Specific Centralities

Spatial configuration linked to socioeconomic complementarity between urban spaces

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Abstract
The objective of this paper is to investigate the organization of the urban system, aiming to clarify the relations between spatial configuration and the process of social-economic interrelations among the different areas of the city. In this sense, the study of spatial configuration system is linked to concepts of urban economy and urban geography.
The city will be considered as a macrosystem made of a group of edified elements and nets of paths that are interrelated through social-economical spatial properties, which will be the basic components of the urban system here studied.
A form of description of the states of the urban system is being proposed, starting from properties with specific centralities. This property is derivative of the application of the centrality, concept considering the disaggregation of the urban macrosystem into subsystems, formed upon relations of social-economical complementarity among urban activities.
This instrument of description has the purpose of investigating areas of stability (of probable continuity of its spatial configuration and soil usage) or areas of instability of the urban system (potential areas of spatial transformation, due to the tension lines acting there).

Keywords:
urban, spatial configuration, centrality, urban economy, urban geography

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1. Introduction

This paper focuses on the analysis of urban spatial structure based on urban geography approach. The city is considered a macrosystem whose evolution is assumed as a cumulative process of individual location decisions ruled by the interaction between spatial configuration and socioeconomic relationships.

The uneven distribution of localized resources across the urban landscape imposes socioeconomic interdependence between urban areas with functional complementary activities, such as residence-commerce, job-residence, etc. These spatial socioeconomic relationships are understood as "attraction tensions" between urban locations.

Tensions can be understood as potential interaction forces linking related urban activities, able to create flows between different locations (Wilson, 1987) and therefore side effects throughout the spatial system.

It is inferred that a diversity of "lines of tension" acts simultaneously in each urban area. "Attraction tensions" between urban locations have different characteristics, according to the land use type and to the organization of complementary activities over the urban structure. Such a system representation can be achieved as follows:

2. Model Specifications

The Urban System can be understood as a complex system by three different facets: it has many essentials elements; it structure is complex; its essential elements are all interacted. It is hierarchical because there are different levels within the urban system, which in this research is divided into three categories: the macrosystem which refers to the city as a whole, the intermediate level which are the subsystems formed by complementary activities and the microlevel, which consists of individual location choices. This structure finds itself in a whole one with a nature of being more than the sum of its parts. In order to describe the structure of urban system through its inferior levels of organization[1] a new application for the centrality model (Krafta, 1994) was developed.

Centrality[2], consists generally of the ability of a determined space to fall on the shortest path between pairs of other spaces in the urban system. It is assumed that each elementary built form can be reached from any other one by means of strings of interconected public open spaces, which can, then be considered central to that particular pair of built forms. The most central space will be the one that appears more frequently in the shortest paths among all pairs of built forms in the system.

In Krafta's studies (1994) spatial differentiation is given not only by morphological configuration, but also by spatial patterns of social appropriation. The calibration of the centrality model results is made by independent external variables, through parameters values of attractivity endowed to built forms, which better fit to the reality of the analyzed system.

Examples:

* land use type;
* built area;
* frequency of people;
* number of employees , etc.

The centrality model requires an abstract and mathematical representation of the urban spatial structure. This can be reached through the description of topological relations between spaces that generate the urban graph. Each point of the urban graph can represent a path of the system, a corner or the space existing between corners, an open area, a built form, etc.

