended to verify if the used mean of transportation differed according to the housing regime, once Aláez et al. (1996) had verify that this was an influential variable. In this study the majority of students are living with their family, with 181 responses (58.8%). Of these 181, most uses private transport (124, 68.5%), 49 use public transport (27.0%) and only 4 students (2.2%) of those living with the household family use non-motorized modes. However, when considering the students who live in a rental place (72 of 308 students), the trend is reversed: the majority (66.7%) moves to the college for non-motorized modes, with 50 hits, while 15 students (20.8%) use private transport and only 7 students move by public transport (9.7%). For students living in university residences, there is a situation similar to that found in renting: 11 cases, 7 using non-motorized modes (63.6%), three public transport (27.3%) and a private transportation (9.1%). There seems to be a tendency to use different modes depending on the system of accommodation. In order to verify statistically the association between accommodation and transport used, we used the chi-square test and found a dependence relationship between two variables (χ 2 (6) = 138.09, p =. 000). The results showed that the proportion of students using non-motorized modes is significantly higher than the expected value when they live in a rental or university residence and significantly less when they live with the household. In relation to private transport, students living with family are more likely to use private transport while, when they live in a rental, the proportion of students that does it is significantly lower than expected. However, we believe some caution is needed in interpreting such results since they may be associated with the housing regime on other factors that influence the choice of mode of transport, in particular, and as we review later, the distance between place of residence.

MODAL FACTORS

The aim is to examine the specific characteristics of each mode of transport, as well as the views and perceptions of each student have in relation to this mode of transport. Synthesized in the following table:

Table 2.

Modal Split	time (minutes)	Cost (euros)	Reasons Modal choice	Major obstacles found on their journey
foot Bike	**16'**	**€2**	**46,7% - Fastness** 28,0% - cost	**65,3% - walking paths/ sidewalk conditions** 53,3% - Pollution
bus	**37'**	**€31**	**34,4% - no other option** 31,2% - Cost	**83,9% - traffic jam** 67,9% - lack of frequency and several delay per day
Subway			**41,7% - Comfort** 25,0% - Fastness	**33,0% - transshipments** 25,0% - sidewalk conditions
Car alone Car jointly	**24'**	**€60**	**51,2% - Fastness** 40,9% - Comfort	**92,1% - traffic jam** 62,4% - lack of parkingplace

Automobile /Private Transport: The majority students use on their day the private car (cars). In order to ascertain whether the time and cost of private transport mode differed from other modes of transport, we used the nonparametric Mann-Whitney, the level of statistical significance, 05. The data obtained in our study show that the modes of motorized transport, private transport is the fastest (z =- 5.165, p =, 000). Without taking into account the distance of the journey, students take on average 24 minutes (SD = 14.6), less than 13 minutes the average time spent by public transport. The data on the reasons for their choices are in line with these results, the main reason indicated fastness, with 84 responses (51.2% of 164). Also, the convenience is presented as a reason, with 67 positive responses (40.9% of 164), thus confirming the results obtained by Sousa et al. (2004) where the obtained answers for not incurring into alternatives to private car were the time, comfort, immediate accessibility, the need to transport the minor children; motivations that reflect the importance the car won in their daily lives and that transcend the pure calculation of advantages and disadvantages associated with it (Sousa et al., 2004).

As the literature reports, the car is distinguished from other modes of transport due to its specific characteristics: such as flexibility, enabling a transport from door to door, greater freedom for a wide variety of destinations and activities, status (social status) due to bad publicity and image of public transport and by allowing people to move to considerably larger distances in less time and in a way more comfortable than public transport. Therefore, it is understood that the automobile is the preferred transport for most people (Banister, 1994; WBCSD, 2001, Nielsen & Jespersen, 2001; Naess, 2003; Cullinane, 2002, Sousa et al., 2004). Despite all advantages the accessibility of the automobile depends on traffic conditions and parking place (Nielsen & Jespersen, 2001).

When we analyzed the results of the major obstacles that students who use the car, face in their journey to college, we conclude that the traffic jam, 92.1% of respondents (152 of 165 students) and the difficulties of parking 62.4 % (103 of 165 students) are the main obstacles identified by students. If private transport is the fastest of the motorized modes and this is the main reason for the choice, the traffic jam might act as a deterrent of this mode of transport attractiveness. However, the traffic jam also consists one of the main problems attributed to public transport by students surveyed (72.1%). It is thus understandable that this barrier, as Sousa et al. (2004) is not enough for users of private transport to start looking for alternatives (Sousa, et al. 2004). From the results, although the individual transport is the fastest motorized mode, it is the most expensive (z =- 4.862, p =, 000). As mentioned earlier the students spend on average €60 per month (SD = 50.05, minimum = € 0, max = € 350), double the amount that students moving in transport spending (M = € 31). *Then will the cost be an influencing factor in the choice of mode of transport?*

Public transport: (bus and metro) from the data collected in relation to public transport users, students take on average 37 minutes (SD = 21.0, minimum = 5 minutes, maximum = 100 minutes) on their way to the college, which characterizes this form of transport as the most time consuming. Note that the second reason given for the choice of transportation was having no other option (23.5%) and, as already mentioned, the traffic jams were considered a major obstacle (72.1%). Although public transport is considered the least fast, it is the most economic of the motorized transports. The users of public transport spend on average € 31 per month (SD = 18.1), varying the values between € 17 and € 132. It is thus understandable that one of the main reasons given for choosing this mode

consists on the cost (30.9%). Thus, we conclude that the cost associated with modes of transport is a factor influencing the choice of mode for some students. These results are in agreement with the study of Ubillos and Sainz (2004). Somewhat surprisingly, pointed to another reason for students using public transport was convenience (23.5%). A more detailed analysis of the results showed that users of the subway and bus users differed as to the motives and obstacles in its path, so we present these results separately. Although there are few pupils who use exclusively underground and caution is needed for interpreting the results, the data showed that users of the subways indicate as the main reason the commodity, with 41.7% of 12, the second reason users of private transport and fastness (25.0%), the first reason given by users of private transport and non-motorized modes. That is, the reasons are closer to the users of other modes of transport than those of the bus, for which the main reasons given for their choice were having no other option, with 26 responses (34.4%) and cost, with 24 (31 2%) responses. The obstacles identified by students who are moving by subway are first the transshipments (33%) and in second, similar to users of non-motorized modes, the sidewalks degradation, with 25% of 12 responses. Those who use public transport also need to move on foot. Accordingly, these users are sensitive to the characteristics of the physical environment such as walking and cycling modes (Cervero, 2002). Nevertheless, from the obtained data, we found that the main obstacle faced by students moving by bus to college, are the traffic jams, which are highlighted by 83.9% (47 of 56) of students. Another obstacle identified by most students (67.9%; 38 of 56) who use the bus is the lack of regularity and punctuality of buses. Both obstacles seem to be related to the duration, unlike users of the Metro, which even point fastness as a major reason for this mode selection. It seems therefore that the subways in terms of students viewpoint offers close advantages to the individual transport and may constitute itself as a viable alternative. Although the subway seems to present advantages over the bus, this is used by a larger amount of students. The obtained data, only 3.8% (12 of 313) of students use the subway, while 17.9% use the bus (56, 313). In fact, in respect to the accessibility of the residence area, 70% of respondents (219 of 312) answered to have the benefit of a bus stop within 5 minutes of their homes, while only 25.6% (80 of 312) has a Subway station close to their place of residence, so that, in terms of coverage, the bus seemed to address a larger number of students.

Non-motorized modes: For data, we concluded that students who move to non-motorized modes of transport (walking or cycling) are those that take less time in their journey to college, taking on average 16 minutes (SD = 5.8, N = 75, minimum = 5 minutes, maximum = 30 minutes). This result is statistically lower than that of who uses private transport (z =- 4.430, p =, 000), with a mean difference of 8 minutes, and those who use public transport (z =- 7.452, p =, 000), being the difference of 21 minutes. However, these results do not take into account the distance traveled. Indeed, according to the literature these are viable ways to travel only short distances (maximum = 3 km) (UITP, 2001; PORTAL_VERDE, 2003; DGTT, 2006). Sanches and Arruda (2004) report that in these short distance trips should be the main modes used, because they are less harmful to the environment (both in terms of noise, consumption of fossil fuels, either in their consumption of ground infrastructures) and mainly because the short trips, whether made by motorized modes, are more polluting per kilometer traveled (Sanches and Arruda, 2004). Moreover, these two modes do not suffer from major obstacle, the congestion and is therefore faster in small trips (Rodriguez and Joo, 2004).

Also, bring greater health benefits while consisting in a good workout (Ewing et al., 2004). The majority said it had no cost, yet some of these students (July 75) is sometimes forced to use other modes of transportation, or for weather or when they go too loaded. The non-motorized modes are of course those deemed to have less economic costs (Sanchez and Alvarez, 2004). In this sense, the two results above are consistent with the answers respecting the choice of a non-motorized mode. The main reason given for choosing this mode of transport is, as in the individual transport, the fastness, with 35 responses (46.7% of 75 who move from non-motorized modes). The second reason given, is also the second reason given by students who move from public transport, cost, with 21 responses (28.0% of 75). From the results, 49 students (65.3% of those moving this way) say the main obstacle they face in their home-faculty track is the deterioration and lack of continuity of sidewalks and 40 students (53.3%) referred noise, visual and atmospheric pollution. Therefore, students moving by non-motorized modes, while not suffering from problems related to congestion, as seen in other modes of transport, suffer from problems derived in part from congestion, such as noise, air and visual pollution as they are the ones who are mostly confronted with the obstacles of the physical environment (Cervero, 2002; Sanches & Arruda, 2004; Rodríguez & Joo, 2004, Ewing et al. 2005).

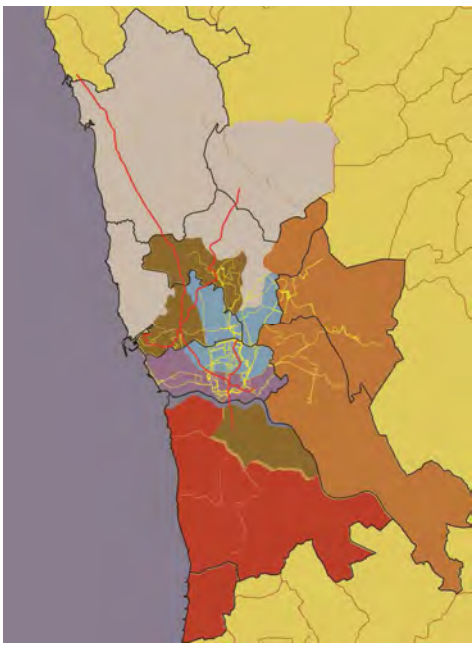
ATTRIBUTES OF THE LOCAL PHYSICAL ENVIRONMENT: Finally, we analyze factors of the physical environment that may influence the mobility patterns of students of FEUP. Several authors (Banister, 1994; Sanz, 1996; Naess, 2001, Kennedy et al, 2005) argue that, along with specific measures on transport should be designed and analyzed measures of urban planning. The aim is to verify if the specific characteristics of context (distance, equipment, accessibility and transport network) differ or are conditioned choices. In this sense, given that we had already some data on the destination - the engineering school, the study framework Polo II - , we analyze the information concerning the origin, collecting from the students' data on the place of residence (postcode). Once the students of FEUP are spread over a fairly wide area, we tried to cluster the residential areas according to two criteria related to the physical environment: distance, population density and accessibility of the place of residence. For this analysis, we include not only the individuals that use a single transport mode (N = 313), but also those that combine various modes of transport (N = 81).

Delimit Residence Zones: The first measure used was the distance between the faculty of Engineering (destination) to the place of residence. The second is the specific characteristics of physical environment related to the accessibility of the place of residence, this includes natural obstacles, transportation system available and density, and appeal to the Census data for 2001, the National Statistics Institute (INE, 2001 Census). Accordingly, we obtained the following areas of residence:

Is it the distance a factor in the travel behavior? From the obtained data, it appears that students residing in zone 1, zone surrounding the University Campus, distinguished by being the only analysis of the various areas to use in their day to day preferably non-motorized modes, with 58 responses (46% of 126). As we go away from the Campus, we found a decrease in the relative value of students using the foot or bicycle mode. Thus, there appears to be an effect of distance on modal choice, noting that students who live near the college have a greater tendency to move by non-motorized modes. These results are consistent with the study of Naess (2003), which showed that the distance was an influential factor. The second zone, corresponding to the area of Porto, also includes a

considerable number of students (19.6%) who moves by non-motorized modes, which is understandable, because this is an area relatively close to the college. Note also that the zones 1 and 2 contain 91.8% of students living in rented houses (76.7% and 15.1% respectively) and all students living in university residences (41.7% and 58 3%, respectively). The housing scheme is associated with proximity to college. The vast majority of students living in rented houses or in university residences live near the college, so it seems that more than the housing regime, the proximity is the main factor for non-motorized modes.

Table 3.

Zone 1	characterized by its proximity to college, students can move easily on foot, this area has an average density (no. inhabitants / ha) of 44.25 and it is well served by public transport system, N = 126, 33 4% out of 377 respondents reported that postal code	Mapa das zonas em estudo 
Zone 2	characterized by being the area with the highest rates of population density (79.67 people per hectare) and a varied transportation system, N = 56, 14.9% out of 377 respondents	
Zone 3	areas outside the city of Oporto, served by a varied public transport system and with a mean density (no. inhabitants / ha) of 29.7, whose journey in network subway - college accounts for a time less than 30 minutes, N = 61, 15.5%	
Zone 4	areas outside the city of Oporto, north of the River Douro, which are served by the metro network, with an average density (no. inhabitants / ha) 16.8, N = 36, 9.1%	
Zone 5	areas outside the city of Oporto, north of the River Douro, which are not served by the metro network, with an average density (no. inhabitants / ha) 16.8, N = 36, 9.1%	
Zone 6	areas outside the city of Porto, southern to the River Douro that have no subway system, with an average density (no. inhabitants / ha) 16.8, N = 36; 9,1%	
Zone 7	brings together the most distant areas that were not mentioned in any of the other groups (N = 38, 10.1% out of 377 respondents)	

A best offer of public transport is a relevant factor in modal choice? The results showed that in zone 3, most students (50.8%; 31, 61) use public transport in their day to day, unlike what occurs in the other areas. Emphasize that this area is served by a variety of public transport, including the subway network which home-college route is relatively short and corresponds to the area best served by direct buses to the college, along with zone 1.

In fact, the zones 1, 2 and 3 correspond to those that are best served by public transport (bus and subway networks), although they present different mobility patterns. In zone 1, for its proximity to college, most students use mainly walking and cycling modes, so we may conclude, as advocated by Naess (2003), the distance factor prevails over a good public transport network. The

second zone has a lower number of students who use public transport (28.6%) compared to zone 3 (50.8%). Indeed, the data show that in terms of provision of public transport, the two areas are quite similar, but there is little variations that may help us understand better the results. A larger number of students residing in zone 3 have at their disposal more direct buses to college (39.3%) than in zone 2 (26.8%), subway station less than 400 meters away (34.4% and 25 , 0%, respectively), we concluded that the transportation systems services in the area 2 is slightly lower than in Zone 3. In this sense, when the local environment has available a good transport network and when they provide appropriate links, there is a greater propensity to use such transport (Ewing & Cervero, 2001). It should also be noted that these areas are also the areas with greater population density (44.25, 79.67 and 29.7 respectively). As referred by Rodriguez and Joo (2004) the population density tends to increase the use of non-motorized modes of transport, a situation that occurs in zones 1 and 2. It is also associated with mobility patterns that favor public transport (Ewing & Cervero, 2001), which occurs in zone 3. It seems, however, that distance has an important role here too, being difficult to discern which factors contribute more to the modal choice. Probably factors influence one another: for large distances, the density can be an irrelevant factor, but not for shorter distances. It is therefore necessary to interpret the density residential with caution, since other factors may overlap the importance of this (Ewing and Cervero 2001). For the density, we put the possibility of this relate to the provision of good public transport network. We consider that these three factors, distance, density and available transport network are interconnected, increasing the propensity to use alternative modes of transport to private transport. From the results, there are three zones that arise by not reflecting the current mobility patterns, the use of private transport does not prevail in relation to other modes of transport. In each contemplate a different assumption: While zone 1 is the nearest to the college and is the area where the vast majority of students moves from non-motorized modes, zone 3 has a better public transport system and is the only area where public transport prevails over individual transport. In zone 2, there is a more equitable distribution between the various modes, and a relevant percentage of students who move on foot or by bicycle, despite the higher percentage is found on private transport. In this regard, we note that the distance affects the modal choice, noting that, for short distances, students prefer the non-motorized modes, and for longer distances, preferably students use private transportation. Another factor related to the physical environment that seems to influence the modal choice is the transport system available in the area. When there is a good transport system, students tend to use more public transport. However, in our study, this factor does not arise entirely independently of the distance. The areas provided with better transportation systems are also the closest and is still important to note that the distance seems to be more important than the transport system available.

Final remarks

We found that half of students move on private automobile and out of those, more than half do it alone. When trying to understand if this mobility pattern is sustainable, respecting the need to travel and guaranteeing fundamental values such as environmental integrity, economic efficiency and social equality, we conclude, in comparison with the literature review that this value is not sustainable (Sanz, 1996; UITP, 2001, WBCSD, 2001; Sanches & Arruda, 2004). A mobility pattern based on individual

transport is more harmful to the environment, not only due to high fossil fuel consumption per passenger, as to the noise, or the rate of consumption of soil (either in the car parking as in the other necessary infrastructures for its operation) and because short travels, are the most polluting per traveled kilometer (Sanz, 1996; UITP, 2001; WBCSD, 2001; Sanches & Arruda, 2004). If most students use the car and this is a means of transport which means more costs, then we can consider that in economic terms this pattern has little efficiency. Thus, the current mobility patterns of FEUP students, by relying mainly on private transport, are not sustainable. Moreover, results showed that the weight of public transport is still limited, with only about a fifth of students who use them regularly. According to literature, within cities, for medium distances and harsh conditions (eg topography and climate), public transport are those with the greatest benefits in terms of sustainability (Nikjamp et al., 1996; UITP, 2001, WBCSD, 2001 ; BCSD, 2006), so that, in view of our results, it is urgent to take measures to make it more attractive and simultaneously adopting further measures to discourage the use of private transport. It should be noted however that the second mode of transport used, with about one third of the students, is going on foot. As it is known, for short trips, non-motorized modes correspond to more sustainable modes because they are cleaner and should consist of real alternatives (Rodríguez & Joo, 2004; Sanches & Arruda, 2004). In this sense, our results show that some students exhibit patterns of sustainable mobility, yet it is a condition that their place of residence is relatively close to the college. Indeed, proximity, like other characteristics, must be taken into account when analyzing the sustainability of transport modes, since one way, particularly non-motorized, may be appropriate for certain circumstances but not others, as for long trips.

