EXPLORING SPATIAL SYNTAX IN BUCHAREST CITY

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ABSTRACT:
Bucharest development after the 1990 was brutal with new buildings trying to cover or replace the past. That is why the morphological evolution of the city wasn't too much modified. Though research on urban morphologies in Bucharest exists, they aren't connected to the renewal and development policies. The result is a complicated tissue and pseudo-functional political framework. In this context, new techniques may reveal some of the connections between the urban space and the population characteristics. The study is focusing on the spatial syntax in Bucharest for identifying those areas strongly affected by the communist intervention or by the neglected policies after the '90s. They are further analyzed when ESDA methodology is applied. Morphological transformations can be observed better and their spatial connectivity offer better insight for future solutions of urban developme.

Key-words: *Bucharest, spatial syntax, ESDA methodology, Morphological transformations.*

1. INTRODUCTION

Most of the Bucharest space has gone rapid changes in the past 60 years, but little has been connected to the real needs of the population or the urban standards. Even if the centralized intervention has been changed, few urban policies emerged for resolving past issues and new ones. The morphology of the city may contain tracks of this evolution which can be followed as new IT techniques are developed. As few recent studies focused on Bucharest morphology have been done, spatial syntax analysis may offer a good perspective for future reference and political insight.

The main goal of the study is the identifying of spatial clusters where logical connection between urban morphology and social-spatial characteristics of the Bucharest city, resulted from the political interventions, may arise. By this it can be explained the urban morphology of the city at the streets network level. In Bucharest, the major interventions from the communist period alongside the legislative dissolution encountered after and the punctual investigations have been the most important factors in urban modeling. The resulted image can be compared by means of spatial syntax to other recent studies where the causes where different. Studies made for other cities from UK, Turkey, Bangladesh, China, South Korea, US, and Brazil prove an increasing attention for this techniques trying to explain the urban morphology form a different angle. Most of these studies have been in the last two decades as the GIS techniques and computer power allowed to empirical show results anticipated by Ben Hillier writings. Even some research on Bucharest has been done. *Gemil (2007)* had a preliminary analysis on this city in order to connect the historical evolution to spatial syntax ideas.

Besides the spatial dimension of the analysis, studies have focused on explaining the hidden connections of the urban space geometry to the social part reflected by the morphometric attributes.

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Development of GIS technologies have allowed integration of many theories as spatial syntax for easier analysis, practical development and material for urban policies *(Turner, 2001, Batty and Rana, 2002, Figueiredo, 2005, Jiang and Claramunt, 2002, Dalton, 2004, Jiang and Liu, 2010).* On the tracks of these software solutions and of spatial syntax theory, the study is researching the urban morphology determined by the Bucharest street at 2002 level. It was chosen that moment as the census data were collected at that time and it was the beginning of the GPS mapping for the streets. As spatial syntax theory insists mainly on streets or building spaces and the census area is too large, the analysis opted for a selection of the building areas from the census. The solution for analyzing census tracts is underlined by other studies *(Franzen, 1992, Fanek ,1997, Legeby, 2009a, b)* as well as by some theoretical approach regarding the building space *(Alexander, 1965, Lynch, 1960, Hillier and Hanson 1984, Lefebvre, 1991, Hillier, 1999, Hillier, 2001, Valentine, 2001).* It can be revealed that society may be studied at certain level by relating to build space. Intervention in urban space contains numerous tracks of evolution through buildings and streets morphology, that can be easily understood once they are reduced to a mathematical algorithm. More we explore the results and try to see if there is some spatial correlation. For this ESDA techniques are used: Morans' I and LISA.

In Bucharest the extracted building areas are analyzed by means of spatial syntax techniques. What it will be further analyzed is the comparison of the social elements with the morphometric ones. The insight of the analysis allows to underline the way in which streets accessibility, determined by isovist lines, may help in understanding some of the dysfunctions caused by the political interventions. If they are overlapping with social elements showing problems there is a high chance in identifying some segregation tendencies. They are discussed in the framework of political evolution of the city, the main factor for the current situation.

Traffic issues and the streets in Bucharest represented in the last 20 years one of the most intensely debated issues on the political agenda. Many discourses have contained as main priority the streets and traffic in Bucharest, but with no visible results till recently. Attempts to address urban traffic have further complicated the system. The results are felt daily as short distances have to be covered by surrounding the streets and thus increasing the time or where the need for urban transport determines large time delays.