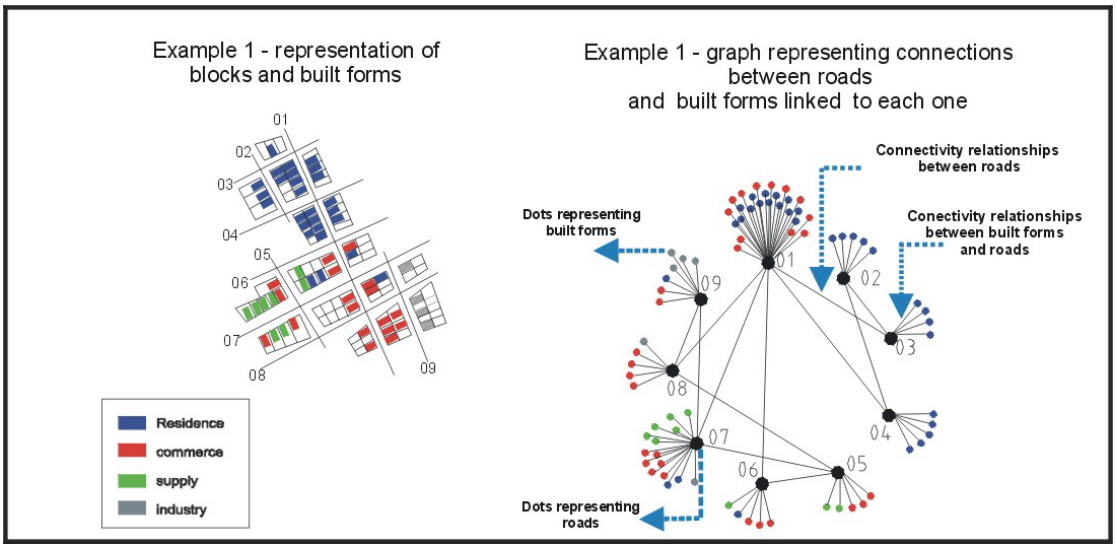


Fig. 1 Urban Macrosystem Graph representing the roadway system and total built stock

The proposed measure of specific centrality improves the centrality model by the addition of principles of urban geography like the location of activities and urban areas specialization.

The urban macrosystem is disaggregated according to its socioeconomic complementary activities that define urban subsystems which are interrelated and mutually act upon each other, thus making a network-like structure. The subsystems can be analyzed in terms of quality, quantity and hierarchy. Quality is its internal definition and specific complementary socioeconomic relationship that distinguish it from other subsystems; quantity displays its elements as well as the relations between its elements in a quantitative approach; and hierarchy indicates the positions of its elements in space.

Considering the "βετα" macrosystem with complementary activities "A" and "B" defining the "A-B" subsystem. The space "alfa", which is a path of "beta" roadway system, presents specific centrality value only in two possibilities:

If space "alfa" is linked to built cells which maintain activities type "A" or type "B";

If space "alfa" was part, at least once, of the shortest path between two built cells that maintain activities type "A" or type "B".

If none of these two possibilities occur, space "alfa" will have specific centrality value for the subsystem "A-B" equal to zero. Therefore the space "alfa" is not affected by the tension caused by the "A-B" subsystem.

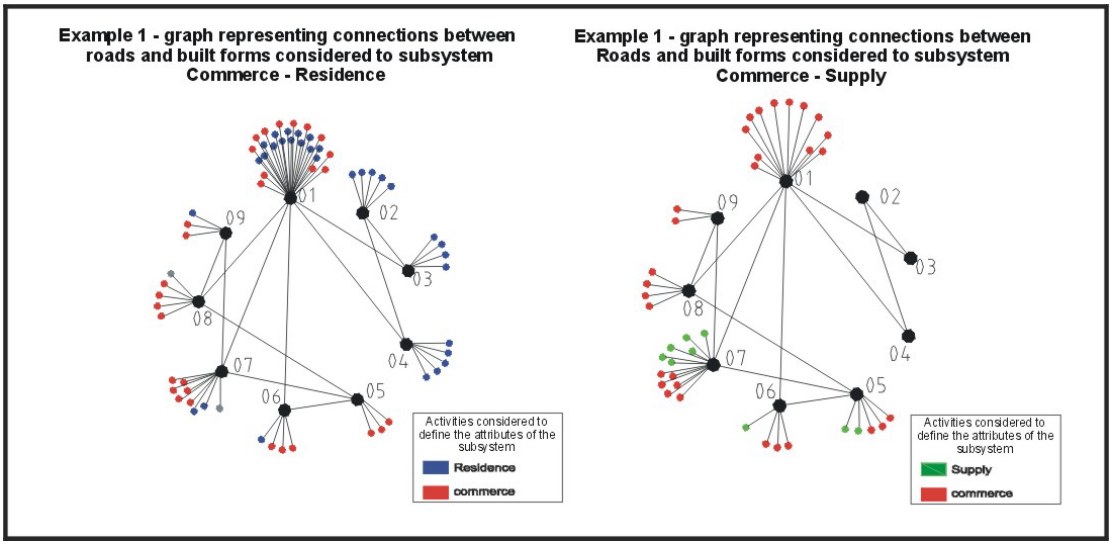


Fig. 2 Urban Subsystems Graphs representing the roadway system and the built stock sheltering complementary activities

3. Measure Test

This application of the Specific Centralities Model tries to demonstrate the capacity of the measure to describe inferior levels of urban macrosystem organization, at a particular time, through its disaggregation in complementary activity subsystems.