In this study, we observed that exist significant differences between the different modes of transport, both in terms of average monthly expenses involved and the level of the average journey time. The car transport is on average faster than public transport, being fastness identified as a major reason for car use. Fastness is thus a factor influencing the choice of mode, and conducive to private transport. Furthermore, we found that the average cost involved with public transport is much lower than private transport, seeming to be equally influential as a factor in the choice of mode of transport to encourage use of collective modes. If we consider, as the literature argues that buses have a minor negative impact on the environment than the private mode, both in air pollution, as in terms of land occupation (UITP, 2001), it is important to adopt related measures - bearing in mind the results of the study - with fastness and the costs of transport modes. One of such measures could be the construction and definition of bus lanes, as advocates Aláez et al. (1996), in order to make collective modes faster. So far it seems a particularly relevant measure given the vast majority of students, who use public transport, relate facing daily traffic jams, obstacle surmountable by the construction of such bus lanes. One must, however attend simultaneously to other factors, since some studies have shown that a single intervention at the level of public transport is not sufficient to change mobility patterns (DGTT, 2006).

We noted also from the results of our study, that mobility patterns are influenced by multiple factors. Individual factors such as age, factors directly related to the modes of transport such as the fastness and factors related to place of residence, as the distance to the destination and the existence of a good transport network appear to influence the choice of mode. Furthermore, there are several factors as mentioned Naess (2003), which are sometimes interrelated, which in our study

occurred with distance, population density and transport networks in the area of residence, or with the distance and arrangements for accommodation, so understanding the role that each factor carries is extremely difficult and requires some caution. Among individual factors, results indicated that age affects the modal choice, with a tendency for older students to use private transportation. In this sense and confirming the hypothesis placed so far, it seems important to focus studies on the younger population and understand their mobility patterns can be a means to encourage the use of more sustainable modes of transport. This happens once young people have a greater propensity to use them, making it easier to encourage behaviors that already occur than changing behaviors. The results also revealed that owning your own car, is an important indicator of travel behavior, as seen in other studies (Cervero, 2002; Naess, 2003; Sanches and Arruda, 2004; Ewing et al., 2005), in this study most students have their own vehicle. The housing scheme is associated with proximity of the place of residence to the college, being by this way these two factors correlated. Thus, it appears that students who live in leasing are close to the college, and tend to use more non-motorized modes while students living with family in more remote areas of residence, tend to use more private transport. In this sense, our study found that the distance seems to be the most influential factor in modal choice, result in conformity with those found in other studies (Naess, 2003, Kennedy et al., 2005).

Indeed, for the home-school journey, for short distances, the mode of transport on foot or bike proves to be the preferred by students. Thus, taking into account that only a small percentage of students live near the college, the university campuses urban planning should consider the possibility of students to live nearby, either by the construction of student residences or by opting for a revitalizing areas of the centers in detriment of the creation of new housing areas in the periphery. By increasing the supply of residence in the area surrounding the campus and the inclusion of a greater number of required services, which are currently only available in the city center, it would be possible for a greater number of students live near the college, encouraging sustainable mobility patterns. As Barjas (2003) points out, sometimes the campuses are fragments of a city that urgently need to be integrated in the city where they are located, while not having, as is the case of the university campus in the study, many services essential to their quality of life. It should be noted that the measures would involve advanced coordination of various entities and strategic thinking in the long term, compromising politicians, planners and managers. In house-college travel option when it comes to longer distances, we found in our study that the scenario changes: the preferred way is always the individual transport. However, if in the areas of residence exists a wide network of public transport, with direct transport to the destination, as in one of the analyzed areas, the preferred mode is the collective. In this sense and as regards Naess (2003), under certain circumstances, public transports can be viable alternatives to private transport. For this possibility, in addition to distance, appear to compete spending, it is important that expenditures are lower than those with private transport and fastness too, requiring that public transport undertakes faster trips, to decrease the time difference existing between both modes. We therefore consider that the measures taken to increase the attractiveness of public transport must necessarily consider the reduction and reliability of travel time (eg through the operation of bus lanes and real-time information at bus stops).

In conclusion, we consider that it essential to find answers to current problems of displacement of students in order to promote sustainable mobility. The results show the possibility of increasing the attractiveness of public transport and encourage non-motorized modes, if certain conditions are achieved. However, results also show the need to adopt several measures simultaneously, which can only be achieved through the articulation of different agencies: public transport services, universities, municipalities and government.

The mobility patterns of FEUP students are not sustainable and being identified fundamental key factors to promote their improvement.

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The true cost of road traffic noise in Portugal

Cecilia Rocha, Álvaro Costa, António Carvalho

Laboratory of Transports, Faculty of Engineering University of Porto

Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

Laboratory of Acoustics, Faculty of Engineering University of Porto

Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

This paper presents some results of the ongoing investigation concerning the economical evaluation of road traffic noise. As the majority of the European countries, Portugal has part of its 10 million citizens exposed to excessive noise levels, according to the WHO suggested values. Considering the relevance of this subject and the constant increase in road traffic volume, it was recognized the importance of an economical valuation of this excessive noise levels, referred to three cost categories: *infrastructure* (increase in the infrastructure cost due to the constructions of noise mitigation measures), *noise externalities* (connected to social, real estate and health noise related costs) and *real estate income loss* (allied to the inability for construction in available land for construction based on excessive noise and the consequent reduction of the patrimonial value). This paper illustrates some of the investigation results for specific municipalities regarded as representative of the municipalities' majority according to its territorial, economical and urban planning characteristics.

1. Introduction

Since the approval of new statutory documents concerning the *third Portuguese Noise Code*[1], the *Real Estate Taxation Codes*[2], the *Territorial Management Systems*[3] and, lately, the *Strategic Environmental Assessment of Territorial Management Plans*[4], the relevance of environmental issues increased and most Portuguese municipalities began to explore the implications of this inconsiderateness.

Taking into account that almost all the cities are undertaking the revision of their Municipal Director Plans (MDP), these legal changes induced severe transformations on the scheduled work. They were obliged to produce Noise Maps and to classify the urban territory regarding noise sensitivity of present and expected uses and to perform the strategic environmental analysis of the upcoming MDP, including the concerns of the population that should be consulted through public participation mechanisms. One of the principal components of this strategic analysis is the preliminary detection of environmental concerns, which could be avoided with the adoption of mitigation measures of diverse types. Concerning noise, some of the questioned measures involve territorial management change (redistribution of incompatible uses), traffic reorganization and traffic calming measures or modification of the regular dressing surfaces (replacement for "*noise-friendly*" surfaces).

To define the "*best noise reduction procedures*" there is the need to identify all noise conflict areas, in each municipality, and to decide if the adequate measures depend on municipal actions or on private actions. To this investigation will be considered the mitigation actions already in-place either from public or private implementation.

2. Noise legal framework

Until 1987, when the *first Portuguese Noise Code* (RGR)[5] and the *Environmental Act*[6] were approved, the *Portuguese Constitution*[7] was the only statutory document where environment and welfare was mentioned. In fact, general concepts of welfare, quality of life, environmental rights,

nature and environmental protection and natural resources protection were stated on articles 9, 66 and 81 and referred as National Authorities responsibilities.

Since then, was approved the *second Noise Code*[8] (RLPS) with the same scope of application but with a new acoustical parameter L_{Aeq}. The subsequent legal document was Decree-Law n.º 146/2006[9], which transposed the European Directive 2002/49/CE, 25th June into the Portuguese legislation, changed once more the acoustical reference parameter (from L_{Aeq} to L_{den}), introduced three reference periods: day (7 h – 20 h), evening (20 h – 23 h) and night (23 h – 7 h) and also strategic noise mapping, action plans and the obligation for public information and participation. Finally, in January 2007, the *third Noise Code*[1] was approved (RGR), harmonizing acoustical parameters, reference periods and noise limits as indicated on Table 1.

Table 1. Maximum Noise limits and Form of occupancy for Mixed and Sensitive zones[1]

Form of Occupancy	Full day period (0 h – 24 h)	Nighttime period (23 h – 7 h)
Mixed Zone	L_{den} = 65 dB(A)	L_n = 55 dB(A)
Sensitive Zone	L_{den} = 55 dB(A)	L_n = 45 dB(A)
Sensitive Zone close to an existent MTI	L_{den} = 65 dB(A)	L_n = 55 dB(A)
Sensitive Zone close to a MTI during design stage (not for airports)	L_{den} = 60 dB(A)	L_n = 50 dB(A)
Sensitive Zone close to a major airport during design stage	L_{den} = 65 dB(A)	L_n = 55 dB(A)
Sensitive Receivers on non classified zones	L_{den} = 63 dB(A)	L_n = 53 dB(A)

MTI - major transportation infra-structure

With this new RGR, municipalities were advised to produce noise maps (L_{den} and L_n, at 4 m height) as a supportive planning tool for the elaboration, alteration and revision of municipal director plans (MDP). It is stated that municipal director plans should guarantee environmental noise quality, promoting reasonable distribution of activities and noise sources as well as establishing noise classification areas (sensitive and mixed zones).

According to RGR, *licensing or authorizing new dwellings is forbidden, as well as new schools, hospitals or similar social equipments and leisure spaces, while the settled environmental noise limits are exceeded*. The only exceptions are new housing, in "*consolidated urban areas*", with approved Municipal Noise Reduction Plan (MNRP) or where environmental noise limits are not exceed more than 5 dB(A). In this situation ought to be considered façade sound insulation reinforcement by 3 dB(A).

3. Case study municipalities

For the evaluation of road traffic noise cost were selected two cities in the north region of Portugal (Maia and Santa Maria da Feira) which can be consider as representatives of the great majority of the Portuguese counties. Thus, the municipality of *Maia* intends to represent cities with a strong services sector and reveals a significant industrial presence, given its proximity to major

transportation infrastructures. The land use distribution demonstrates a dense urban occupation pattern (about 40% of the territory is classified as urban) and is densely populated (close to 1 700 hab/km^2). *Santa Maria da Feira* is a municipality with an extremely relevant industry sector, although the services sector is also present, and represents an important part of the municipal economy. As for land use characteristics, there is a dichotomy of occupation spite the consideration of 34% of the territory as urban. The western part of the municipality is more densely occupied and its inner part is dedicated to others forms of occupancy less populated.

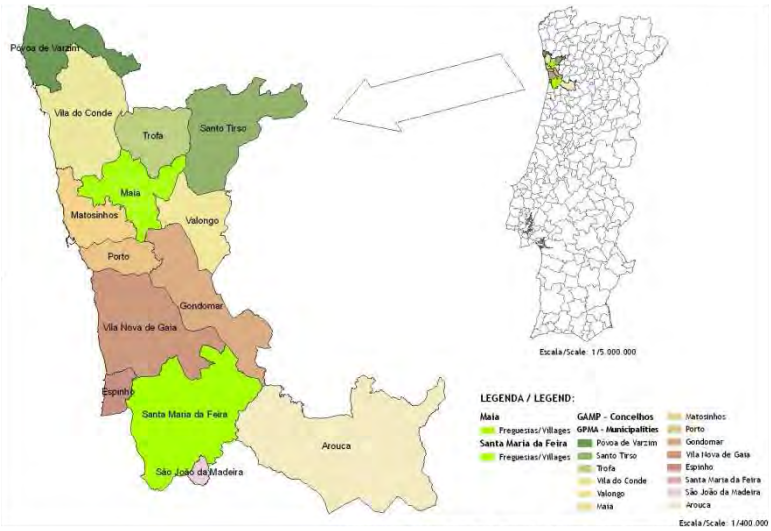


Figure 1. Case-study municipalities' location (Maia and Santa Maria da Feira).

Table 2. Summary table with characteristic indicators (2007) of Portugal and Case Study municipalities [(10) (11) (12) (13)]

Characteristics	Portugal	Maia	S.M. Feira
Population	10 599 095	138 226	146 367
Parishes ("*freguesias*")	4 260	17	31
Population density (inh/km^2)	114	1 663	680
National Road density (km/km^2)	10	0.3	0.2
Activity Sector (%GDP):			
Primary: agriculture/fishing	2.4%	0.1%	0.3%
Industries	21.2%	39.5%	65.5%
Services	62.5%	60.4%	34.2%
Actual MDP	-	2009	1993
Area (km^2)	92 090	83	215
Land use: urban (ha)	481 082	3 267 (39%)	7 359 (34%)
Land use: industrial (ha)	75 151	769 (9%)	530 (2%)
Land use: public equipments and parks (ha)	37 837	982 (12%)	419 (2%)
IMI Tax		0.50%	0.50%
IMI income		€ 16 840 361	€ 11 361 210
Percentage of total revenue		20%	19%

4. Infra-structure cost

The evaluation of the *infrastructure cost surplus* was conducted through the analysis of all the investments performed by road concession holders with the purpose of eliminating the existent noise conflicts, both in the 24 h period (L_{den}) and in the nighttime period (L_n).

From the available noise alleviation measures, both concession owners chose to implement measures in the noise source (noise-improved pavements) and on the noise path (noise barriers) for a better protection of the receivers, mostly in dwellings, with the guaranty of an effective environmental noise reduction.

The unitary cost of these measures is summarized in Table 3, together with the *global additional cost* (Δ) for the construction and *global cost* for renewal of special noise reduction pavements (considering as reference surface: *dense asphalt concrete*) and the *full investment cost* for noise barriers. The average renewal price is referred to the construction year through the consideration of discount rates in order to achieve the Present Value (PV)[14]:

$$PV = \left[\frac{1}{(1+i)^n} \right] \quad (1)$$

where:

i – discount rate

n – year of expenditure (pavement rehabilitation)

The *regular maintenance operations cost* both for noise barriers and noise-reducing pavements were not considered, as there is no standard enforcement for these procedures.

Table 3. Summary table with the implemented noise mitigation measures [15], [16]

Characteristics	€/m^2	Maia	S.M. Feira
Pavement with improved Acoustical performance			
Reference Surface: DAC (dense asphalt concrete)	3 - 4		
PAC (porous asphalt concrete)	5 - 6	356.250 m^2 Δ = € 710.500	287.834 m^2 Δ = € 575.668
PERS (poro-elastic road surface)	4 - 5	472.450 m^2 Δ = € 472.450	-
Average cost for pavement renewal (each)	6 - 8	€ 2.493.750	€ 2.014.838
Noise Barriers			
Leca block wall with absorption (*Leca®Mursom*)	70 - 80	143.702 m^2 € 10.777.650	-
Metallic with absorption	120 - 140	-	17.622 m^2 € 2.290.860
Acrylic	140 - 150	1.650 m^2 € 239.250	1950 m^2 € 282.750

5. Noise externalities

The *noise externalities* were estimated taking into consideration two primary aspects: *Health Impairment* and *Annoyance*, usually supported by the population in general and, in particular, by those who experience directly those negative impacts.

Concerning *health impairment*, excessive traffic noise levels can motivate different health effects, for instance, *sleep disorders*; *weaken concentration* skills and related *working injuries* or *reduced productivity*; *diminished learning and understanding* aptitude; *hearing damage*, *stress episodes* (leading to change of heart beat frequency, increase of blood pressure and hormonal variations) and even an increasing risk of *cardiovascular diseases* and *psychiatric disorders*. These health costs might be evaluated through medical costs, productivity and working time loss or raised mortality costs. An estimate performed by CE Delft[17] for T&E, evidenced average social costs, due to excessive traffic noise levels, over € 40 billion per year on EU22 countries, mainly derived from road traffic (90%).

With reference to *annoyance*, the "*feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them' or 'a feeling of resentment, displeasure, discomfort, dissatisfaction or offence which occurs when noise interferes with someone's thoughts, feelings or daily activities'* "[18], the evaluated impacts refers to the mentioned disturbance experienced by citizens exposed traffic noise.

Taking into consideration the quality of data, it was not possible to perform all the initially expected calculations. As so, it was considered an alternative estimate method, for which all the anticipated information was available. The elected method was the one defined on the European Project HEATCO (Developing Harmonised European Approaches for Transport Costing and Project Assessment) for the evaluation of environmental costs and, in particular, costs related to noise.

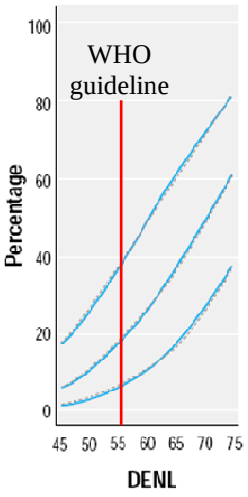
The assessment methodology was the *Impact Pathway Approach* (IPA)[19]. This method involved the consideration of noise dispersion models (including emission and propagation mechanisms) and the associated noise levels on the receivers, both in the Initial Situation (Do-nothing situation) and the Final Situation (Do-something situation: Noise mitigation measures), whose results are indicated in Table 4.

This variation on environmental noise levels was assessed in terms of welfare changes (health impacts and annoyance) and, later, quantified through concepts of monetary valuation, namely, *willingness-to-pay* for noise reduction, which allowed determining *Noise Costs*.

This line of action followed the subsequent steps: *calculation of noise exposure* for the initial situation without noise reduction procedures; calculation of *annoyed and sleep-disturbed persons* with exposure-response functions (ERF) and *monetary valuation* of those impacts. Then, reapply the same procedure for the final situation incorporating the implemented mitigation measures. The results of these procedures are graphically revealed in Figure 2 and Figure 3.

Table 4. Summary table for exposed population *before* and *after* the execution of noise mitigation measures (NMM)

Noise Classes	Exposed population in Maia		Exposed population in S.M. Feira	
	Before NMM	*After NMM*	*Before NMM*	*After NMM*
$L_{den} \geq 75$ dB(A)	5192	3894	36	27
$65 \leq L_{den} < 75$ dB(A)	25 747	24528	8 869	8 449
$55 \leq L_{den} < 65$ dB(A)	49 656	44691	18 473	15 458
$45 \leq L_{den} < 55$ dB(A)	26154	31385	30 794	32 728
$L_{den} < 45$ dB(A)	*5471*	*7722*	*71 906*	*73 416*
$L_n \geq 75$ dB(A)	360	270	0	0
$65 \leq L_n < 75$ dB(A)	8 650	7353	21	2
$55 \leq L_n < 65$ dB(A)	30 719	24575	5 702	4 832
$45 \leq L_n < 55$ dB(A)	52701	55336	22 749	19 466
$L_n < 45$ dB(A)	*19790*	*24686*	*101 606*	*105 778*



Percentage of "*Little Annoyed*" persons

$$\%LA = -6.235\times10^{-4}\,(L_{den}-32)^3 + 5.509\times10^{-2}\,(L_{den}-32)^2 + 0.6693\,(L_{den}-32) \quad (2)$$

Percentage of "*Annoyed*" persons

$$\%A = 1.795\times10^{-4}\,(L_{den}-37)^3 + 2.110\times10^{-2}\,(L_{den}-37)^2 + 0.5353\,(L_{den}-37) \quad (3)$$

Percentage of "*Highly Annoyed*" persons

$$\%HA = 9.868\times10^{-4}\,(L_{den}-42)^3 - 1.436\times10^{-2}\,(L_{den}-42)^2 + 0.5118\,(L_{den}-42) \quad (4)$$

Percentage of "*Highly Sleep Disturbed*" persons

$$\%HSD = 20.8 - 1.05L_{night} + 0.01486L_{night}^2 \quad (5)$$

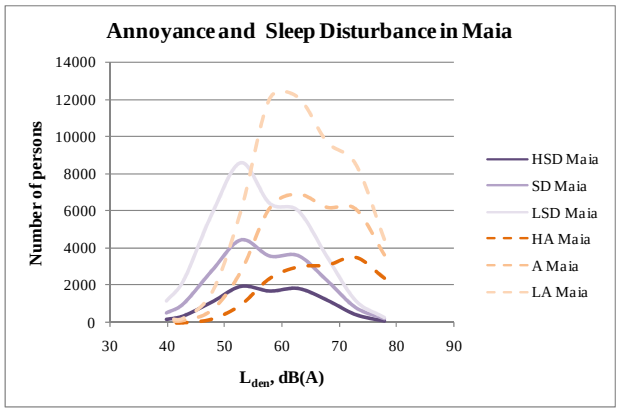
Percentage of "*Sleep Disturbed*" persons

$$\%SD = 13.8 - 0.85L_{night} + 0.01670L_{night}^2 \quad (6)$$

Percentage of "*Little Sleep Disturbed*" persons

$$\%LSD = -8.4 + 0.16L_{night} + 0.01081L_{night}^2 \quad (7)$$

Figure 2. Estimated curves and polynomial approximations for L_{den} and L_{night}, regarding *annoyance* [20], [21] and *sleep disturbance* [22] for road traffic noise.