Actions from the political environment have resumed to starting large projects, abandonment of them, and streets customization (flowers, trees, changing asphalt almost every year on the same streets etc.). They haven't been related to the social environment. Moreover, the speculative development of the city meant numerous building construction with no urban local or master plan. Streets with no connectivity to the city system or no urban quality are now common issue for Bucharest.

The structure of this paper is focusing on 2 elements: description of the morphometric attributes and their spatial correlation through exploratory spatial data analysis. This techniques applied for Bucharest may allow to sustain or not if Bucharest is on a good way of development and if results obtained are supporting the spatial syntax theory.

2. DATA

Bucharest was the most important urban center of Romanian space over the past 500 years. Developed on the basis of commercial connections from the Middle Age, Bucharest has defined a concentric street network, having as main focal points the Lipscani market and the royal residence. Until the Boroczin master plan from 1846, the city was evolved

without a planning perspective though much influenced by the different orientation of various rulers (Phanariot, Turkish, Balkan or even French). These characteristics have greatly influenced the central part of the city – Historical Center which maintain the original concentric structure

The interwar period was marked by the master planned developed by Cincinat Sfintescu (1919, 1931) but unimplemented. The role of its development was assumed by the communist regime, but which has radically changed it according to the Russian plans.

Bucharest city has started a long process of sustained reform by implementation of ideological principles of socialist development and planning where Russian recommendations were the main one in the '50s, then followed by the nationalistic ones till about '80s, while in the last decade of communism personal decision of leaders were the most important ones. From the point of view of dwellings and streets building, the city is segmented in this period into three:

- Old part build as the population could adapt to the environment and economic conditions. This can be easily traced by its spatial logic because of the successfully maintenance of economic activities even when harsh planning was done here. In this part of the city, the streets are small, intersecting under no rules as the economy conditions imposed in the past.
- The part belonging to the large housing estates developed by the communist planning, where the people were brought from all over the country to work into the large plants newly erected. Because of the estates were finished after the plant (most of the cases) the spatial logic may be seen only at the large streets level, which were supposed to collect people going to and coming from work. The inside of this large estates was under the different theory planning; that's why is hard find any logic when you are supposed to surround many buildings to reach otherwise nearby locations and go by foot because the streets are too narrow for RATB vehicles. This situations has some variations where the communist intervention has stopped in 1989.
- The outskirts part has similar characteristics as the first one. Here streets are developed as for rural activities and they may encounter high values from the point of view of spatial syntax indexes. It was supposed to be planned later, but even now it remains mainly a rural area belonging to the city.

After the 1990 too many changes followed doubled by an unclear legislation in the urban planning. The city evolved chaotic, almost every person being able to build as he wished anything until almost 2000. For example, many housing estates were build but with no local planning, streets being unconnected to the city – there were/are only some dirt road. Because this situation continues, the city planning department couldn't cope in resolving so many cases (it was closed because of political involvement in such projects).

3. METHODOLOGY AND DATA

Spatial situations analyzed by the founders of spatial syntax theory *(Hiller, Hanson)* show the existence of some architectural pattern of the city seen as build environment (streets, buildings). The city can be analyzed at microscale event inside a building as well as medium scale level, when streets analyzed are implied. Initial theoretical intuitions are nowadays reveled by studies focused on spatial syntax which emphasis the relation between architectural space, meant as urban space, with the social elements sketching its logic. The

variation of spatial morphology may show different transformations of the city parts and how they are connected to the city system. Understanding these variations may help to a better urban planning by identifying and improving some of the issues which are hard to detect otherwise.

The critics on this theory and its methodology *(Lawrence, 1990, Osman and Suliman, 1994, Ratti, 2004, Batty et al., 1998)* lay on the fact that by a graphical representation there isn't possible to include many elements of urban space dimensions and properties or that by sketching one cannot analyze the social side *(Leach, 1978).* Another critical approach is focusing on the too flue characteristics *(Montello, 2007).* The assessment that people may relate to metrical system was criticized *(Penn, 2001),* as the spatial syntax theory refers to topological elements. All these critics stay on solid arguments, but the empiric results of the past years prove that is still a long way till the theory will be finalized. Thus, the general opinion is that spatial syntax isn't quite a theory, but a method included in the urban morphology theory.

As the practical novelty of the spatial syntax has begun not far away and is accepted mainly in urban planning from the UK, the current study tries to follow this encouraging path. What has to be with caution approached is that any metrical element of spatial syntax shouldn't be treated as reflecting precision of the social part of the city or the the society behavior against the space organization.