The Hypothetical Urban System "A" provides a basis for simulation of distribution of socioeconomic activities over the urban landscape. Two hypothetical urban development stages were generated. This process was simulated in order to investigate the sensibility of the Specific Centralities Model to identify modifications on urban system's structure caused by the addition of new buildings to the initial system.

Urban System "A" is constituted of 136 blocks and 1272 lots. It was disaggregated in 133 axial lines. Along with global centrality, the subsystems considered in the analysis were the following:

* Subsystem commerce-residence;

* Subsystem commerce-industry;

* Subsystem commerce-supply;

* Subsystem residence-services type 2.

The attributes of the built cells of system "A" were defined arbitrarily, considering each type of activity, as well as the features of the buildings, as shown on the chart bellow:

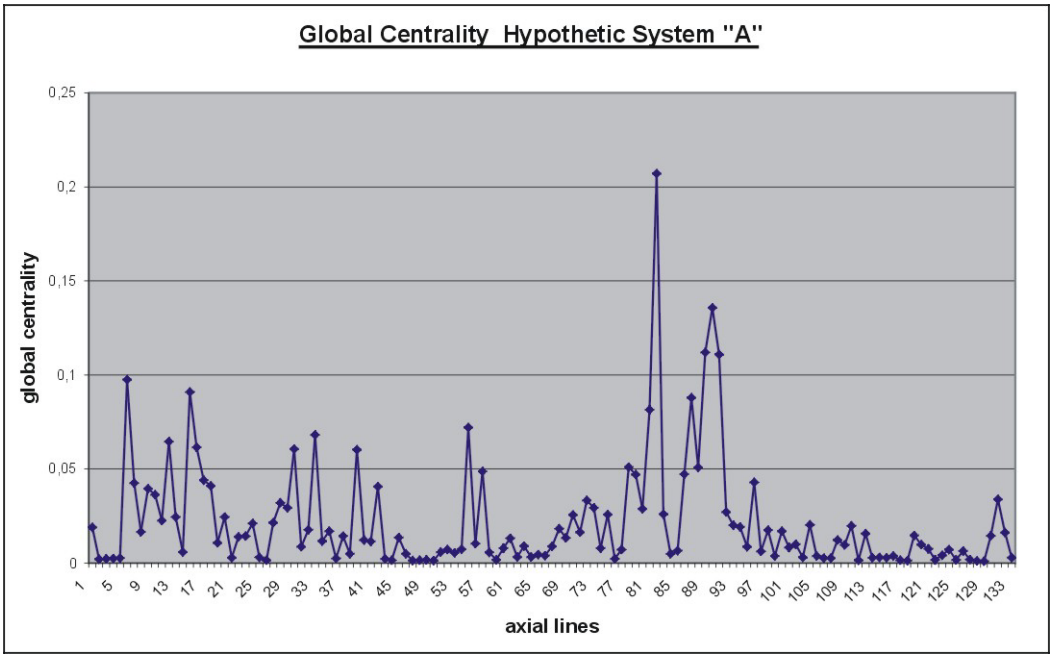
Table 1 Urban system "A" stock - development stages 1 and 2

Activity/ edification type	Attribute	Total stock Stage 1	Stage 2
C.B. 6 to 10 floors	700	6	68
C.B. 3 to 5 floors	350	104	104
Commercial ground floor	200	188	209
Commercial gallery	500	3	3
Supermarket	500	2	10
Shopping Center	1500	0	7
Supply	700	13	29
Industry	800	17	45
Public services	500	17	17