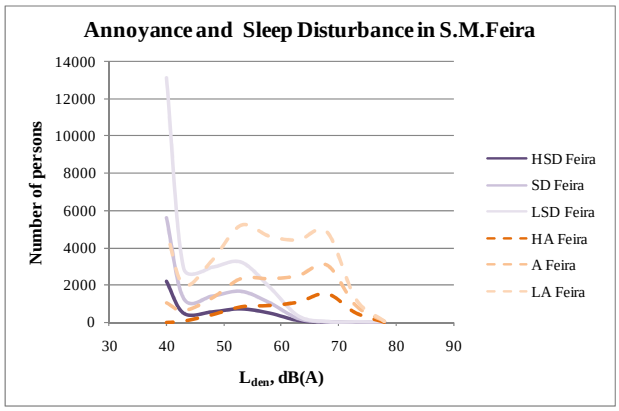


Figure 3. Estimated number of people *A-annoyed* (L_{den}) or SD-*Sleep Disturbed* (L_{night}) due to road traffic noise exposure, in Maia and Santa Maria da Feira.

For the monetary comparison were applied the *HEATCO noise cost factor tables* derived for Portugal[23), (24), (25)], by person and by year, to the highly annoyed population in the Initial Situation (IS) and in the Final Situation (FS). These tables include both health and annoyance costs in two situations: "*New approach*" (health and annoyance was based on dose-response functions); "*Central value*" (health and direct WTP for reducing annoyance based on 'stated preference' studies) and the results are indicated in Figure 4.

L_{den}		n.º persons	Noise Cost	Δ persons	Δ noise cost
"New approach"	***Road***				
Maia	IS	107 684	€ 2 341 238	-1 863	-€ 192 543
	FS	105 821	€ 2 148 695		
S.M.Feira	IS	64 016	€ 727 971	-851	-€ 44 916
	FS	63 165	€ 683 055		
"Central values"	**Road**				
Maia	IS	96 371	€ 5 852 054	-4 324	-€ 528 242
	FS	92 047	€ 5 323 812		
S.M.Feira	IS	40 020	€ 1 698 843	-3 930	-€ 170 722
	FS	36 090	€ 1 528 121		

Figure 4. Estimated global Noise External costs per year in Maia and Santa Maria da Feira.

6. Real estate cost

The *noise indirect effects on municipal taxes income* were modeled in view of three main areas: *Territorial Management*, *Noise* and *Real Estate Taxation*.

Regarding *territorial management*, was collected all the significant data on municipal territorial partition like urban space characteristics, present constructions, most relevant activities, *spatial distribution of uses* and *construction potential coefficient* (CPC) by use; and the effective *constraints* as ecological, natural and agricultural reserves, forest and wood production areas, protection area to the transportation infra-structures (airport, aerodrome, railway, metro and road), preservation area to patrimonial constructions, etc.. In fact, there was a common constraint between territorial management and noise, *Noise Classification Zones*.

With reference to *noise*, was gathered all the information related to the previous noise map and was introduced and calculated the new L_{den} and L_n parameters. With this information congregated with territorial planning guidelines were designed the municipal noise classification zones. Subsequently, it was possible to determine the presence of *conflict areas*[228]and the related *degree of conflict* (how many dB(A) exceeding the legal noise limits).

Concerning the *real estate taxation model*, the new IMI Code[(2)] (2003 and revised in 2006) was the primary working material. The calculation of *equivalent area* (A) and the definition of the *location coefficients* were the most important tasks, especially as there was no data available. All the data had to be calculated or determined through indirect techniques. The first information needed refers to vacant building area. The analysis of the present situation, in terms of construction, revealed the status of land occupation. Joining that information with building restrictions was calculated the *vacant land for construction*, according to the future activities and class of use.

However, for the purpose of this study, the interesting vacant land for construction did not refer to its total extent. In fact, the relevant area for analysis was the one under a noise conflict. Therefore, the following step was area selection. From all the vacant land for construction, it was only essential to consider *noise conflict influenced areas* whose primary occupation would be noise susceptible, as housing.

Afterwards, as the patrimonial value depends on the construction area, it was required to estimate the maximum achievable total construction area. In the Municipal Director Plan (MDP) regulations and in line with the possible uses of each class of urban space, are specified the construction parameters, which allowed the calculation of the expected *total construction area of the municipality under noise conflict*.

The computation of *equivalent area* (A) involved the observation of complementary information with diverse nature. On one side, there is the evaluation of the possible construction area (A_a and A_b) and, on the other, the remaining area of the allotment (A_c and A_d). The influence of taxation model arises at this point with the *location coefficient for land value* (% T) and, afterwards, with *housing location coefficient* ($C_{L\ housing}$). These two factors along with the *construction value* (V_c), *area function* (C_a) and *quality and comfort coefficients* (C_q) will consent to the estimate of the total patrimonial value as a *regular urban property*.

[228] Human occupied areas where environmental noise surpasses the correspondent *noise limit*.

$$V_{t\ \text{regular urban property}} = V_c \times A \times C_a \times C_{L\ \text{housing}} \times C_q \quad (8)$$

$$A = (A_a + 0.3\,A_b) \times \%\,T + (0.025\,A_c + 0.005\,A_d) \quad (9)$$

This process was reapplied, in the context of "other" urban property, but now the important factors were the *construction value* (V_c), *housing location coefficient* ($C_{L\ housing}$) and the *allotment area* (A_T) which will determine the new patrimonial value as *other urban property*.

$$V_{t\ \text{other urban property}} = V_c \times A_T \times C_{L\ \ housing} \times 0.005 \quad (10)$$

The last procedure refers to the real estate tax calculation – IMI value.

Each municipality has an individual tax with a maximum of 0.5% whose application to the calculated patrimonial values will endorse the estimate of municipal tax income loss.

Table 5. Assessment table for real estate cost related to excessive environmental noise levels

Characteristics	Maia	S.M. Feira
A (m^2)	1 407 554	62 463
V_c (€/m^2)	615	615
C_a (average)	0.97	1.00
C_q	1.00	1.00
$C_{L\ dwellings}$ (average)	1.19	0.96
$C_{L\ land\ for\ construction}$ (average)	0.25	0.19
Patrimonial value (Vt): Land for construction	€ 1 027 600 375	€ 36 529 805
Patrimonial value (Vt): Other properties	€ 27 144 811	€ 1 056 362
IMI tax (2007)	*0.50%*	*0.50%*
IMI revenue: Land for construction	€ 5 086 640	€ 182 252
IMI revenue: Other properties	€ 133 189	€ 4 918
IMI revenue variation	*€ 4 953 451*	*€ 177 334*

7. Results

In Table 6 are presented the preliminary results of this study for an expected lifetime of 20 years (standard horizon for the road network in Portugal).

During this time frame for the *noise mitigation measures*, the noise-improved surface is expected to require two renewals (compared with dense asphalt concrete), noise barriers are considered to be in place and effective for the overall period. In both cases, no maintenance operations are expected.

Regarding *noise-exposed population*, were calculated the expected noise externalities (health and annoyance costs) according to HEATCO procedures for the Do-nothing and Do-something Situations. For *real estate costs* was also calculated the expected reduction in municipal

IMI income for both situations. Finally, was evaluated the difference between the noise related costs in the initial situation and after the investment and implementation in noise mitigation actions.

As it can also be seen in Figure 5, the situation is not similar for the two municipalities. In fact, there is a significant disparity between them and one of the most probable reasons might well be the "*urbanity*" of Maia contrasting with Santa Maria da Feira. Maia is a municipality with all noise sources possible and with an important part of its territory already occupied (housing, services, public facilities, diverse modes of transportation and an important industrial area) on the other hand; Santa Maria da Feira has a considerable part of the territory (almost two thirds) dedicated to natural reserves, thermal-water areas and yet to be built zones, where one primary mode of transportation: road network and multiple industrial plants not concentrated in industrial areas.

Table 6. Summary results for road traffic noise related costs

	"New approach"		"Central values"	
	Maia	**S.M. Feira**	**Maia**	**S.M. Feira**
	L_{den}		L_{den}	
Noise externalities with no noise-reduction actions (20 years)	*€ 46 824 760*	*€ 14 559 420*	*€ 117 041 080*	*€ 33 976 860*
Health costs (per year)	€ 2 341 238	€ 727 971	€ 5 852 054	€ 1 698 843
Annoyance cost (per year)				
Real Estate Cost with no noise-reduction actions (20 years)	*€ 99 069 020*	*€ 3 546 680*	*€ 99 069 020*	*€ 3 546 680*
reduction municipal IMI income (per year)	€ 4 953 451	€ 177 334	€ 4 953 451	€ 177 334
	€ 145 893 780	***€ 18 106 100***	***€ 216 110 100***	***€ 37 523 540***
Noise externalities with noise-reduction actions (20 years)	*€ 42 973 900*	*€ 13 661 100*	*€ 106 476 240*	*€ 30 562 420*
Health costs (per year)	€ 2 148 695	€ 683 055	€ 5 323 812	€ 1 528 121
Annoyance cost (per year)				
Real Estate Cost with no noise-reduction actions (expected for 20 years)	*€ 66 046 013*	*€ 1 773 340*	*€ 66 046 013*	*€ 1 773 340*
reduction in municipal IMI income (per year)	€ 3 302 301	€ 88 667	€ 3 302 301	€ 88 667
	€ 109 019 913	***€ 15 434 440***	***€ 172 522 253***	***€ 32 335 760***
Additional infrastructure cost				
Pavement (including 2 renewals)	€ 6 170 450	€ 4 605 344	€ 6 170 450	€ 4 605 344
Noise Barriers	€ 11 016 900	€ 2 573 610	€ 11 016 900	€ 2 573 610
	€ 17 187 350	***€ 7 178 954***	***€ 17 187 350***	***€ 7 178 954***
Population (inhabitants per municipality)	112 220	130 078	112 220	130 078
Initial Noise Externalities and reduction IMI income (by inhabitant)	€ 1 300	€ 139	€ 1 926	€ 288
Investment in noise mitigation measures (by inhabitant)	€ 153	€ 55	€ 153	€ 55
Remaining Noise Externalities and reduction IMI income (by inhabitant)	€ 971	€ 119	€ 1 537	€ 249
True Cost of Road Traffic Mitigation (by inhabitant)	***€ 175***	***-€ 35***	***€ 235***	***-€ 15***

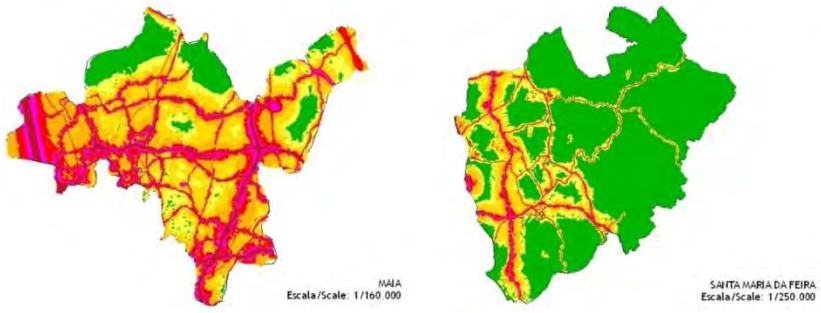


Figure 5: Noise Maps (L_{den}) from Maia and Santa Maria da Feira.

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Short papers

Evaluating Walkway Environment in Guimarães City Center, Portugal

Khan Rahaman, Júlia Lourenço

Department of Civil Engineering, University of Minho, Campus de Azurem, 4800 058 Guimarães, Portugal

rubayet@civil.uminho.pt

Phone/fax numbers: +351 965970 000 Ext: 517249

Planning pedestrian environments require assumptions about how pedestrians will respond to characteristics of the walking environment in city center. Guimarães city center has a long history from medieval period to encourage walkers in the city center for different purpose. The city center connects well with major attractions of the city along with a very good open space and varieties of shops nearby. Walking is being considered as one of the egress and sustainable mobility modes of urban transportation especially in the city center. But, walkers face several problems considering safety, continuity, landscape, walkway surface and illegal parking and unwanted hindrances. This study focuses the present problems experienced by the walkers in Guimarães city center. Prescribed questionnaires have been surveyed to the walkers in January 2010 to evaluate the pedestrian's impression about different problems while walking in the city center. Observation surveys have been followed to assess the pedestrian flow and volume in the study area. Result shows that most of the pedestrians consider illegal parking on sidewalks and hindrances on walkways as major problems. At the same time, walkers also put better impression on walkway's safety considering the elevated sidewalks and well maintained crossing lights and colors. This paper also tries to explain the walkway's problems in detail so that they can be considered in the transportation and mobility plan of the city in near future to take the advantage of receiving significant number of tourists in coming years as the European Capital of Culture in 2012.

Keywords: Walkway, Environment, City Center, Guimarães.

1 Introduction

Walking is one of the oldest and most basic forms of human transportation. It requires no fare, no fuel, no license, and no registration (Portland, 1998). With the exception of devices to enhance the mobility of the disabled, walking demands no special equipment. Thus, walking is the most affordable and accessible mode (Rahaman, 2006). Innovations in planning for pedestrians have occurred largely in response to environmental pressures. In the first half of the nineteenth century, the arcade offered protection from wheeled traffic as well as a clean, dry surface for walking when European streets were poorly drained, even treacherous (Zacharias, 2001). In Portugal, the two largest cities, Lisbon and Porto, experienced successful revitalization attempts of their riverfronts and city centres during the second half of the 1990s with special programs of widening the enhancing public space walkways to encourage more pedestrian activities (Carlos, 2007). However, medium – sized cities like Braga and Guimarães are yet to be studied for Pedestrianization and problems of walkers. Municipalities are incorporating pedestrian plans inside the urban transportation planning system. This creates opportunities for the walkers to get better walkways but most of the time, transportation plans are highly burdened with infrastructures and motorized mobility plans. When the term revitalization is used in medium sized cities, it also appears with urban landscape planning and motorized accessibility to the city centers as experienced in the past decades. This paper tries to highlight the existing problems of pedestrians on walkways in Guimarães city center and to bring attentions and policies that may offer walkers a smooth and comfortable sidewalk environment. Walkways in Guimarães city center are very well connected among different urban facilities such as:

police station, shopping centers, University of Minho, Guimarães castle and football stadium. Walkers and tourists, who are using walkways to take a short trip (within 2 kilometers) among those urban attractions, are feeling more comfortable when the walkways are free of illegal parking and free from unwanted obstacles. Series of interview and observation surveys have been carried out to assess the walkway environment in city center to quantify the result. It incorporates the impression of walkers to know their satisfaction level while using the walkways in Guimarães city center based on prescribed criteria too.

2 Objectives

This study has two specific objectives as:

i) To know the existing pedestrian problems in Guimarães city center based on interview and observation survey and

ii) To assess the walkway environment based on seven prescribed criteria

3. Study Area

Guimarães, a northern city of Portugal, has a very rich cultural heritage and it keeps projecting itself in the future. It will be European Capital of Culture in 2012. The municipality has a land area consisting almost 241 sq. km with 161,000 inhabitants (Guimarães Municipality, 2010) but its head consists of 40.000 inhabitants. Over many years, Guimarães city officials pursued a policy of preserving architectural forms and rededicating spaces to new functions so that old and forgotten areas of the city center were given a rebirth. Guimarães is the focus of greater levels of interest and recognition, both nationally as the first capital of Portugal and internationally, as a result of the city's strong commitment to the criteria it adopted and craftsmanship it supported in this area. The last thirty years have testified the accomplishment of some old projects and ambitions.

The renovation of public spaces and of municipal buildings, dedicating them to new functions and services, along with the technical and financial support for private initiatives, represent the three main strategies that have helped in achieving the prime goals for the Historic City Centre of Guimarães. Those goals were basically:

First, the renovation of the landmarks in the Historic City Centre strove for the highest level of authenticity by using traditional materials and techniques, an ideal which not only maintained the architectural integrity but also respected the quality of form and function.

Second, the number and type of residents living in the Historic City Centre should be maintained the living conditions of this population improved and gentrification was not welcomed.

The historical city center is dedicated for the walkers with pedestrian precinct. But the adjacent areas have access to cars and motorized vehicles with several shops that attract people to buy different kinds of goods. The study has identified that there are different types of shops in the adjacent areas of city center as: newspaper stands, pharmacies, clothing shops, souvenir shops, kiosks, restaurants, others. In the central area, there is water fountain and beautiful seating arrangements for people who can spend time walking and seating in the sun. The space is landscaped with small trees, buckets of flowers and small gardens. Walkways are well connected within 1 kilometre radius of city center to integrate football stadium, police station, University of Minho

campus, shopping malls, municipality office, historical monuments, church and the famous Guimarães castle to attract tourists and local people.

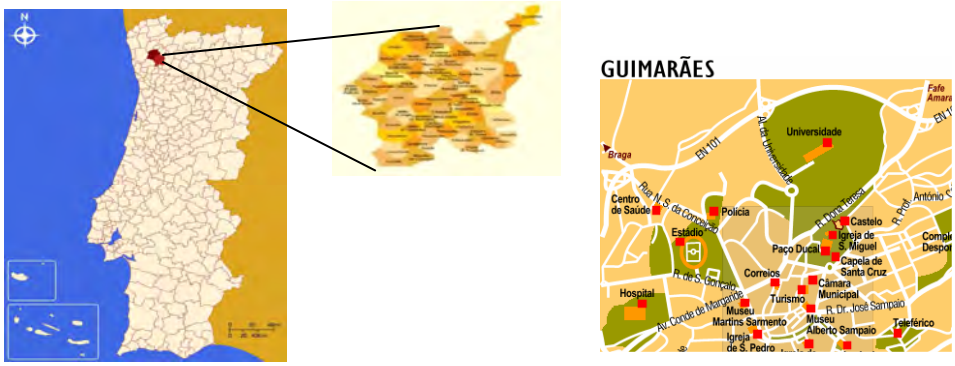


Figure 1. Map of Guimarães and Guimarães city center.