Gathering data to a more detailed level wasn't possible at this moment. That's why a dilemma has formed: if there is possible to analyze from the spatial syntax point of view the census elements. A recent study shows positive directions and allows the analysis with reserves because of a scale smaller than the presented study *(Barros et al., 2010).*

Another issues is the cartographic base. For a better representation the study adopted the streets system from the CPUMB which was developed with the help of a GPS. The drawback is that it was done in 2002 and some streets weren't mapped because the car couldn't pass some "streets".

The use of spatial social logic or spatial syntax contains alongside concepts some instruments with the help of which it can be proved the theoretical part. Urban space is mapped at street level with the help of GIS software. The spatial representation of streets is done by lines which shows maximum visibility and which are overlapping this network. Drawing the lines has to be made according to the criteria of spatial syntax: same angle, connected, not double overlapped, maximum distance from one streets to another, minimal number of lines overlapping the street space, intersection of end margins of the lines, maintaining the rules on the whole study. The results of this mapping are lines called isovist which allow the calculus of some morphometric indices. Their analysis stands at the basis of hierarchy of streets network and chromatic representation on a scale with 9 divisions.

Axwoman 4.0 was the instruments used and the methodology proposed by *Jiang (2009)* was applied. The streets with no connectivity were remove or corrected as needed in order to have a coherent urban network. Following this, next steps were done in ArcGIS for clipping the streets to the census units. The result was every unit could contain isovist lines and their respective attributes. One of the goals for this methodology was to allow correlation between metric indices and the social variables of the census in order to see if the theory is proved for Bucharest. The other goal was to have the spatial syntax analyzed through ESDA in order to see if there is some spatial concentration of positive or negative cluster association of the respective indices. This was done with Geoda software on the methodology described by *Anselin et al 2006*.

The study uses LISA for identification of the clusters distribution and the possibility of examining some possible patterns where areas with similar values of metric belonging to spatial syntax are nearby to each other. This is done by the visual information determined by maps where it can be seen those grouping areal as hot spots or cold spots. In fact they are the residential units in which the parameters values (global integration, local integration, local depth, global depth and connectivity) are similar (positive or negative against the mean), being surrounded by other units with the same data characteristics. This means the localization of those areas according high clustering of some process can be identified, despite of its position against the mean value. The subjective description perceived before the study is mostly proved: the central part of the Bucharest contains the most areas with high organic development, while the rest is a mix caused by too many interventions

Though many studies of spatial syntax focus on neighborhoods analysis for Bucharest this wasn't the case as they have no administrative limits and their existence involves a high degree of subjectivity.

4. ANALYSIS

The results of spatial model shown by the axial map allow to examine the spatial differences given by the streets integration and the correlation of morphometric with social variables. Geographical differences are obvious in the case of global integration of streets in Bucharest (**Fig. 1**).

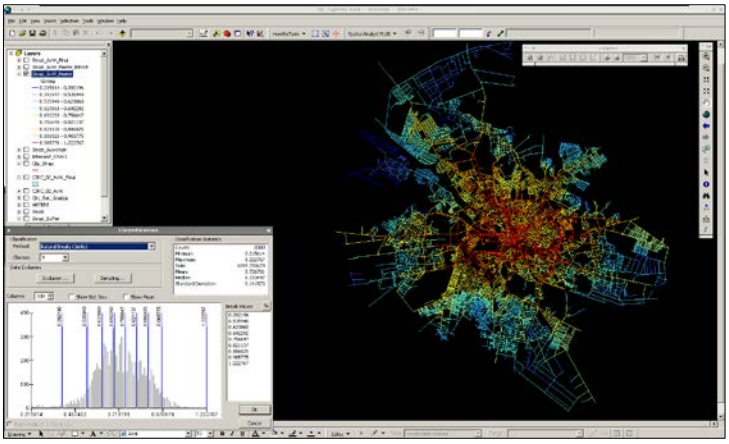

Fig. 1 Global integration.

Three areas almost concentric can be noticed, corresponding to the radial-concentric development of the city: the central part, the intermediary part or the 2nd ring and the large housing estates part. Powerful integration found in the central part may be explained by the organic evolution, partially modified by some small projects from the communist period. As the distance from this grow, the global integration values diminish. What is visible as being highly connected to the urban system are the large avenues. They had and partially remain with the same purpose of collecting the urban traffic between dwellings and industrial areas; now mainly replaced by commercial areas. The plans for this network were

design to have economic, social and cultural features, but were abandoned in many cases. With the new economic and social system many spaces along the streets were attracted into the commercial activities. Their increase and that of number of cars produced many traffic problems. That's why some of the spatial syntax elements doesn't reflect the exact situation of such streets.