C. B. = Commercial Building

Residence/ edification type	Attribute	Total stock Stage 1	Stage 2
50 m2	5	107	107
100 m2	10	125	125
200 m2	20	78	78
Building 1 to 3 floors	75	146	196
Building 4 to 6 floors	150	147	147
Building 7 to 10 floors	300	0	93

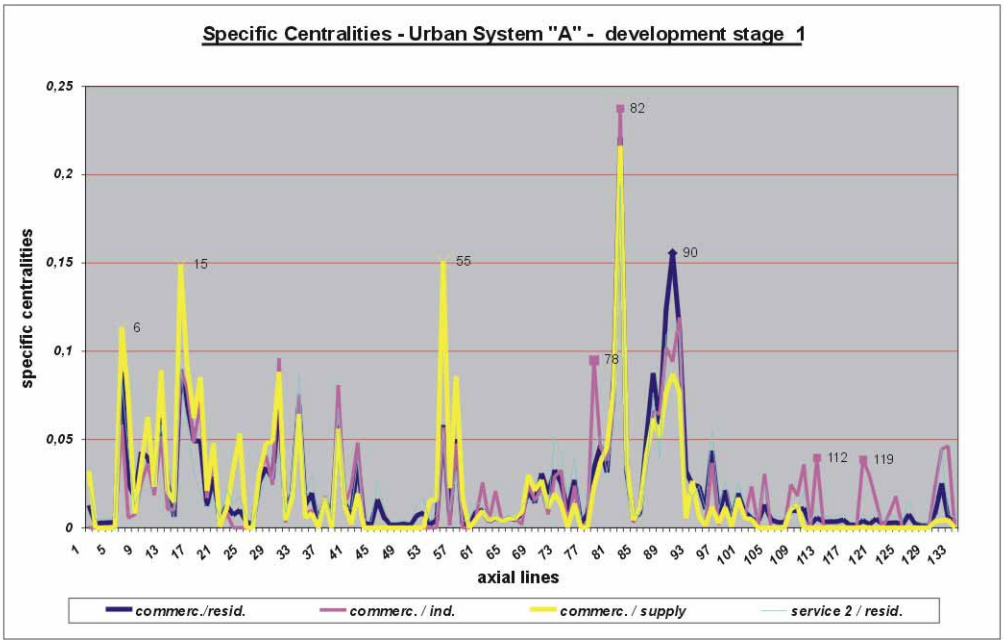
The results of the global centrality measure related to development stage 1 are displayed in Graph 1 which contains the distribution of the global centrality value assigned to each axial line of the urban system "A".



Graph 1 Global Centrality - development stage 1

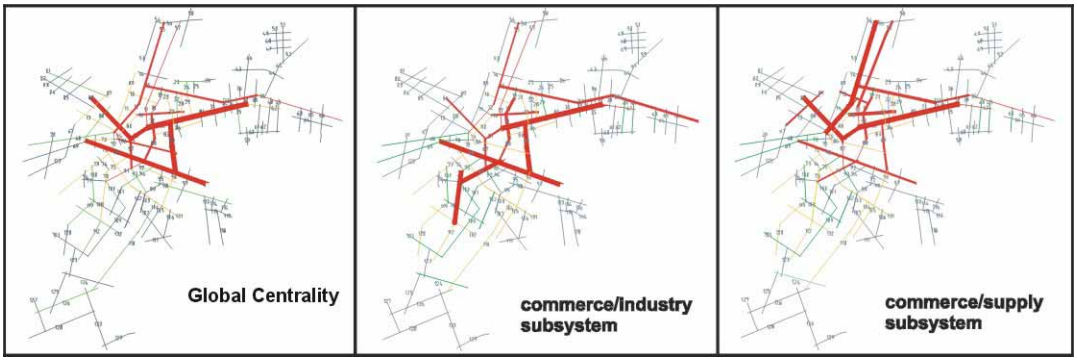
Graph 2 displays the distribution of the specific centralities values computed to each axial line of the urban system "A" for the development stage 1.