Above figure shows the map of Guimarães and the detail city center streets. It can be seen that the major attractions are very near by from the city center of Guimarães city to walk within 2 km radius. Both sides of the road in city center have sidewalks and at the center, there is a pedestrian precinct.



Figure 2. Pedestrian Precinct and Sidewalks in Guimarães city center.

Figure 2 shows the beautiful city center with wide pedestrian precinct. Next to the pedestrian precinct, streets are shouldered with beautiful sidewalks. But the sidewalks have some major problems which will be discussed in following sections.

4. Methodology

In the beginning, there were almost nine criteria were fixed based on literature and practical experiences to assess the walking environment in city center of Guimarães. After careful review and judgment, seven criteria have been finalized as:

a) Discontinuity of walkways : It incorporates the pedestrian's perception about safety as well while walking in city center.

b) Space: It offers the assessment of having enough space for walking in city centers and on sidewalks
c) Hindrances: Mostly considers unwanted items on sidewalks which are creating problems to the pedestrians. For example, switch boards and electrical wires.
d) Illegal Parking: Illegal parking on sidewalks creates problems for walkers and forces them to walk on carriage way which is considered one of the major assessment criteria for city center walking environment.
e) Street Furniture: It considers the smoothness of walking environment, landscape and streetscapes. These furniture are being placed to increase beautification of the city center but those sometime offer unpleasant walking environment.
f) Dustbins: Those are also considered as hindrances but can also put other problems in terms of pungent odor on sidewalks.
g) Shades: these are typically shades for walkers during rain and warm sunlight.

Indeed, weather condition and waste on walkways did not get significant values during survey. For this, those two criteria have been omitted in the end. After fixing these criteria, a brief questionnaire has been prepared to take interview to the walkers in Guimarães city center. One hundred questionnaires have been distributed and graduate students have been sent to ask the questions on street at different time period. Observation survey has been conducted in the same period of time to know the pedestrian speed and volume, physical features on walkways followed by photographs that describe well about the existing problems in the studied area. Finally the collected information have been summarized and analyzed following simple statistical methods in a presentable format.

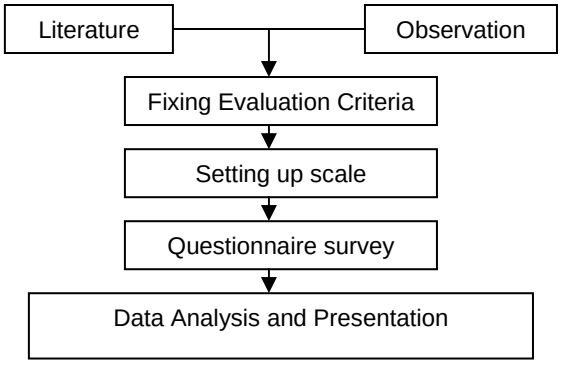


Figure 3. Work Flow Diagram.

The above figure shows the simple procedure of the present study. Seven criteria have been assessed both in terms of subjective and objective form. Pedestrians chose their standing in a scale of 1 (best case) to 5 (worst case) to rate the present situation of walkway environment in Guimarães city center. It has been plotted in graphs to show the results at the end.

5. Who are the walkers in Guimarães?

Recent guidelines for physical activity recommend that adults accumulate, on most days, 30 minutes or more of moderate-intensity physical activity (such as brisk walking), in minimum bouts of around 10 minutes (Pikora, et. al., 2003). Transport research unit of Oxford University has unveiled

information (2005) that in Portugal, 49.9% of the families have at least a car. During the last couple of years, the car ownership in Portuguese cities grew even faster and has been predicted that at least 68% families have a car in 2008 (Dargay. J, 2005). In this regard, number of walkers has decreased for longer trips but inevitably people need to walk for taking transits, especially in the city center.

Table 1. Walkers in Guimarães city center

Time Segments	Youth (0 to 15)	Young Adults (15 to 40)	Adults (40 to 65)	Elderly (65+)
Morning (upto 12 AM)				
Lunch Hour (12 to 15.00 PM)				
Afternoon (15h – 17h)				
Afternoon(17h-20h)				
Night (20-23h)				
Night (23-2h)				
Night (After 2h)				

Legend:

Less than ≤ 20%	
20% <Medium Low ≤ 35%	
35% <Medium ≤ 50%	
50% <High ≤ 65%	
Very high> 65%	

Table above shows that young adults between 15 to 40 age group are walking more than other age groups in Guimarães city center. At the same time, young adults chose to walk more during the night as because of going to the clubs and bars. Elder people aged more that sixty five years feel happy to walk in the morning and afternoon for physical fitness and leisure. Whereas, the youth pedestrians are walking almost whole day for different reasons and adults aged between 40 to 65 walks mostly during evening time segment. Usually this age group people walk for shopping at the nearest shops in the city centers and occasionally walking for leisure or recreation.

6. Assessing Pedestrian's Impression of Walking Environment

Assessment of walkway environment in Guimarães city center has been carried out based on some prescribed criteria as cited earlier in the methodology part. Observation survey also supports the impression of the walkers in the city center. Different models and techniques have been adopted earlier to know the pedestrian's walking environment earlier. But the adopted technique is very simple in terms of talking with the pedestrians and to know about their impression.

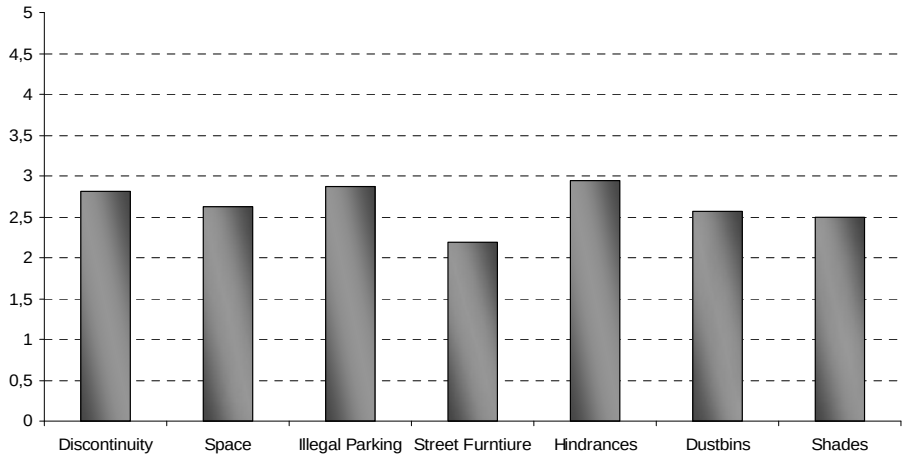


Figure 4. Pedestrian's Responses of different criteria.

The figure above shows that according to pedestrian's evaluation on seven distinct criteria rated at a scale of 1 to 5. Hindrances on walkways and illegal parking receive worst evaluation. It shows that street furniture and shades have received better evaluation from the pedestrians.

6.1 Discontinuity

Walkways often break the continuity in terms of width, length and pavement surface. Pedestrians claimed mostly that the walkways in Guimarães city center did not offer continuous walkways in many areas. This happens because of accessibility to shops, nearest houses and broken surface for discontinuous elevation. Observation survey reveals that the average elevation of the walkway surface goes higher than 1.83 cm at least in ten spots. This means that pedestrians need to be very much cautious while walking on the sidewalks. It otherwise offers safety threat to feet.





Figure 5. Discontinuous walkway surface in Guimarães city center.

Above figure shows that the walkway surface in Guimarães city center is not well maintained. This situation is very dangerous for the walkers especially for child and older pedestrians. At night, pedestrians can not see those areas well and it offers even worst situation. Pedestrians also claimed that this situation is not friendly for the handicapped and pregnant women to walk in a comfortable way on sidewalks. But they must walk on these sidewalks in the city center to move.

6.2 Space

Space for sidewalks is important so that walkers in different directions must not collide each other. It has been found from the observation survey in Guimarães city center that sidewalks and walkways are providing enough space according the pedestrian flow and speed. It has been noticed that the pedestrian flow speed during peak hours in the studied points are almost 124 persons per 15 minutes. The sidewalks are almost 1.5 meter wider which accommodates this flow of walkers. But the problem comes once there are unwanted situations like illegal parking, encroachment and presence of vendors on the facility. Pedestrians are always asking for spacious ways so that they feel comfortable to walk. This is the reason the criteria receives 2.5 average score from the respondents.

6.3 Illegal Parking

Illegal parking brings very difficult scenario for the pedestrians in the city center areas of Guimarães. People park the vehicle on sidewalks for different reasons like buying something from the adjacent shops or dropping somebody from the cars.



Figure 6. Illegal Parking on sidewalks in Guimarães City Center.

The above pictures have been taken from the city center streets during peak hours. Car drivers often chose small and narrow roads to park their cars on footpath to avoid unnecessary policing. It can also be seen that the cars stay on footpaths for longer than 20 minutes by putting the emergency vehicle lights on. As a matter of fact, pedestrians need to walk on streets and they are further exposed to accident vulnerability and probable collision fear with motorized vehicles.

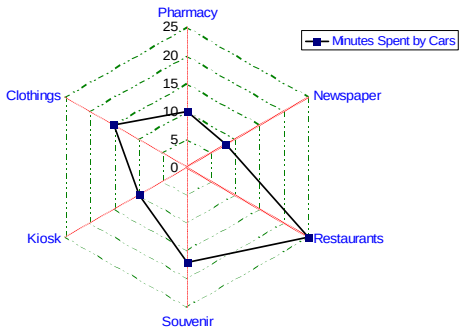


Figure 7. Time spending by cars on sidewalks in front of adjacent shops.

The above figure shows that drivers spend time up to 10 minutes in front of kiosk, pharmacy and newspaper stands in compare to 25 minutes in front of restaurants and 17 minutes in front of souvenir shops. Considering these major problems in the city center, the pedestrians put their impression in the scale and it implies that the authenticity of evaluation has proper evidences in the line of observation survey.

6.4 Hindrances, Dustbins and Illegal Encroachment

Hindrances specifically refer here as unwanted activities on sidewalks. Dustbins are very common on sidewalks as pedestrians can throw garbage on their way to the destinations by foot. Illegal encroachment is not common apart from the busy streets, so far the observation survey implies. It has been revealed from the survey that densely walkways are bringing more shopkeepers to encroach sidewalks to show their goods and to attract more people in their shops.



Figure 8. Hindrances and illegal encroachments on sidewalks in Guimarães

At least, eight spots have been identified in the city center where there is presence of trees to create problems for the walkers and, at least, three major points have been recognized where the shopkeepers invade with their goods. Figure 8 shows the evidences on sidewalks in the city center of Guimarães. Moreover, dustbins are not only creating unnecessary hindrances in intersections but also offering unpleasant odors if they are not well maintained. Forcefully the pedestrians then need to avoid those dustbins and illegally encroached areas for a smooth walking environment. Twenty percent of the respondents have claimed that there might not be enough spaces on sidewalks in city

centers for the disabled people and for pregnant women. The respondents also mentioned uneven walkway surfaces that are creating problems for the pregnant women if they want to walk for leisure and for shopping. Dustbins are certainly being placed in a place that does not offer hindrances considering the effective width of sidewalks. But, for lack of frequent maintenance, dustbins produce bad and pungent odors. This unwanted situation offers unpleasant walkway environment in the city center area. During the weekends, number of walkers in city centre increases almost 20% considering weather and sunshine. In this moment, people are dropping more staffs in the nearest dustbins of walkways. Frequent maintenance of dustbins is inevitable during weekend so that dustbins shall not produce bad smells in the nearest areas.

7. Conclusion

Guimarães is traditionally being considered as pedestrian friendly city center. It has a major open area of pedestrian precinct in the city center. These walkways are well connected with shopping areas and other city center facilities. People of different ages are coming to the city center for socialization, shopping and recreation purposes. Moreover, the city center has a medieval tradition of connections to the shopping and tourist spots as Guimarães is the oldest capital of Portugal having many tourist attractions within walking distances from the city center.. The study reveals that there has been a recent increase in interest in pedestrian mobility. Guimarães has been declared as the European City of Culture in the year 2012, thus it is expected that many tourists from different continent will visit in coming years to see the rich and traditional cultural heritage of the city. This study has an attempt to introduce some problems in recent times in Guimarães city center and to summarize the pedestrians impression of the existing walking environment. However, more empirical research is needed to fully apprehend this important mode of people's mobility not only in Portugal but also in every small and medium sized cities of the world. Albeit there has been a significant policy shift in which local governments are taking up increased responsibility in ensuring a safe pedestrian environment, much remains to be implemented. Representations of safer and convenient city walkways thus encourage more people to walk for shorter trips which certainly leads to healthy and carbon neutral city. This study is further an attempt to propose a methodology for quick assessment of walking environment and walkways problems in medium-sized cities in Portugal. More empirical research is in demand to further develop this methodology. The importance of this approach is that less time is needed to apprehend the problems, to list and classify them and assessing the present condition in the line of observation survey. Likewise, more time can be devoted to problem discussion and finding of solutions within a public participatory atmosphere.

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Urban Art – difficulties in its tipification, and evaluation methods

Pedro Neves

Architecture Department Instituto Superior Técnico, Lisbon Technical University (IST-UTL)

nfo@userdesign.org

Phone number: 00 351 965787653

The present article arises in the context of an urban rehabilitation process which took place in Bairro Alto, a neighbourhood in Lisbon. This process, which was set in movement in July of the year 2008, aimed, amongst other things, to re-establish a visual uniformity of the public surfaces that both integrate and delimitate this specific area. Indeed, for more than two decades, a variety of non-regulated and non-commissioned personal and visual expressions multiplied and were gradually rejected by the local actors. Having a durable rehabilitation as objective, the city council had the need to identify, preserve and promote the quality of some of these visual expressions whose authors are internationally recognised by credited contemporary art institutions such as the Tate Modern Museum, the Cartier Foundation, and so on.This being, the definition of the theme in analysis, that is, "Urban Art", is clarified through a chronological summary of the terms' applications. Given the complexity of the term itself only the relevant aspects of its definition to this paper are here presented. The analysis methods adopted are those which are generally applied to analyse the characteristics of public spaces and here identified to be useful to analyse "Urban Art".

Keywords: Graffiti, Street art, Appropriation, Participation, Public space, Urban art analysis

Introduction

There are several aspects that influence the diffuse meaning of Urban Art term. For example one of the aspects it's the language in witch the reference to the term it's made. In this French language article, the expression Urban Art it's used to identify certain aspects of Alberti's treaty - De re aedificatoria:

(...)La fonction constitutive de cette exigence esthétique fut très tôt formulée par l'un des plus grands théoriciens de l'histoire de l'urbanisme (ou plus exactement de l'art urbain), l'humaniste Leon Battista Alberti (1404-1472), qui en énonça le principe dans son De re aedificatoria, publié en 1483 (…)[229]

Urban Art expression also arises in reference to the work of pré-culturalists like John Ruskin or William Morris or cultural urbanists like Camillo Sitte and Ebenezer Haward.[230] As Alberti, this authors identify the "Urban Art" concept as Urbanism, or even building, underlining the aesthetic component.

The transition from image based plans to management urban planning, that arises from the need to incorporate more flexibility in the city development processes in Portugal append since 1954.[231] pushed the usage of the word Art in association with the city context to the expression Public Art.

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[229] *L'urbanisme - De l'art urbain à l'urbanisme* disponível em: http://www.memo.fr/article.asp?ID=THE_ENV_003 in LA VEDAN, Pierre (1975). *Histoire de l'urbanisme à Paris.* Paris: *Hachette*

[230] CHOAY, Françoise (2003). *O Urbanismo: Utopia e realidades de uma antologia*; São Paulo: Editora Perspectiva

[231] LOBO, Margarida Sousa (1995). *Planos de Urbanização. A Época de Duarte Pacheco*, Porto: DGOTDU/FAUP

In the book “Espaço publico e a interdisciplinariedade, (CPD, 2000)” in the article “*waterfront*, Arte pública e cidadania” of Antoni Remesar[232], it's present the following definition of Public Art: *(…) let's clarify that when I speak of public art I use the concept in a very general way, I understand it like a group of “artefacts” of dominant aesthetic characteristics that furnishes the public space. (…) This perspective over the concept allows the conception of Public Art as a generator of meaningful places “co-production” agent, and not just an “artistic” manifestation placed in public space. As a producer of sense of place and trough the capacity of generate meaning and “identity”, Public Art would be one of the key elements to put in practice the social processes of appropriation of space.*

Therefor, when I speak of Public Art, I refer myself to things like public space design, landscaping, sculpture, performances, etc (...) and in conclusion *(…) this art it's possible when the regeneration program principles are based in the values of sustainability and in social cohesion, put in practice in their real dimension and not just like propaganda arguments, like usual (…)*

Maybe it's possible to assume that public art in opposition to urban art, it's allowed, commissioned, even when in situations were the works are controversial and put in cause their institutional profile, as the paradigmatic cases of Maia Lyn's Vietnam Veteran Memorial or Richard Serra's Tilted Arch.

By other side it's difficult to place a clear border between the terms. According to Portuguese study *O chão da Cidade; Guia de avaliação do Design de Espaço Público,* do Centro Português de Design (CPD) it's possible to attribute public art *(…) sculpture, murals, decorative art, commemorative objects, photography, pavement design, water design, light and sound, ephemeral works, performances, graffiti, etc (...)*[233]

However there's a gradual renascence of the Urban Art term, due to the need for distinction the mural inscriptions that are made without consent, from the Public Art concept. The fact of “Urban Art” now being associated to “graffiti” or “street art” expressions it's mainly connected to the British flow of work put in motion by the artistic project “Banksy” and others, that trough the worlds most varied museums and art galleries have a strong impact in the contemporaneous artistic medium. (Tate modern; Fund. Cartier; CCCB, MOCA...).

It's according to this most recent interpretation that the expression “Urban Art” it's adopted in this paper. This renovation of term usage, have a global profile and it's connected to environmental and social issues, putting in evidence the importance of the direct participation of the citizens as had been deliberated in the United Nations conference for environment and development (1992) that driven the elaboration of the XXI Local Agendas.

Should be “Urban Art”, an activity that it's put in practice by few, a pioneer act and an example to follow by all of us? Should we be active in our collective space transforming it in effective public space? The awakening of the “notion of care”[234] it's essential, and should be the most inclusive as possible.

“Urban Art” expression puts in evidence a new dimension of the city: the city as an living organism that it's built and developed in a spontaneous, natural and free way. Therefore, and under

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[232]REMESAR, Antoni (2000) “waterfront, Arte pública e cidadania” in: Brandão, P.e Remesar, A*. Espaço público e a interdisciplinariedade*, Lisboa: CPD

[233]BRANDÃO P., Águas, S. e Carrelo, M. (2002) *O chão da Cidade* ; Lisboa: CPD

[234]*RICOEUR, Paul Sympathie et respect. Revue de Métaphysique et de morale. Paris (1954), pp.380-397.*

the influence of this interpretation, the projectists must be sensible and integrate the diverse dynamics of urban appropriation that frequently are contradictory.