The most affected areas from the point of view of integration into the urban system are those found near the industrial sites. They have a low integration in every part of the city. This means a poor planning management, at that times being reflected by very crowded buses and trams.

Some reserves arise when the correlatio between the build period of houses and the integration degree. Areas as those from Berceni, Bucurestii Noi, built in the '80s are characterized by a good integration. On the other side, Ferentari, Berceni--Turnu Magurele, Ozana and Giulești area have small integration. They are difficult to explain as very different project were developed along many years. Still the common approach may be given by the fact that most of this areas had dwellings with low standards and were among the first planned in the communist period. As the need for workers was high, the planners focused mainly on buildings (even so poor types) and ignored the accessibility of the streets and good integration to the urban system.

This elements are better shown by global integration when they are discussed inside the living units of the census tracts. The distinctions between central area and the large housing estates is very clear. Moreover, this approach shows that the part lived by elites in the communist period has a very good integration. It is the case of areas from the sector 1 and 2 inside the 2nd ring. The attention focused on this streets was high because of the importance of people living there (then and now) and of the increasing traffic needs towards the nodal points from the northern part of the Capital (airports, main railway station, touristic areas).

A second morphometric element is local integration. It shows that there arent secondary centers in the city. The city isn't planned at this moment for supporting other centers. They may exist, but the network needs great improvement as last planned for redevelopment have started lately. Some exception may be noted: 23 August / Industriilor areas appear as centers, but in fact they are old villages inserted into they city limits. The old organic evolution of this part remained unmodified as a consequence they look more local integrated. Another peculiar situation showing centrality is the areas covering Bucureștii Noi, Chitila, Dămăroaia neighborhoods. Numerous buildings with rural characteristics are presents in these areas and the streets network was focused on main streets for bringing people to the nearby plant (Laromet). Same findings are in the Rahova, where demolishing plans stopped at the end of 1989, allowing this area to keep the same rural specificity.

One important conclusion may be drawn from the analysis of local integration: where communist interventions were high the value is small, proving the wrong plans for city development. Important parts of Titan, Drumul Taberei, Berceni South are the most evident situations for this. They suffered brutal interventions: first for streets re-dimensioning and second for building densification (it was considered that higher buildings density will allow better agricultural use at the city outskirts).

Relating the study to other results (*Vaughan, 2005, Legeby, 2007*), it is proved a spatial isolation of areas with rural characteristics. This is facilitated by using in analysis another parameter of spatial syntax: depth (**Fig. 2**). In these areas the values are some of the highest, exceeding 60 steps in the case of local integration.

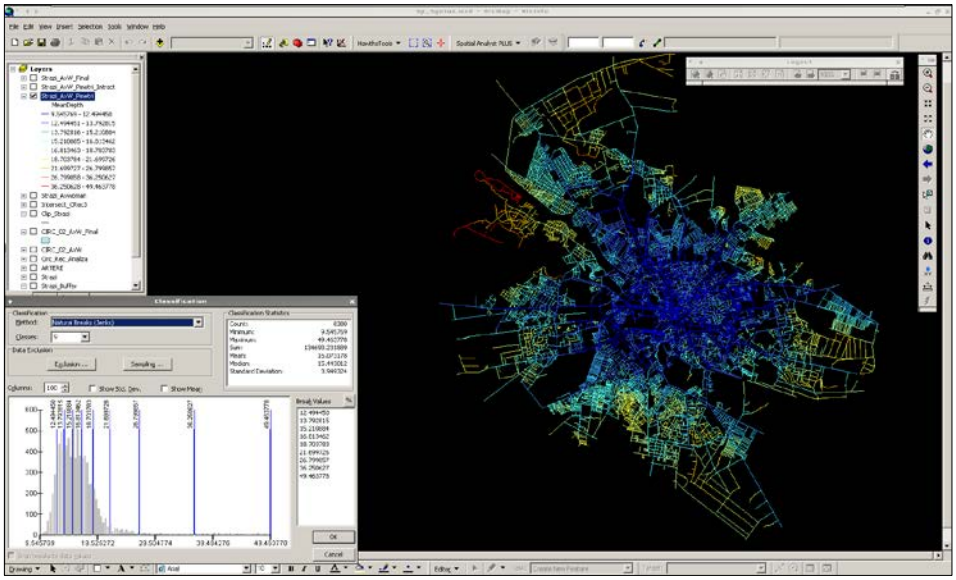

Fig. 2 Global depth.