Centrality of the urban system is described in two different ways: the first describes the centrality of each space of the system taking in consideration the whole set of attractors; the second describes a group of specific centralitites related to each space. The disaggregation of the urban macrosystem through Specific Centralities presents a complex of hierarchies. The spaces that constitute the urban system present different values of specific centrality, according to each socioeconomic complementary relationship. As can be observed by checking the obtained values for the supply/commerce subsystem, some spaces can even present specific centrality equal to zero.



The following maps represent the spatial distribution of values of global centrality and some specific centralities computed to "Urban System "A". They show the "displacement" of the most central spaces according to the macrosystem, commerce-industry and commerce-supply subsystems.

Graph 2 Specific centralities - development stage 1



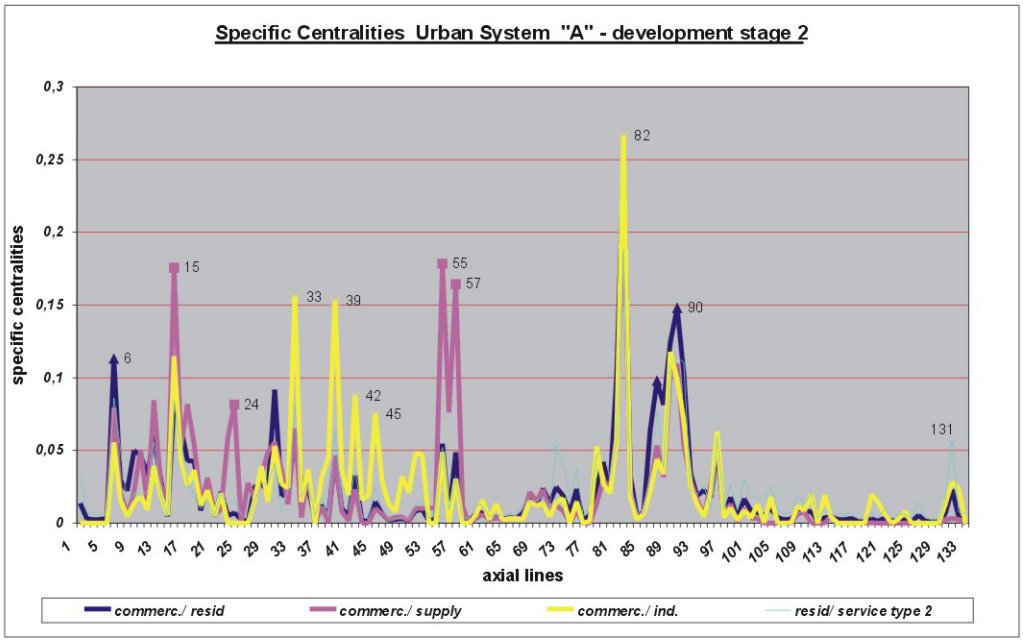
Maps 1, 2 and 3 Development stage 1

Graph 3 displays the distribution of specific centralities values to development stage 2. Hierarchic modifications that occurred on some spaces by insertion of new buildings were appropriately described by the model.

Insert Maps 4,5 and 6 here

Supposing the existence of a series of different tensions acting over the urban landscape the following situations can occur:

* There is consonance among buildings, typology and a kind of tension that predominates on public space, here denominated "specific centrality" that assumes major values in the whole act of forces. In this sense, the incident force could be strengthened through new buildings of some kind that shelter the same activity, without characterizing the subsystem stagnation (dynamic equilibrium);



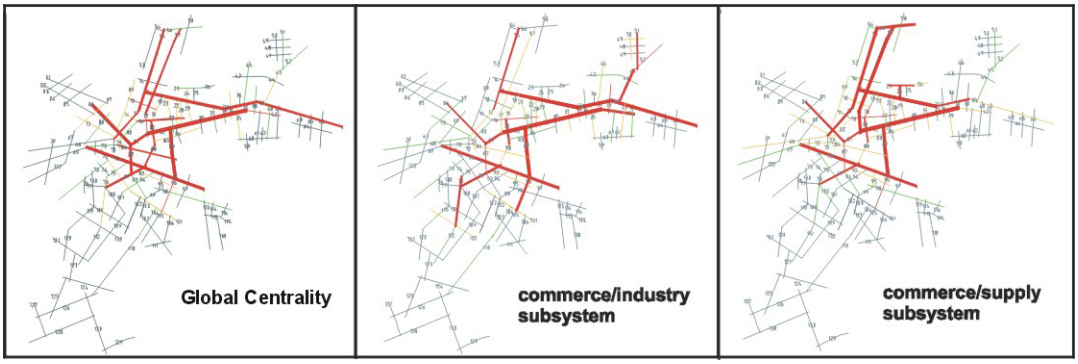
Graph 3 Specific centralities - development stage 2