It's necessary to face the “Urban Art” as something serious and with it's proper characteristics, as a kind of force of nature that must be necessarily considered, even if not contemplated in the project. It's important to foster knowledge and proximity of citizens and projectists (even if trough symbolic or representative ways). This aspect needs languages and evaluation criteria with common points.

In the end, everything it's reduced to the apparently unperceived decisions and actions of each citizen in the process of changing collective space into effective public space. Aiming the search of a analysis method that can support an eventual inventory, the relations between Urban Art and a selection of public space analysis methodologies are proposed in the body of this paper.

Evaluation methodologies

***What Makes a Successful Place?* Project for Public Spaces.**

Project for Public Spaces, it's an organization with origin William White (The Social Life of Small Urban Spaces)[235] work, doesn't have profitable purposes and it's based in New York, and since 1975 it's dedicated to planning, design and education helping citizens creating and sustain their public spaces, generating stronger communities.

By PPS experience, they reached the conclusion that successful public spaces are the ones that have four key qualities:

- accessibility;
- citizen activity generators;
- comfortable and with a good image;
- and social activity platforms.

[235] WHITE, William, 1980. *The Social Life of Small Urban Spaces*, Washington, D.C., The Conservation Foundation.



Figure 1. *"The Place Diagram"***.** Source: Project for Public Spaces (PPS).

Its important to put in evidence the qualities of comfort and image, but it's also important to give some attention to the social and citizen activity factors, values like security, attraction, cleanness, and amenity.

This values are relevant for the Urban Art analysis, the proposed indicators as patterns of seating, walking, or maintenance can be interpreted as relevant, the rest need some adjustment, because they are based on data like criminality, environment, and eco-diversity,

The questions that this key quality trough it's values and indicators try to respond need to be put in evidence, ex:

•The space causes a good first impression?

•Are there spaces clean of trash? It's there regular maintenance?

•The area seams safe? Do it have regular surveillance?

•Are there people who take photos? Are there photography motives?

In the key quality "uses and activities" there are relevant values like specialization, diversion, spontaneity, and diversity, trough the indicators use / frequency (degree), number of different usages, user satisfaction, maybe with less importance but also to refer the economical and commercial values.

•The relevant questions are:

•Witch parts of the space are used and witch don't?

•Can be identified someone responsible present or accessible?

Public space preventive and composition aspects are evidenced. The composition aspects are relatied in a direct form with the qualities that Urban Art inflicts in Public Space. The preventive

aspects are related with Urban Art due to the fact that some interventions can be interpreted as merely destructive acts, and because of that it's necessary to generate security and surveillance. This relation it's delicate and important to be analysed with it's proper time outside this paper.

Finally in face of the socialization qualities analysis, it's important to consider the cooperation, community, pride, amenity and interactivity values. The relevant presented indicators are the street life, social networking, night usage, number of women, old persons, kids, self-esteem and social responsibility.

Urban Design Alliance. *Placecheck*

Presented as a methodology essentially oriented for mobilizing participation into action, trough a participated diagnostic. This starting point it's in concordance with the spontaneity and attitude of interventionist profile characteristic of “Urban Art”.

But for the “Urban Art” analysis purpose it's not very practical the way how the verifying list it's built.

In the first part are placed tree very broad questions:

- What do we like in this space?
- What do we don't like in this space?
- What needs to be changed?

In the second part, are presented 15 specific questions that unfold in multiple other questions, in a total of more than 100 questions that for this paper purpose I put in evidence the following:

G. How can we make this a more special place?

G7 Public art

Are there places where works of art (such as sculpture, paving, water features and lighting) could enhance the place’s character and sense of identity?

J. How else can public spaces be improved?

J3 Art and craft

Are public art, craft-work and well-designed street furniture needed to give identity and interest to public spaces?

J8 Graffiti - Are there places where graffiti needs to be removed or protected against?

K How can we make the place more welcoming and easier for people to find their way around?

K1 Landmarks

Are new landmarks (buildings, works of art or other features) needed to create or improve views, and help people find their way around?

In this methodology the relations with “Urban Art” are essentially connected with composition aspects. Giving focus to the Graffiti expression direct reference, as something that we should remove or protect ourself from, classifying it as a not desirable element in the public space.

With more detail in the study *O chão da Cidade; Guia de avaliação do Design de Espaço Público,* do Centro Português de Design (CPD) in the chapter about Quality of Urban Design are identified several composition and citizen engagement aspects that are “Urban Art” related.

(…) the good design it's a response to the expectations and needs of the users, and deliver spaces suitable for appropriation, cared and used by their communities (…) it's equally important that the public participate, direct or indirectly trough associative structures of media or representative political

instances to encourage the good design of their locations (…) Should be valorised the aspects that promote singularity and the spirit of the place (…) in contrast with the (…) patterning of the processable typologies, the materials and constructive techniques (…) The public intervention as still the objective of participation in the management and maintenance of public spaces (…)

In the classification of the public spaces (identification of it's several types) the "Urban Art" it's transversal in all, with a bigger incidence in the places that give greater visibility: space channel (train paths, highways and speed ways), avenues and streets, and in the permanence places like main, large or small squares, and multifunctional spaces, by their central and attractive characteristics (particularly if appropriated by youth activities like skate, bmx or parkour).

It's important to consider In the evaluation criteria:

- Identity, the human factors; Above all "Urban Art" it's an activity that starts from human search for identity.
- Security and comfort (…) need for maintenance and vandalism resistance having security and comfort as an objective (…) factors as illumination, conservation/ cleanness degree or the quality of the construction materials. Here it's identified the preventive perspecti
- Inclusion / social cohesion (…) the satisfaction of specific needs of differentiated groups should be faced as complementary aspects that operate at a integrated and unitary logic (…) In the readings, are proposed several perspectives by paths, borders, neighbourhoods, crossroads, and points [236] (…) to potentiating focal points, helps people to conceive mental geo reference systems (…).
- Diversity and adaptability (…) the public space it's an Open work[237] (…) clearly related to the "Urban Art" concept.
- Resistance / durability (…) the public spaces deterioration prevention it's processed at two levels: education (rules for usage and follow up of developed activities) and surveillance (have a vandalism dissuasion effect)(...).

In this situation the focus it's again on the preventive perspective, but here the risk on the rule determination and surveillance it's high, if badly used can cause some problems [238].

In what concerns sustainability, the *O Chão da Cidade* study mention the Richard Rogers [239] following selected examples:

- a beautiful city – were art, architecture and landscape stimulate the imagination and renew the spirits;
- a creative city – experimentation
- a city that gives opportunity for contact;
- a diverse city – the diversity of outdoor activities, and that the maintenance of new spaces can be easy and economical

The reference to the composition, prevention and participation call, are again the aspects to evidence as important in witch "Urban Art" it's concern.

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[236] *LYNCH*, *Kevin* (1960). *A Imagem da Cidade*. Lisboa: Edições 70

[237] ECO, Umberto (1989). *Obra aberta*. Lisboa: Difel

[238] ORWELL, George (1999). *Mil Novecentos e Oitenta e Quatro*. Lisboa, Edições Antígona.

[239] ROGERS, Richard; GUMUCHDJIAN, Philip. (2001) *Cidades para um pequeno planeta*. Barcelona: Gustavo Gili

In the specific criteria analysis are indicated some artistic expression elements (public art) with the already mentioned definition ; are identified several objectives: social and recreational, economical and institutional, educational and cultural, civic, and environmental.

In the same source it's mentioned the Javier Maderuelo[240] proposal, in witch the classification it's made with some criteria, it's important to mention for the paper purpose the following:

- fiscal
- monumentality
- meaning (site specific concept)
- commemoration (ex: Maia Lyns, Vietnam Veteran memorial)
- utility (functionality, urban values)
- environment and participative quality (works that reclaim participation)

In the same chapter it's mentioned the program elaboration. Here lays one of the fundamental differences in what "Urban Art" it's concerned, in fact it's in total absence of program that "Urban Art" it's developed. The commission (by consequence the program), it's the opposite of what here it's identified as "Urban Art" this manifests spontaneously, in a viral way, with marked characteristics of subversion, and provocation and with capacity of transforming the aesthetic of a determined place (*site specific*).

In the element and urban communication systems criteria, the dimensioning and positioning of advertising and information panels reference it's relevant. By other side non of the six categories proposed by Mitzi Sims[241] it's useful for the paper purpose. It's important to refer that about "equipment and urban furniture, structures and lightning elements in the streets/ transportation" all have a reference to vandalism resistance, fact that as already mentioned it's "Urban Art" related.

It's also proposed a check list, method that in order to work had as reference (…) a normal project, and a median pattern of witch elements must be satisfied (…). Here are to refer as relevant, the aspects of quantitative evaluation, of project orientation face to general criteria as resistance, durability (1 to 5 evaluation) and in the specific criteria, elements of artistic expression (Public Art) being evaluated the vandalism resistance in all items of this criteria.

***Public Art: A Guide to Evaluation,* from the British IXIA**

IXIA "think thank" it's a non profit association, financed by the England's Art Council. This guide it's the result of a commission from IXIA to OPENspace investigation centre based in Edinburgh College of Art and Heriot-Watt University.

This evaluation proposal it's have two sections:

- The evaluation of the results (trough a process denominated "the matrix")
- The assistance to the evaluation of the processes (developed in the "Personal project analysis")

In "the matrix" it's proposed it's usage in several stages of the process (in the start, one or more middle stages, and in the end) engaging the creators, the hosts (eg: the community) and the promoters. It's based in the social, artistic, economic and environmental value definition logic, that

[240]MADERUELO, J., (1999). *Arte Pública em Espaços Urbanos. Seminário Integrado no curso de Pós-Graduação em Design Urbano, 4-5 Novembro 1999,* Lisboa, Faculdade de Belas Artes.
[241]SIMS, M., (1999) *Sign Design.* Londres, Thames & Hudson LTD.

subdivide into more detailed aspects. The evaluation it's qualitative by levels of priority (importance): high, middle, low and none.

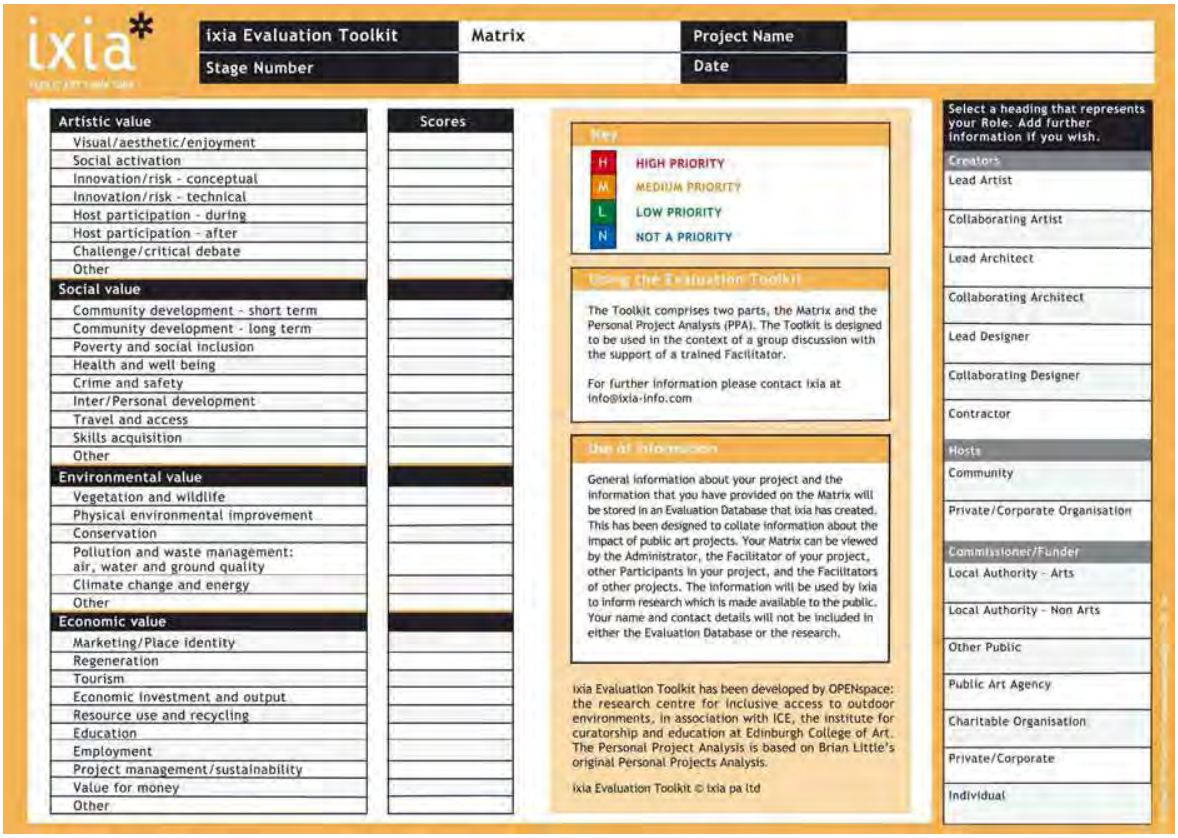


Figure 2. IXIA Evaluation Toolkit Matrix, fonte: *Public Art: A Guide to Evaluation.*

In the “Matrix” evaluation are identified the involved actors, grouped by type of creators, guests, and promoters. The presentation of this information it's proposed in a table form, with labels and short descriptions of the main fields (Figure 2).

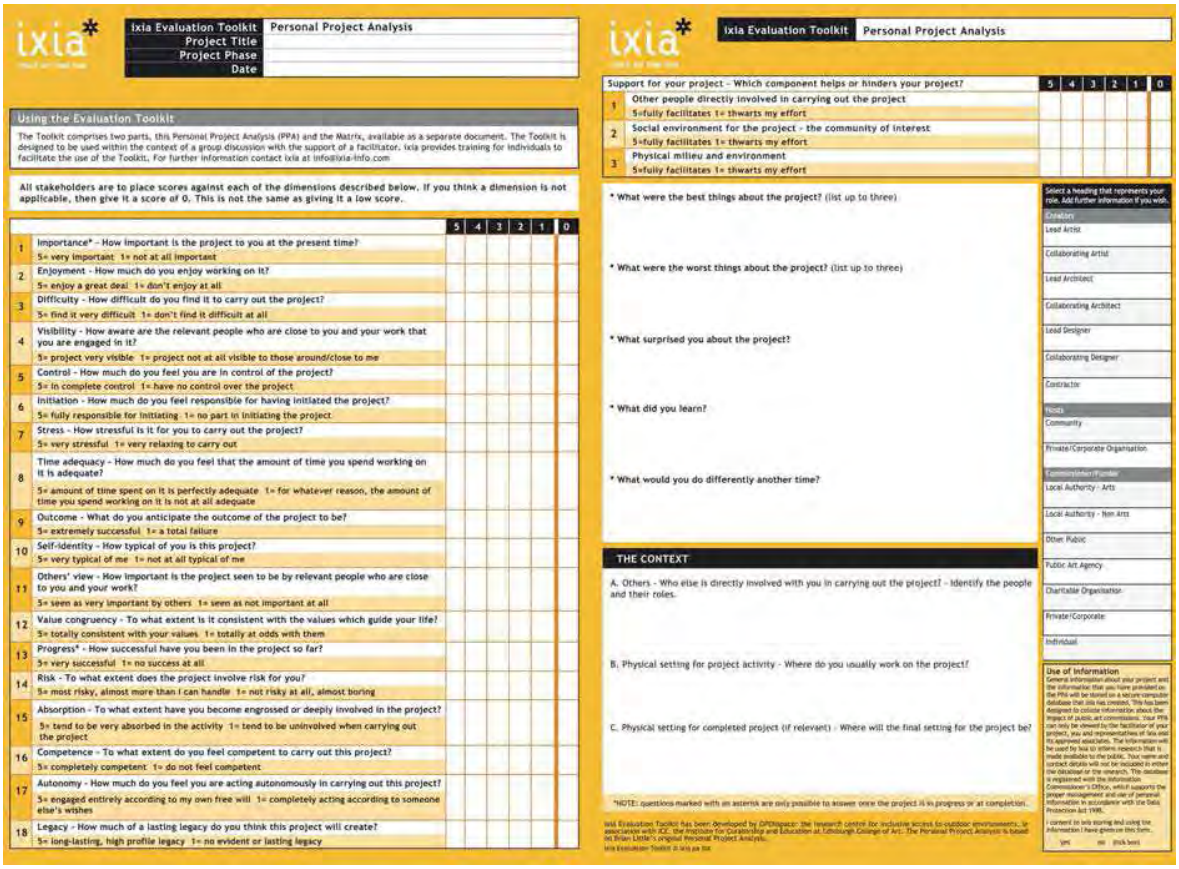


Figure 3. XIA Evaluation Toolkit Personal Project Analysis. Source: *Public Art: A Guide to Evaluation* IXIA.

The process evaluation (Personal Project Analysis) consists in a facilitator developed inquery, where are preserved the privacy and veracity of the collected information. The purpose of this evaluation guide it's centred in the knowledge of the results and impacts of the artistic practice in the public space. For the purpose of designating the analysis theme, it's initially defined the meaning of Public Art, in a very open way:

(...)"The spectrum of artistic practice represented by the term public art encompasses art commissioned as a response to the notion of place, art commissioned as part of the designed environment and process-based artistic practice that does not rely on the production of an art object. When searching for a definition of public art it is most helpful to regard public art as a process of engaging artists' creative ideas in the public realm."(...)

It's also identified the fact that Public art as being commissioned, to give response to a notion of space or to be part of the designed environment. The commission it's one of witch it's not contemplated in what in this paper it's designated as Urban Art (graffiti, street art...).

It's the commission factor that gives support for the differentiation of the terms "Urban Art" and Public Art. In my interpretation, "Urban Art" it's an act of sharing, donation, an altruistic action of a determined citizen into the collective space, without any kind of exchange expectations beside the recognition of the work or body of work. Therefore there's a great deal of spontaneity in the

appropriation/ physical direct and immediate interpretation, far from any premeditation associated to a commissioned work.

Conclusion

In a certain way, the referred methodologies “Urban Art” approximation factors have a repetition pattern, allowing the characterization by the very open composition (aesthetic), preventive (vandalism) and population engagement (participation).

Following what's been determined about the “Urban Art” term, and face the predominat characteristics of the methodologies in analysis, it's normal that the relevant data for an eventual method of “Urban Art” analysis have a predominance of factors that analyse it as something very similar to Public Art.

The fact that existing some divergences in the Public Art and “Urban Art” in the interpretation of the term graffiti it's manifested by one side in the *O chão da Cidade* Portuguese study in witch the term it's in the public Art definition, and by other side in the *Place Check List* its interpreted as something to eliminate.

It's important to compensate the interpretative factors of “Urban Art” as something similar to Public Art as distinctive factors in the approximation of certain graffiti or street art interpretations, sometimes badly interpreted as vandalism.

However it's certain that it's precisely in this point that the analysis it's problematic and diffuse, maybe because this is the frontier from were the phenomenon develops, legitimating trough realizations that have been identified as undesirable and that today are somehow objects of museum cult.

This is why that's important to contemplate participation factors that develop not only in the creative (aesthetic, artistic) aspect but also by the prevention, as well the already mentioned factors that mention question of durability, safety or even surveillance.

This way I conclude that by quantitative or qualitative methods, in a “Urban Art” inventory process, this can be supported in the referred factors that arise from the public space analysis methods, with particular necessity of deeper knowledge in its adaptation to the main differences of Public Art and “Urban Art” concepts, as factors that intensify participation.

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Public Art: A Guide to Evaluation IXIA. disponível em: http://www.ixia-info.com/wp content/uploads/2009/02/public-art-a-guide-to-evaluation.pdf

Porto’s diabetes’s prevalence - a good reason to rethink urban planning

Ana Monteiro[1], Sara Velho[2], Carlos Sousa[2]

1 Department of Geography

ISPUP (Instituto Saúde Pública da Universidade do Porto), anamonteirosousa@gmail.com

Phone/fax numbers: 00 351 919698402 - 00 351 226077150

2 Projecto PTDC/SAU-ESA/73016/2006

ISPUP (Instituto Saúde Pública da Universidade do Porto), sara.pinheiro.velho@gmail.com

Phone/fax numbers: 00 351 933644695 - 00 351 226077150

The current Porto’s form and structure, resulting from a history of more than 8 centuries, show some dysfunctions that may be materialized, for example, in some health, quality of life and well being indicators. Having in mind some important risk factors for diabetes (type 2) – i.e. life style, diet, physical activity - and the huge increase of this disease in recent years, we collect and analyze the frequency of occurrence and the spatial distribution of diabetes’s admissions in Porto’s four main hospitals between 2000 and 2007. We conclude that there seem to be, at Porto, some objective and subjective conditions related to urban planning decisions that might help to explain the diabetes’s spatial distribution. Looking from a geographical perspective to the Porto’s urban supply and demand – biogeophysical, functional, demographic, social and economical – we find an, at least apparent, coincidence between the areas where the relative weight of diabetics is higher and the supply of conditions for the practice of leisure and recreation is of lesser quality and socio-economic status of residents is more fragile (age, income, literacy, etc.) Looking through this data relationship, it seems that Porto’s diabetes prevalence may be a good reason to motivate citizens, urban planners and decision-makers to rethink sustainable urban planning policies nowadays.

Keywords: Urban Planning; Diabetes (type2); Environment; Social and Economic Condition; Wellbeing

1. Introduction

The new millennium urban competitiveness and success implies a multiple purpose and several compound scales city skills approach. Having in mind the preference increase of urban way of life, these new puzzle should include the needs to accommodate more people and activities without losing any of its advantages. The attractiveness of a city depends of some key factors like investment opportunities, employment, safety, cultural and educational dynamic, aesthetic values, development choices, affordable housing, services, accessibility, environmental quality, freedom, human scale built environment, etc.. Within these enlarged framework, health, quality of life and well being indicators are efficient ways of rethinking planning goals towards a new puzzle concept.

Considering that the *diabetes mellitus* is one of the diseases whose aggravation depends of physical activity, diet, stress and lifestyle in general, that has had a huge increase in urban areas during the last decades (Fig.1), we propose an analysis of the spatial Porto's diabetes's prevalence as a way to face urban planning goals in a medium size city.

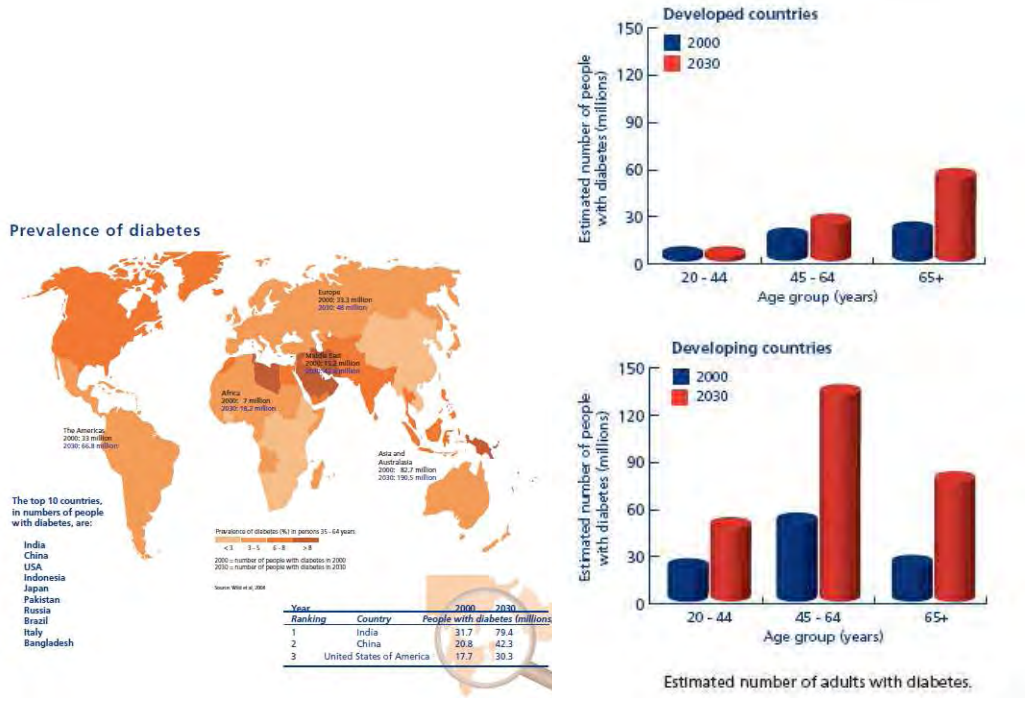


Figure 1. Prevalence of Diabetes - global view and projections in developed and developing counties. Source: WHO, 2009.

As far as WHO conclude in its reports, the diabetes-type 2 great increase seems to be a consequence of a spread of an westernized lifestyle around the planet with a lot of nutritional mistakes, over nutrition and a lack of physical activity. According to Wild et al (2004) the number of cases of diabetes worldwide in 2000, among 20 years of age's adults was estimated to be about 171 million.

The urban lifestyle together with westernization of societies, means that citizens spent, in average, twice the time used by rural people in leisure activities but the metabolic rate is significantly higher in rural people than in urban citizens (Fig. 2). While the rural typical leisure activities include several energy consumption actions, several spare time and recreational activities in urban areas have no significant metabolic rates.

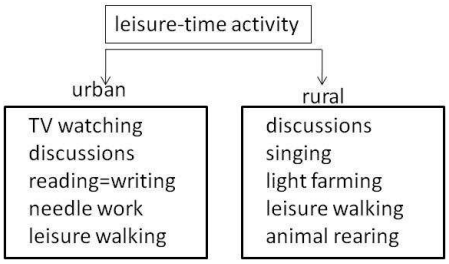


Figure 2. Leisure activities in rural and urban lifestyle.

2. Methods

The accomplishment of our work began with the collection and analysis of temporal and spatial distribution of diabetes in the Metropolitan Porto Area (GAMP) and in Porto. We collected the data of daily hospital admissions in the four main hospitals in the GAMP (St. John, St. Anthony, Santos Silva and Pedro Hispano) between 2000 and 2007.

In this exercise we started by analyzing the relative importance of diabetes-type2 when compared with the total number of admissions during the same period. Afterwards, we confirm the relative high weight of this pathology in the resident population (Table 1 and 2).

Table 1. Total admissions and admissions with diabetes in Porto 4 major hospitals (2000-2007)

	Inhab.	Admissions Total	Admissions Diabetes
Porto	263131	178841	19652
GAMP	1551950	820193	77117

Table 2. Rate of diabetes admissions per total of admissions and per inhabitant (2000-2007)

	Diabetes/ Admissions	Diabetes/Inhab.
Porto	11%	7,50%
GAMP	9,4%	5,0%

In the next step we tried, using a GIS, to assess, simultaneously, the spatial distribution of some biogeophysical, social and economic data and the highest values of diabetes's prevalence in Porto.

3. Results and discussion

Having in mind that the people more vulnerable to be a diabetes type 2 victim are those older than 45 years, or that had diabetes during a previous pregnancy, or that have excess body weight (especially around the waist), or with a low activity level (exercising less than 3 times a week), or with a metabolic syndrome or with a family history of diabetes, or a baby born weighing more than 4kg, or with HDL cholesterol under 35 mg/dL, or with high blood levels of triglycerides, a type of fat molecule (250 mg/dL or more), or with high blood pressure (greater than or equal to 140/90 mmHg), and reminding also that as a chronic disease, diabetes is well supervised by the patient himself and only a few number of cases need care at an emergency room and even a lower number need to be admitted in an hospital, we look to the density of admission cases in the GAMP and at Porto (Fig. 3). Considering international and WHO patterns, we determined that diabetes admission values above 7% of inhabitants are exceptionally serious (Fig.4).

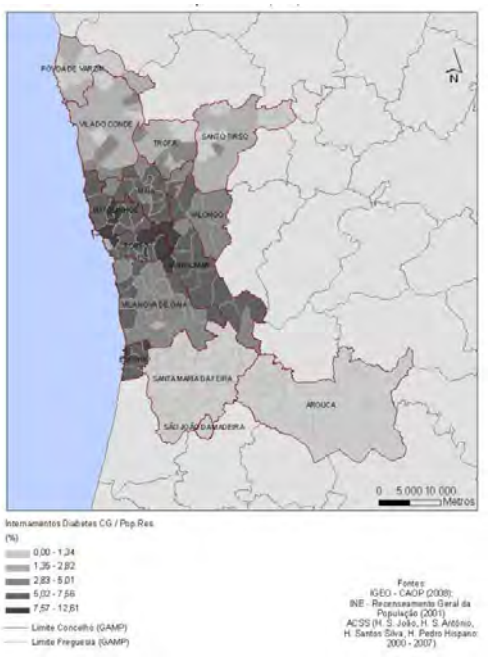


Figure 3. Distribution of diabetes admissions in GAMP and Porto from 2000 to 2007 (% inhabitants).



Figure 4. Distribution of the highest rates of diabetes admissions in Porto (> 7% of inhabitants).

The NE and the old and central parishes of Porto are the areas with a higher density of acute diabetes-type 2 cases that needed to be attended and admitted in one of the four main hospitals (Fig. 4).

Having seen these we used a GIS tool to appreciate and compare the spatial incidence of diabetes and some social, cultural economic characteristics of each of the Porto parishes (Fig.5 and Fig. 6).

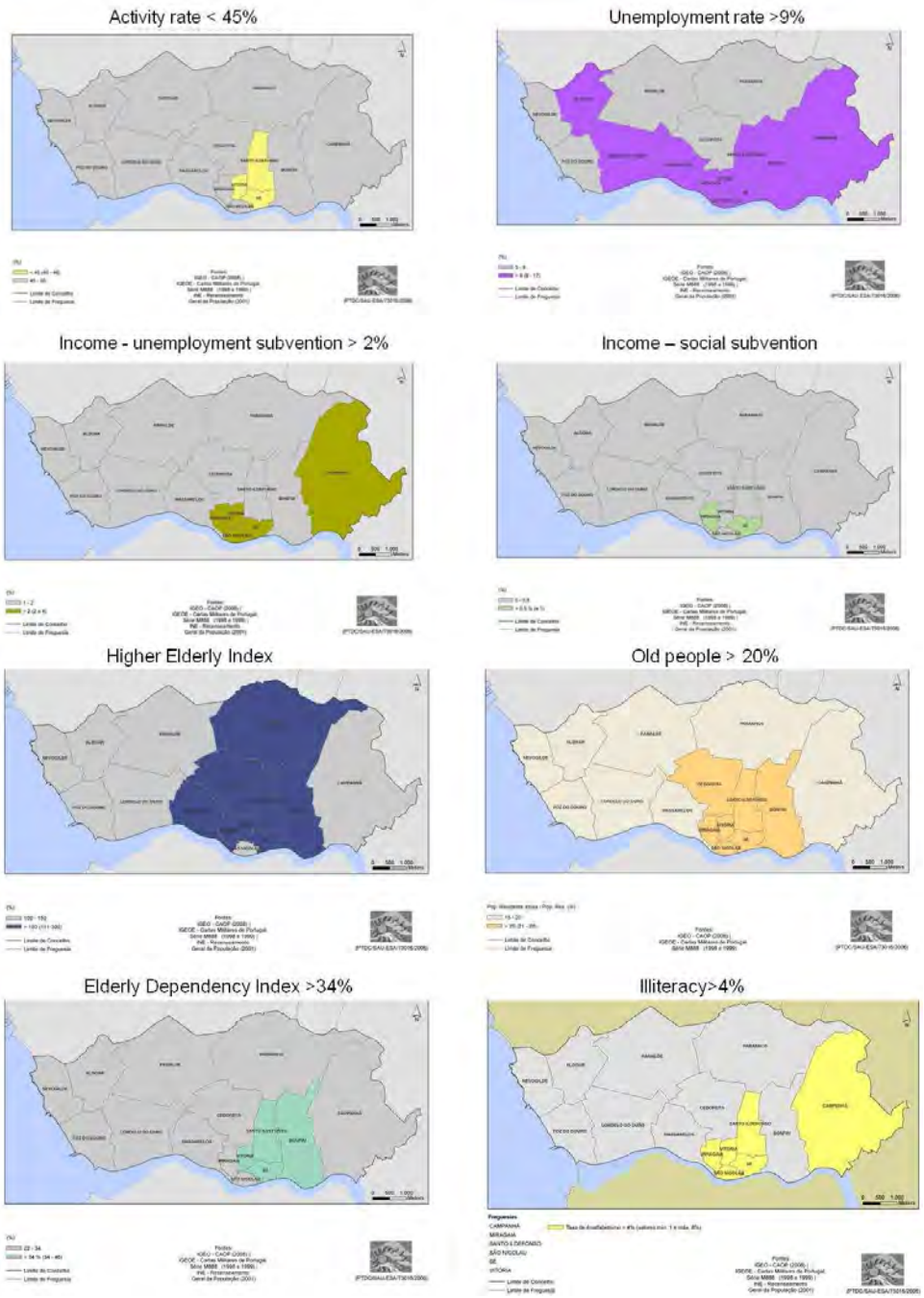


Figure 5. Some social and economic indicators that might determine diabetes prevalence at Porto.

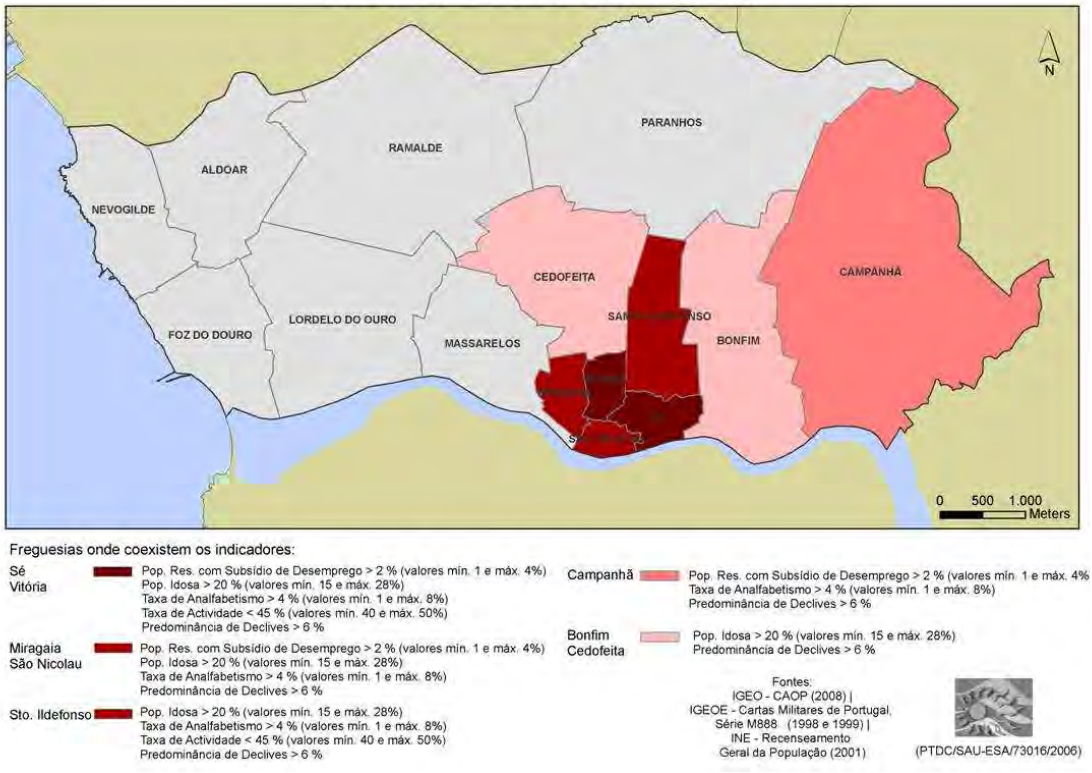


Figure 6. Social and economic indicators incidence at Porto.

Considering the results obtained we realize that the major diabetes incidence coincides with the parishes with: i) people living with unemployment subvention > 2% (1%-4%); ii) old people > 20% (15%-28%); iii) Illiteracy rate > 4% (1%-8%); iv) activity rate < 45%; v) slopes > 6%

4. Conclusion

The diabetes's prevalence at Porto seem to be a very good reason to rethink urban planning policies because the rate of success of the disease treatment experiences show that may it might be achieved either with pharmacology and/or lifestyle changes. But the urban lifestyle modifications depends upon induced and objective factors. As we saw at Porto the areas with the worse or careless neighbourhoods, the least aesthetic qualified, those with less usable green areas, with none or bad walking conditions, with less safety, or those more inaccessible and with less outdoor climate comfort conditions are the ones with more diabetes's admission rates. The parishes with lowest incomes rates, with highest illiteracy, with lowest activity rate and with high elderly dependency are also the ones where the diabetes's prevalence is higher. There are other objective factors like genetics, diet, sport facilities, etc. that we didn't evaluate are also very important to understand the disease aggravation. Anyhow we can consider the knowledge of the behaviour patterns of each socio-economic groups to support the narrow relationship between socio economical and environmental injustices and health inequities.

Within this complex sketch inside a city, the urban planners are supposed to know the social and cultural backgrounds diversity and the variety of solutions that have to be available to change wellbeing patterns. It is not worthwhile just ensure better conditions to provide employment, security, environmental quality, leisure and recreation spaces, education and health facilities, it is needed a much more holistic approach to the existent resources and human beings in order to transform those ingredients in healthier objective planning options.