* There is dissonance among kinds of buildings and the predominating tension; this would generate some subsystem's instability and the possibility of space transformation and land use modification. It does not necessarily indicate immediate transformation, because the last could be the result of factors as the profit and the competition among the different specific centralities.

* The insertion of a building of different characteristic in a subsystem already established would cause the centrality change, not only in its intensity but also in its character, and in an accumulation process, it could reach the change both of a ruling order parameter and of spatial configuration.

The description of the urban system through Specific Centralities allows a more detailed and realistic analysis of the urban structure. As it can be observed through the graphics and maps above, it is possible to define what kinds of socioeconomic forces are acting on each area of the city as well as the degree of influence of each one over the urban spaces.

Maps 4, 5 and 6 Stage of development 2



4. Conclusion

Like other complex systems, the urban system is dynamic. It is never absolutely stable and immutable. "Development concerns the introduction and growth of new activities, and the successful mutual adaptation of the landscape anthe population to these changes, leading to their maintenance and continued development (Allen, 1997)". Each modification conceived by an agent to the subsystem through the insertion of a new building, modification or substitution of one already existent causes adjustment and changes in the urban structure that maintains continuing evolution. From these little changes the acting external forces over the subsystem are modified through factors such as:

* Cooperation among compatible activities, which come to coexist in the same urban area taking advantage of the same facilities offered by themselves;

* Competition among incompatible activities which start to coexist in the same space, from the insertion of a new element, which modifies the subsystem's socioeconomic inter-relations in relation to the urban macro-system. In this situation instability is created and, from a series of economic factors, social, spatial, etc., a new order must overcome the older one.

An analogy can be traced between principles of Synergetics (Haken, 1973) and the socio-economic relations mentioned above. That theory analyses the behavior of a system through microscopic interactions of different agents. This process determinates the rules of global behavior of the agents creating the so-called "parameter of order", that describes the macro-scopic structure of the system (Haken, Portugali, 1995).

The modification of a state of any subsystem (space and land use transformation) would be given by the competition process among the forces related to activities practiced in areas which are part of the system and by its intensity of influence over the referred subsystem. It can be admitted that either the predominant force modification over an urban subsystem or its modification of intensity reduces its resistance and increases the possibilities of space transformation and land use modification.

An area is considered stable when the prevailing "power line" is suitable with the nature of the built stocks that exist in the area. This way, there is cooperation and a condition of continuity in the social-economical relations of the area in relation to the complex of the city, which takes further the spatial characteristics and the types of activities developed there. When stability is faced this way, it is not mistaken for the stagnation of a certain urban area, but has to do with the changes that happened inside this area, which reinforce the complementarity existing between this certain area and the complex of the city.

The destabilization appears when internal modifications result in increasing or decreasing certain forces that act there. Depending on the intensity of this change, the destabilization will be capable of modifying its complementarity relations with the other urban areas. This way, the emergence of a new force that is not compatible with the nature of the existing stocks in the area, could lead to the modification of the morphological characteristics of the buildings, due to new spatial demands required by this modification.

What is suggested by the presentation of these concepts about space transformation and urban land use through Specific Centrality properties, may be characterizing a potential force of change, as an example of what occurs with the centrality measures in the theory of

Potential/Centrality (Krafta, 1997). The Specific Centrality could be taken as a starting point to the development of a dynamic model representing the spatial process of transformation of the urban system as a self-organized system.

Notes

1 Organization: relations between the essential elements of a system.
2 In this paper Centrality in its general definition will be equivalent to Global Centrality.
3 The concept of axial lines is described in Hillier and Hanson (1984).

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