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Assessing the impact of poor housing conditions on human health in Portugal

João Vasconcelos 1**, Elisabete Freire** 2**, Ricardo Almendra** 3**, João Machado** 4**, Paula Santana** 5

1 Escola Superior de Turismo e Tecnologia do Mar, Instituto Politécnico de Leiria, j.vasconcelos@netcabo.pt

Phone/fax numbers: 262 783 607 - 262 783 607

2 Faculdade de Arquitectura , Universidade Técnica de Lisboa, elisfreire@gmail.com

Phone/fax numbers: 213 615 000 - 213 625 138

3 Alto Comissariado da Saúde, Ministério da Saúde, ricardoalmendra85@gmail.com

Phone/fax numbers: 221 330 50 00 - 21 330 50 97

4 Faculdade de Ciências e Tecnologia, Universidade Nova de Lisboa, jmachado@fct.unl.pt

Phone/fax numbers: 212 948 300 - 212 954 461

5 Centro de Estudos Geográficos, Universidade de Coimbra, paulasantana.coimbra@gmail.com

Phone/fax numbers: 239 859 900 - 239 83 673

Morbidity and mortality has obviously a multivariable cause. One is surely the thermal discomfort in our homes where, as a sedentary being, we spend most of our daily life. A continuous exposure to cold debilitates our health and will lead to cardiovascular and respiratory diseases. Improvements on housing quality are important in order to reduce thermal discomfort and thus a better health. A survey was undertaken to assess the housing conditions of those patients admitted in different hospitals, in Portugal, suffering from any sort of acute coronary syndromes. This assessment has contributed to a better understanding of some housing aspects that might contribute to the incidence of this ailment. A better knowledge about the influence of weather and climate on such ailment may be applied to built up a guide for housing design (to new and to restorations of old dwellings), to set up the policies and strategies for protection and adaptation, for health planning, as well as, to trigger alert systems, in order to reduce the number of deaths by cardiovascular failure.

Keywords: Cold exposure, cardiovascular disease, housing conditions, Portugal, temperature

1 Introduction

Housing conditions are determinant on life quality and thus to human health. However, lately, there were some improvements in the building industry, most of the Portuguese dwellings show a poor building quality, in particular on thermal insulation; dwellings are cold and humid in winter and hot in summer. As a corrective measure, Portuguese are investing on acclimatization facilities, in order to attain the thermal human comfort. But, this represents an important financial burden on the family budgets that only some are fortunate to afford. The exposure to cold and its consequences upon people, though less studied in Portugal, may seriously reduce the quality of life and health of a large amount of population. Improvement on housing quality is fundamental for reducing thermal discomfort and thus the exposure to cold and for a better health.

Morbidity and mortality has obviously a multivariable cause and one of them is the thermal discomfort in our homes where, as a sedentary being, we spend most of our daily life. A continuous exposure to cold surely debilitates our health and will lead to cardiovascular and respiratory diseases. These illnesses show a clear seasonal variation, and the higher values occur at the same months as the lower temperatures (Freire, 1996).

Cardiovascular diseases are one of the most important causes of death in the world, and it is expected that it will turn into the principal cause in the nearest future, according to climate change predictions.

The cardiovascular morbidity and mortality rates, on summer and winter months, vary throughout Europe. For example, in those areas with normally a mild winter seems to be the ones with higher number of seasonal mortality. In fact, among the southern countries, Portugal has the highest mortality rate, in winter (together with Ireland). However, the number of studies relating cold weather and morbidity/mortality is still very rare (Freire, 1996). These occurrences are suspected to be associated with housing quality especially thermal insulation.

Accordingly, the general endeavour of the present article is to establish the interrelationship between the trilogy climate-housing-health.

1 Excess winter morbidity in Portugal

We have used the hospital admissions for acute myocardial infarction (from 2003 – 2007) in order to assess the burden of excess winter morbidity (EWMorb) in Portugal.

In Portugal mainland, it was recorded 4596 admissions with acute myocardial infarction, in excess, during winter months (table 1).

Table 1. Excess winter hospital admissions with acute myocardial infarction, in Portugal (2003 a 2007

Districts	03/04	04/05	05/06	06/07	Average
Aveiro	266	290	294	279	282
Beja	121	98	101	108	107
Braga	295	287	296	310	297
Bragança	103	80	63	88	83
C. Branco	114	105	88	132	110
Coimbra	202	222	207	227	214
Évora	135	125	132	97	122
Faro	177	208	223	204	203
Guarda	83	76	88	102	87
Leiria	164	174	182	105	156
Lisboa	1191	1214	1026	1006	1109
Portalegre	92	62	63	98	79
Porto	834	847	753	806	810
Santarém	183	143	121	200	162
Setúbal	389	478	459	488	454
V. do Castelo	113	124	97	113	112
Vila Real	76	84	87	52	75
Viseu	161	114	124	139	135

Dividing the EWmorb by the resident population, a northwest-southeast gradient was found in Portugal, with a high concentration of EWMorb in the Alentejo region.

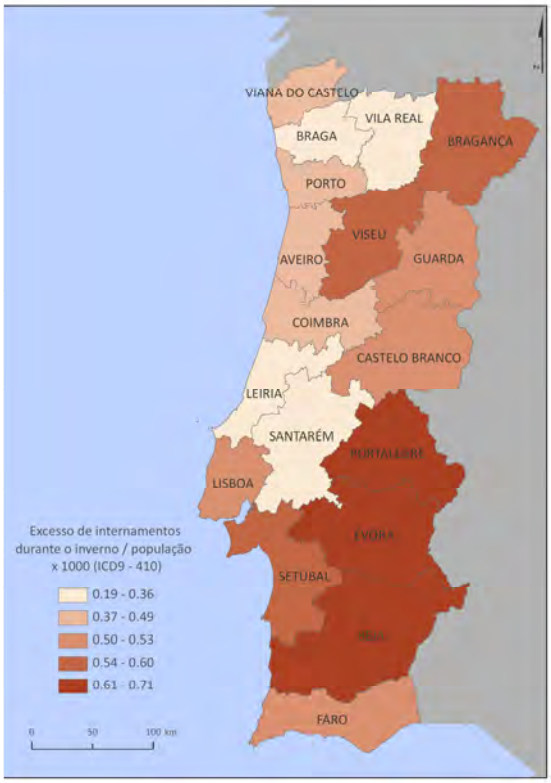


Figure 1. Excess winter morbidity by population, in Portugal mainland.

To evaluate the spatial pattern of EWMorb, in Portugal, is essential to fully understand the causes of this seasonal variation and for the definition of health and planning policies.

It is generally accepted that beyond other risk factors that might explain this disease seasonality (i.e. shift in food and alcohol consuming, as well as, lack of exercise) the exposure to cold also plays an important role.

In fact, several studies have been showing an inverse relationship between air temperature and cardiovascular diseases, during the cold season.

In Lisbon county, during 2003-2007, it was found that the maximum air temperature daily average can explain about 40% of the hospital admissions variation with acute myocardial infarction (figure 2).

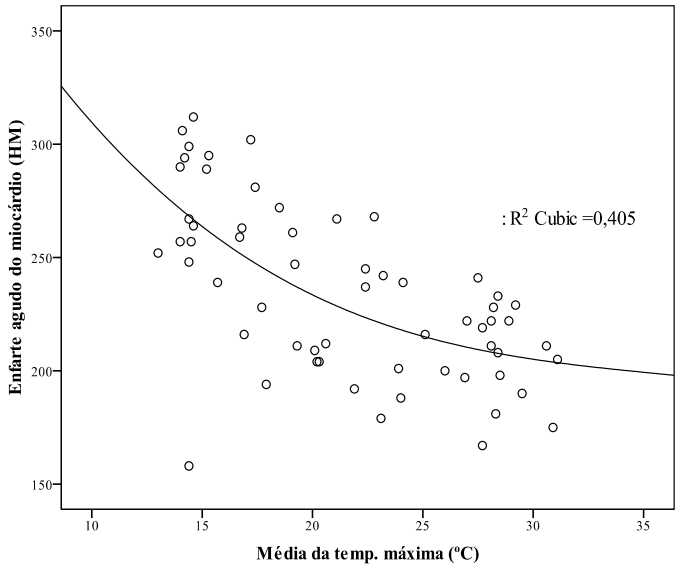


Figure 2. Relationship between maximum air temperature daily average and hospital admissions with acute myocardial infarction, in Lisbon county (2003-2007).

2 Excess winter morbidity – the role of housing conditions

As seasonality intensity varies so clearly from region to region has raised the suspicious about the fact that where people live or spend most of their time may be the "key" to understand their vulnerability to cold.

There seem to be evidence that the use of adequate heating facility, as for example, the use of central heating, is an important aspect to protect from cold and contribute to reduce the excess mortality/morbidity, in some regions (Aylin *et al.*, 2001; Olsen, 2001; Wilkinson e Armstrong., 2001). The impact of poor building quality can be felt at various levels. In a study on housing quality and health, in UK, it is pointed out that the people who live in worst home conditions and in colder areas have a 45% higher hypertension frequency than others (Blane *et al.*, 2000). In addition, it was also noticed an *inverse housing law* between the need and the possibility of heating dwellings, in UK (Mitchell *et al.*, 2002). This is, the worst housing conditions were concentrated in the cooler areas and where the climate is more severe.

Reinforcing these ideas, a study on the excess winter mortality in Europe have concluded that countries with the worst housing conditions (lack of thermal insulation in walls, double glazing and central heating) had the highest percentages of deaths in winter (Healy, 2003). The author has suggested that the excess winter mortality can be reduced by a socio-economic progress: by eradicating poverty, diminishing income inequalities.

The best living conditions in terms of protection from cold are thus linked to better energy efficiency houses. Based on this concept, it was identified a variation in risk of dying due to the type of housing (Wilkinson and Armstrong, 2001).

This study has showed a yearly variation on the risk of dying according to energy efficiency. So, there is a higher rate for worst energy efficiency homes (Figure 3)

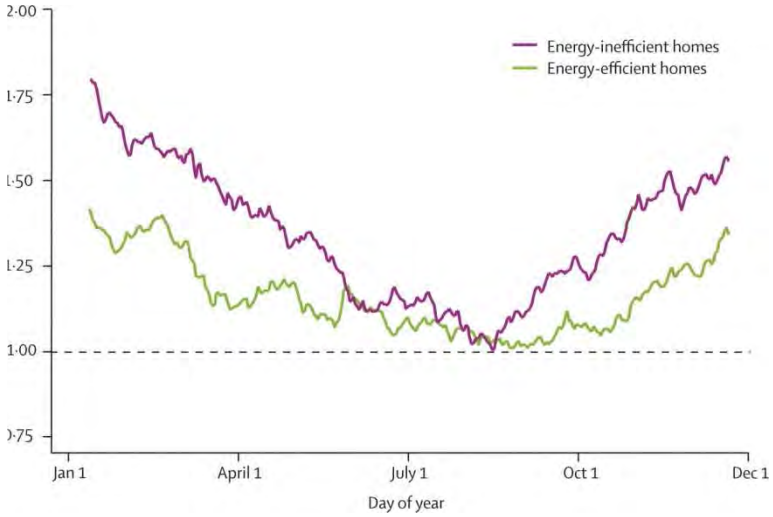


Figure 3. Risk of death and home energy efficiency. Source: Wilkinson e Armostrong, 2001.

The authors have also established a positive relationship between the building age and excess winter mortality, in UK. The population living in houses built prior 1850 has recorded a higher excess mortality, in winter (Armstrong and Wilkinson, 2001).

In Portugal, in 2004, 35.4% of people reported having health problems because of the cold, while 49.7% stated that their homes are cold or very cold (Nogueira *et al.*, 2004). In fact, this study was later reinforced by a publication of the European Commission (Eurostat, 2008) on Europeans life conditions, where Portugal is presented as one of the countries with the poorest housing quality (Fig 4). In this figure, it is shown that the percentage of population in Portugal that have declared that could not keep their homes adequately heated is higher than 40%.

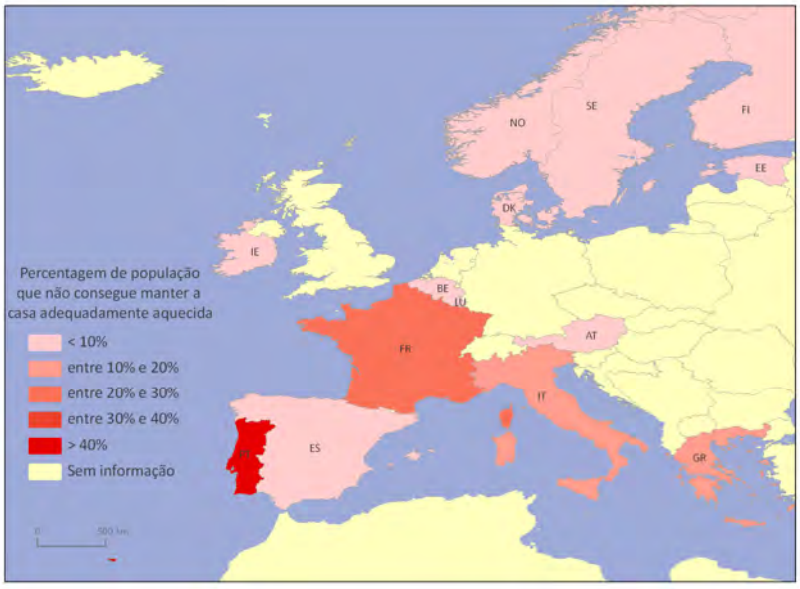


Figure 4. Percentage of population that cannot keep their homes enough heated. Source: Adapted from Eurostat, 2008.

Based on the previous, it is expected that a poor indoor thermal environment, together with outdoors cold exposure, might contribute to worsening health conditions, including the incidence of acute heart diseases.

To better understand this relationship in Portugal, a survey on housing conditions was applied to patients interned in some hospitals with acute coronary syndrome in. In this paper, we present the preliminary results of the study case of Algarve region.

3 Preliminary Results - the Algarve

In the winter of 2009/2010 (from November to March), it were interned in the Cardiology Department of the Faro County Hospital 51 patients with acute coronary syndrome and they have answered to the survey. This sample represented 20.4% of the average of patients during the winter months (2003 to 2007).

The respondents are mostly male (75%), Caucasian (96%) living in Portugal (89% residents in the country for more than 1 year) and unemployed or retired (63%). The individuals interviewed are between 38 and 91 years of old, but 50% are under 65.

About 76% of respondents reported that they were in a closed space (housing, car, or other space-conditioning) at the moment when the first acute myocardial infarction symptoms were felt. 24% of the patients were outdoors at that moment.

These data suggest that most episodes of acute cardiac were triggered in spaces where thermal comfort can be changed (perhaps improved).

Of those subjects who experienced symptoms indoors, only half reported to have some sort of air heating device. 30% of these assumed that the only heating device was an electric radiator (Figure 5).

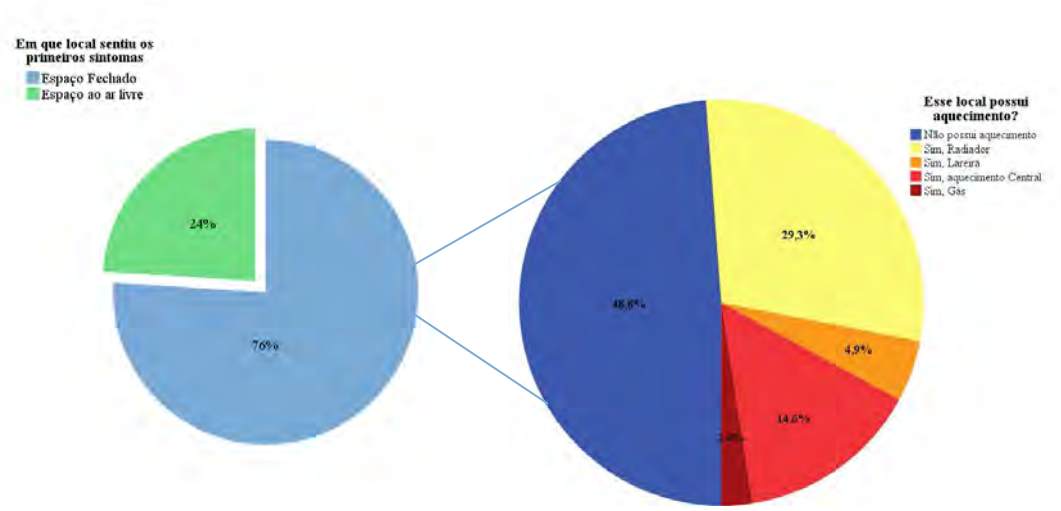


Figure 5. Place where the first symptoms were felt and the kind of heating device is used during winter.

Based on the information recorded, it is possible to assume that the way we use to heat our homes is not efficient and the desirable; since that the majority of patients only use an electric radiator and 80% of them have stated that only some rooms are heated.

Furthermore, only 17% of patients who have declared to have some sort of heating have been using it during the cold winter.

All these information might have two readings: first, it might reflect the predominance of comfortable and efficient homes, which justifies that heating is unnecessary, or, on the other hand, these data may reflect a passive attitude in seeking a suitable thermal environment indoors; in this last case it might show carelessness in keeping the house properly heated or in some kind of deprivation.

In order to outwit these possibilities the patients were questioned about their subjective assessment of their own homes. 57% of the respondents identified the home as a comfortable place, while 35% considers it to be cold and only 8% consider it hot (Figure 6).

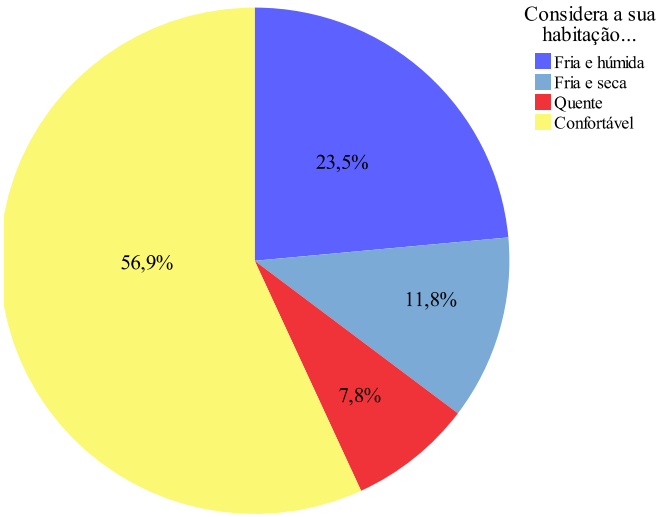


Figure 6. Subjective assessment of patient's homes.

In parallel, patients were also asked about the insulation, the conservation level and the solar exposition of their homes. Almost one third of the persons have pointed out that they could feel the air through the windows and almost 10% reveals that their homes have no sun exposure during the winter.

Those 33% of respondents who claimed to have heating but that did not use it during the winter they have also reported that their homes are cold and that they have a weak insulation and so they reveal a strong vulnerability to cold.

This information is particularly important if we consider that 29% of respondents that did not use any kind of heating during winter remember being cold just a few days before they had heart failure which has resulted in their hospital admission.

4 Conclusions

It is believed that part of the influence of cold on mortality may be changeable, by adopting preventive measures.

Some of the major indications have pointed to measures such as the implementation of educational programs for the adoption of i) appropriate behaviour (e.g. clothing, time spent on street food), and ii) changes in architecture and urban planning (e.g. housing quality, use of heating, better housing insulation, shelter deployment on the streets).

In modern western lifestyle working conditions and living environment outside is getting smaller. It is increasingly common to spend the day indoors, while at work, at home or travelling between them. Thus, it is considered that cold exposure may be significantly related to living conditions and to be expected that the poorly insulated housing, with no heating, poor building quality and without adequate sun exposure are those where were found most of the cases of exposure to cold and those that constitute the greatest risk for the incidence of cardiovascular failure.

Better knowledge about the influence of meteorological variables in this pathology can be applied to the creation of a regulation for the building (applied to both new buildings as well as to those to be rehab), measures/policies of protection and adaptation (such protection procedures as active in the external environment as in raising awareness to use heating facilities), as well as warning systems, to reduce the number of deaths from heart failure, since it can be avoided by implementing preventive measures.

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Visual analysis methodologies based on Virtual Reality (V.R.) technology: Rio de Janeiro's Botanical Garden, Brazil and Cerco's Garden, Portugal

Aurélio Nogueira, Teresa Heitor, Maria Carreira, Gelly Rodrigues, Ana Pedroso

Escola de Belas Artes

Universidade Federal do Rio de Janeiro, aurelio.nogueira@gmail.com;

Department of Civil Engineering and Architecture

Instituto Superior Técnico, teresa@civil.ist.utl.pt;

This paper refers to a research study developed within the framework of IN_LEARNING project aiming at the development of an urban morphological description tool, through visual analysis methodologies based on Virtual Reality (V.R.) technology. The research is based on two case studies selected in the framework of cultural landscapes such as historical gardens in urban contexts – Rio de Janeiro's Botanical Garden, Brazil and Cerco's Garden in Mafra, Portugal. The morphological description considers their historical, geographical and formal dimensions and it is based on the existing bibliography and iconography complemented by field work. The paper discusses the contribution of Virtual Reality to visual analysis and its capacity to support spatial descriptions. The paper is divided into three parts. The first one introduces the two case studies: Rio de Janeiro's Botanical Garden, Brazil and Cerco's Garden in Mafra, Portugal and the second one describes the methodological procedures applied and the main tasks carried out. The third part, presents the case studies. Finally the potential of the proposed method for the spatial description of urban environments is discussed.

Keywords: Electronic Interactive Means, Virtual Reality, Virtual walk, Botanical Garden, Cerco's Garden

1 Introduction

This paper refers to a research study conducted in the context of In_learning project. The aim is to explore interactive procedures of urban morphological description enabling: 1) a new approach to knowledge acquisition and sharing; 2) the development of an active learning tool based on the observation, exploration and discovery of the urban form.

A major part of the work is to develop a new approach to effectively integrate these strategies into forward looking and reliable morphological descriptive tool. The ultimate goal is to develop a tool that is people-centred, inclusive and development oriented.

It was intended to develop a comprehensive morphological description tool, capable of incorporating physical and cultural features, by applying visual analysis methodologies based on Virtual Reality (VR).

The use of Virtual Reality technology has spread very quickly in the areas of architecture and urbanism, enabling the creation and visualization of stereoscopic images as well as the interactive manipulation of virtual models, and making it easier to conduct experiments in unconventional collaborative and sharing information environments.

These advances can lead the research in the field of morphological studies for new directions, emphasizing the use of new technological tools and providing new developments in the descriptive process (Ferreira, 2004). As Malik, et al (1998) advocates: "The degree to which VWH sites will succeed depends on: (a) the matrix that is used to create/describe the spaces, (b) the manner in which the matrix is represented in the human-computer interface, and (c) the extent to which the matrix is dynamically meaningful to users."

The historic garden in urban context was selected as the object of study. Regarded as a heritage resource, framed by the concept of cultural landscape, its morphological description is justified both by its cultural significance as an expression of a man-made environment, historically produced, and in its relevance for the understanding and significance of the city. According to the Florence Charter, article 25 (ICOMOS, 1982) "interest in historic gardens should be stimulated by every kind of activity capable of emphasizing their true value of the part of the patrimony and making for improved knowledge and appreciation of them". Explicit in this statement is the need of developing efficient and useful procedures of data collection, analysis and evaluation.

The purpose of the morphological description applied to the study of historic gardens is not just establish by their spatial characteristics, but also reveal its cultural value as well as improve the legibility of their spatial layout. Rather than seeking to reconstruct its spatial form, it becomes essential to reveal the limits of existing materials, spreading and giving it new values in order to dialogue with the past and promote its appropriation and reinterpretation. As Mudur et al (1999) regards there is an absolute need to preserve and catalog these assets for future study and memory “right from the beginning of the first civilizations, documentation of events, religion, culture and significant structures has been of utmost importance for further study and preservation.”

The aim is to develop a virtual catalog for Web and multimedia, through panoramic 360º based on two case studies: the Botanical Garden of Rio de Janeiro, Brazil, and the Cerco's Garden in Mafra, Portugal.

Virtual Reality (VR), through 360° panoramic views , allows "virtual" access to the case studies and provides an interaction with various applications by presenting a great potential to be exploited in the process of morphological description. It can also be applied as a three-dimensional description device to record, read and interpret the existing urban fabric. “Virtualized' architectural heritage offers the research community and greater public the possibility to quickly and accurately document our past for future generations.” (Alonzo, et al: 1998).

The paper is divided into three parts. The first one introduces the two case studies: Rio de Janeiro’s Botanical Garden, Brazil and Cerco’s Garden in Mafra, Portugal and the second one describes the methodological procedures applied and the main tasks carried out. The third part, presents the case studies. Finally the potential of the proposed method for the spatial description of urban environments is discussed.

2 A brief historic introduction of the case studies

The Botanical Garden of Rio de Janeiro (JBRJ) is located in the Botanical Garden sector of Rio de Janeiro. It is one of the city’s most visited historical attractions; it also works as educational tool regarding the Brazilian biodiversity (Koatz, 2006). It was designed in the beginning of the 19th Century after the arrival of the Portuguese Royal family in 1808, following the interest of King João VI to natural resources and a new perception in the art of landscaping (Terra, 2008). The current collection comprises various species and presents a range of environments consisting of fountains, statues, ponds and pergolas around the park. The access is public and offers extensive information on the botanical species, properly documented and descried about its origin, utilities and curiosities.

The scientific collections of JBRJ contain specimens of plants domesticated by man, medicinal plants, fruit trees, wild plants, often unknown to the general public, ornamental plants of rare beauty and endangered species.

The Cerco's garden (JC) is located in the metropolitan area of Lisbon, in the municipalty of Matra. It was built between Mafra's, palace-monastery the largest baroque building in the country and Mafra's Park, the largest national walled park. This garden has the unique potential to combine architectural and landscape values together with a strong cultural statement of the baroque era in Portugal. As a baroque garden, the succession of fountains and lakes stand out, as well as the wide paths encouraging visitors to a contemplative attitude.



Figure 1. 360° Panoramic of Jardim Botânico in Rio de Janeir o – Main Access.



Figure 2. 360° Panoramic of Jardim do Cerco in Mafra – Main Access.

3 The methodological procedures

The methodological procedures were structured into five sequential stages. Each stage involved a group of activities and tasks to be undertaken, as well as an analysis of the procedures to be applied.

3.1 First Stage

The first stage involved the collection of information - raw data - concerning the case studies. A variety of bibliographic sources, as well as historical iconography, blueprints and aero-photogrammetric were consulted and compiled. The collection of raw data constitutes a fundamental tool for preparing the morphological description of the two spaces.

3.2 Second Stage

The second stage considered the field work performed in Rio de Janeiro (Fig. 3a)) during the first semester of the academic year 2010/2011 and in Mafra (Fig. 3b)) during the second semester of the academic year 2010/2011. The field work included site visits, interviews with stakeholders and researchers, as well as visitors of these spaces, in order to develop a database with information and images to support the primary sources analyzed.



Figure 3. a) Map of Jardim Botânico in Rio de Janeiro b) Map of Jardim do Cerco in Mafra.

3.3 Third Stage

The third stage was concerned with the study of the visual analysis system requirements, based on Virtual Reality (VR) technology, using panoramas of the Botanical Garden of Rio de Janeiro and the Cerco's Garden of Mafra. This system provides the basic resources to process the results developed in Windows environment, since it covers a larger number of users. The applications were applied through a multimedia application to generate hypertext, images and panoramas (with the possibility to change viewing angles in real time in any axis x, y, z). In addition to these functionalities, high quality and realistic panoramas were generated using various peripheral interface devices such as joystick. Additional new features, like sound, smell or a virtual presenter can be later added.

Initially, the possibility to visualize the panoramic views in a Digital Cave[242] (Cave Automatic Virtual Environment), with the help of the Ogre (Open Source 3D Graphics Engine), which operates with different systems: Windows, OS X, Linux was considered. The visualization of each case study by small groups of guests/visitors (e.g. researchers, students) would occur at scheduled periods. The goal was to generate an active learning process by fostering both the visitor contact with information concerning the morphological features and historical events of the site, and its sensory immersion, i.e. the experience of entering into the three-dimensional environment, and being intellectually stimulated by it.

However, a cost benefit analysis has demonstrated this solution would imply substantial financial resources (in the rental or purchase of the Digital Cave) and time (schedule adjustments between multimedia and Ogre applications, fine-tuning of design and logistics for project implementation).



Figure 4. Digital Cave of USP/POLI/LSI.

After reassessing the proposal it was decided to apply another system to visualize the case studies: through a PC or a notebook screen (not stereo), on- and offline (media), using the Windows system with minimal configuration of Windows 98, 333 MHz Intel / AMD processor, 128 MB RAM, 50MB available hard drive space, CD-ROM drive, Video display capable of 800x600 pixels with 16 bit colors or higher and Mac. However these technical requirements have limited processing capacity related to graphic details.

3.4 Fourth Stage

The fourth stage was focused on the digital photographic recording. The techniques applied to build the interactive panoramas follow the evolution of analogical to digital photography and the subsequent development of manipulation softwares. This has allowed both the individual visualization of panorama views and the navigation between different panorama views through hotspot systems, i.e. the interconnection between two panorama views. For the creation and display of this type of

[242] The Digital Cave has projections in all its walls, which are actually projection screens. A computer set (cluster) provides the images projected on each screen, creating a virtual harmonic environment. The projected images are in a stereoscopic format and are displayed in an alternating fast pattern. The users have glasses with shutters, which open and close in sync with the alternating images, giving the user the illusion of depth. Tracking mechanisms associated to the glasses tell the computer how to adjust the projected images as you walk within the cave. Typically, the users carry a driver device to interact with virtual objects or navigate through parts of the environment. More than one user can be in the CAVE at the same time, although only the user who is wearing the tracking device is able to adjust the point of view: all other users will be passive observers. The user has a wide field of view, in real scale, something that would be impossible to view with the screens.

image, it was possible to apply specific applications, such as 3D Studio Viz v-1.8, Realviz Stiler, QuickTime VR (Virtual Reality), Factory, Vr Worx 2.0 and Pixia Pro, among others.

The techniques applied to perform panoramic and virtual walkthrough are user friendly, being easily handled with accuracy and interactivity by non-experts users. The virtual walkthroughs, which are displayed in the Visualization Room, digital Cave or even the Internet (with the help of a browser and a plug-in PC) also enable an accurate visualization and understanding of space promoting the knowledge sharing and the discussion of ideas.

The technique for performing panoramic views is low cost, requiring a minimum of a digital camera (if possible with memory card and USB cable for export of image files to a PC), a tripod and a computer. According to Rigg (2005) a panoramic is defined as an image, which provides an elongated field of view larger than what can be seen, presenting the image behind the observer.

The recorded material was organized in individual folders with their respective files with different extensions, such as: psd, jpg, tif, Tga, Png, in accordance with the proposed use. The photographic process was carried out with a camera (SLR, Nikon 90D and a SONY DSLRα100) and with the support of two semi-professional tripods. Different sites were chosen based on the research carried out in the first stage and the second stage observations. For each panoramic the equipment was positioned at a specific chosen point, in which the camera is on the tripod and rotated around its axis, generating several images, which subsequently will be visualize together, in a large angle then the portrayed and generated a panoramic with an angle up to 360° (Fig. 5).

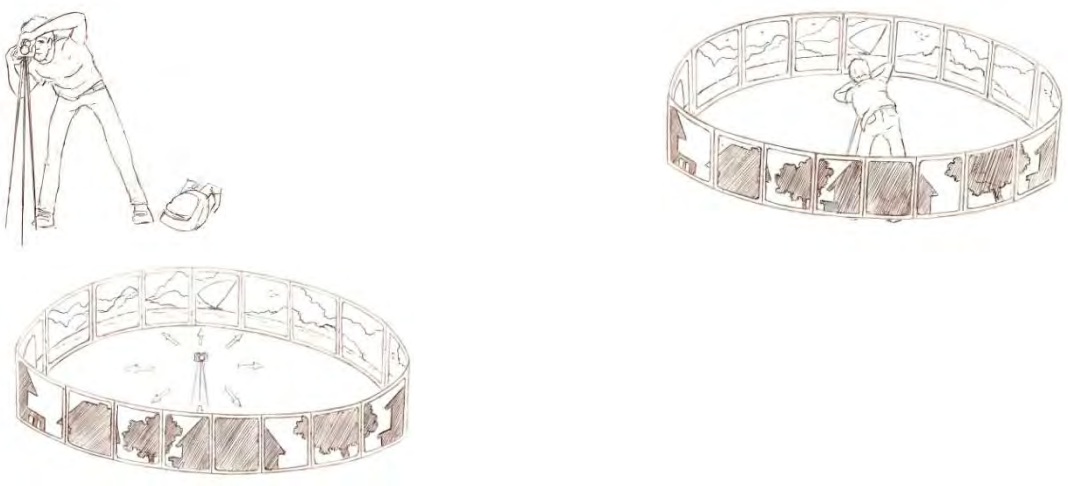


Figure 5. The principle of an infinite presentation of a circular panoramic.

The digital photographic images (Fig. 6) are fixed according to the different perspectives contained in each of the images within the same sequence. Next, they are stitched together and rendered. Later on, a file with the extension ".jpg" is generated.

Planned Images and ".mov", as well as interactive 360° (or different angles) panoramas can be visualized with Quick Time VR (which is based on Apple QuickTime), featuring a series of codec which form a ISO standard library for exhibition and production of digital video files and panorama view across multiple platforms (Macintosh, Windows and UNIX).

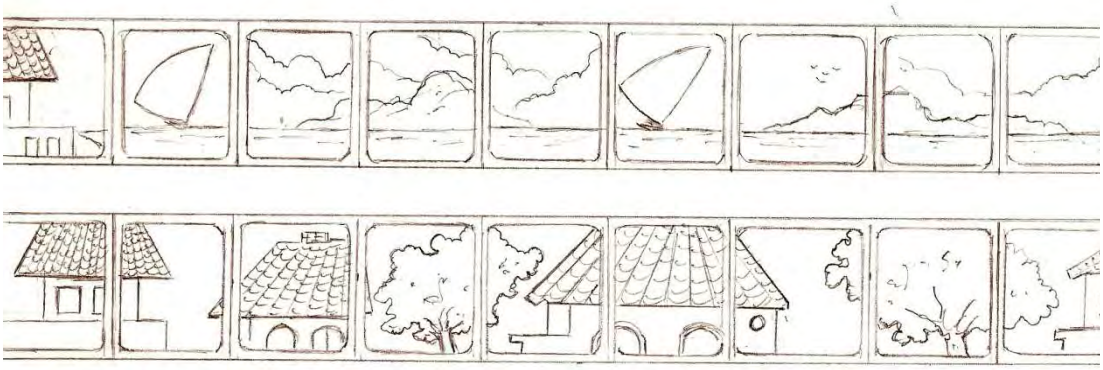


Figure 6. Linear presentation of a circular panoramic.

All the processed material can be used to make a Virtual Walktrough using Multimedia (trough CD-ROM and DVD), kiosks and the Internet. They can also be printed or used in publications together with the data surveys, held on the first stage, as well as information about Virtual Reality (VR) the technology. The Figures 7 to 9 illustrate 360° Plan ned Panorama views of the Cerco's Garden and the Rio de Janeiro Botanical Garden (Figures 10 to 12).



Figure 7. Planned 360º Panoramic of the Cerco's Garden – Central Fountain.



Figure 8. Planned 360º Panoramic of the Cerco's Garden – Landscaping composition with flowerbeds and fountain.



Figure 9. Planned 360º Panoramic of the Cerco's Garden – Kindergarten.



Figure 10. Planned 360º Panoramic of the Botanical Garden – Entrance.



Figure 11. Planned 360º Panoramic of the Botanical Garden – Cactus.



Figure 12. Planned 360º Panoramic of the Botanical Garden – Greenhouse.

Since, the process described includes the real images without photographic treatment, lighting, color or texture features were not changed in the panoramic.

3.5 Fifth Stage

The fifth stage considers the development of the Multimedia (offline) using the Adobe Director Mx application. At this stage it was intended to use the versatility of this application to create a multimedia, self-executable, loaded with the virtual walkthrough using the panorama views performed in the previous stage plus a series of hypertext and interactive photos. The in-Learning project portal

includes an interactive multimedia with a virtual walkthrough, developed with Adobe Macromedia Dreamweaver.

4 The potential of the proposed method for the morphological description

This study shows that RV can be applied as a tool for morphological description and will be aggregated under the IN_LEARNING project.

The Virtual reality technology allows the construction of three-dimensional visualizations which simultaneously integrates a variety of data and images in an environment of digital and cultural inclusion, facilitating the acquisition and transmission of knowledge in the field of urban morphology.

By exceeding the space-time limits, virtual environments make possible the exploration of urban form, acting as a kind of "time machine" (Dainese et al 2003). Besides, it offers the possibility of analyzing a site from different angles promoting the understanding of its morphological features. By facilitating the knowledge acquisition and sharing about urban form, the use of virtual reality contributes to the recovery of its memory, while acting as a tool for active learning. As such, virtual reality can be an instrument of great effectiveness. As in many other areas, innovation does not necessarily mean replacing the old and the new, Virtual Reality as a new form of morphological description, will not replace existing technologies, but rather complement them (Campos and Sampaio 2005).

Moreover, the integration of Virtual Environments within the urban morphological description enables fundamental changes in work processes, allowing the researcher immersion and direct interaction with the urban environment under analysis (Nogueira, 2008).

Thus, it is proposed the development of a (mobile) visualization room with stereovision. This room consists on a stereo front projection screen, two projectors, polarizing filters, glasses for stereo visualization, sound system, peripherals and a PC or laptop with graphics drivers similar to those for computer games, installed in an auditorium or a room with possibility of complete darkness. It can promote the development of an efficient learning tool, enabling the view of the selected sites, through multimedia images, hypertexts and others. In comparison with the digital cave, the viewing room is not only a more economical solution but also highly efficient.

5 Final remarks

"A historic garden is an architectural and horticultural composition of interest to the public from the historical or artistic point of view". As such, it is to be considered as a monument. (art.1). (...)As a monument, the historic garden must be preserved in accordance with the spirit of the Venice Charter. (art.3) (...)The term "historic garden" is equally applicable to small gardens and to large parks, whether formal or "landscape". (Art. 6).

HISTORIC GARDENS (The Florence Charter - 1982)

Both the Cerco’s Garden and the Rio de Janeiro Botanical Garden are exceptional sites, combining natural and built elements and performing an important and recognized heritage value.

Whereas the role of cultural heritage is to be constructive (Choay 2001), it becomes essential to engage with the past through its appropriation and reinterpretation. In this sense, the present study

should be further developed and enhanced to become an effective learning tool., thus supporting cultural heritage preservation and memory.

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