Regarding the second goal of the study – exploring the spatial data, the findings are surprising. There isn't a spatial correlation in most of the spatial syntax parameters. Powerful intervention over the whole city destroyed any possible social characteristic which could have been found through this methodology. The only spatial correlation exist in the central part of the city, the part where the planning spared some areas. They are noticed for the global integration and mean depth (**Fig. 3**, **4**). The statistical correlation is high underlining the strong relationship between the urban space and community.

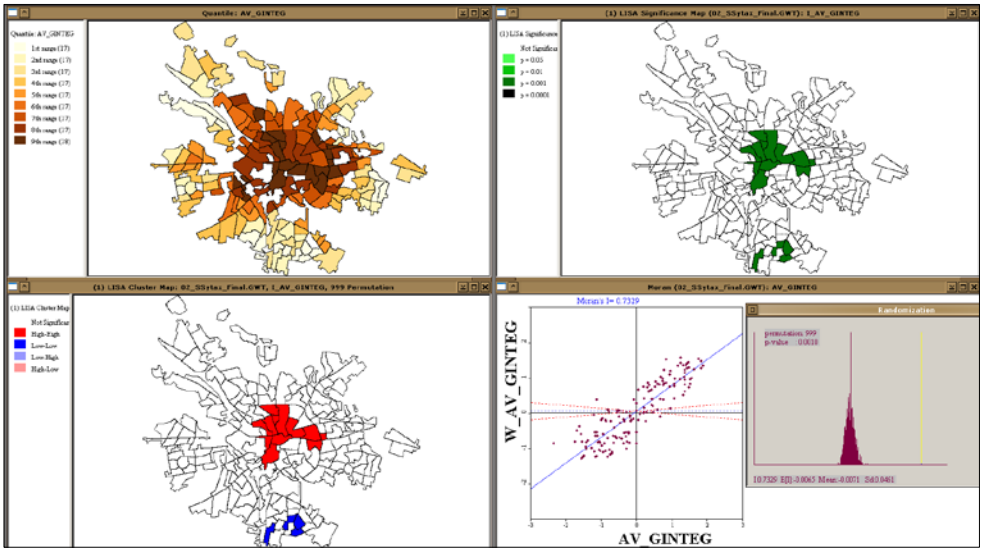

Fig. 3 Spatial exploration of global integration.

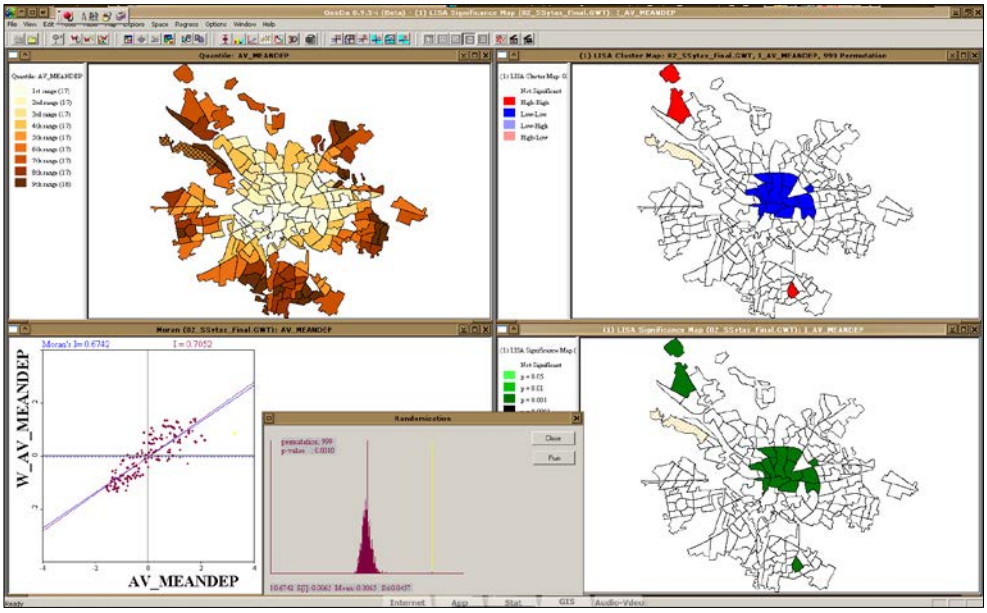

Fig. 4 Spatial exploration of global depth.

This analysis is only the beginning of the spatial syntax in Bucharest. As more data will be available and new development in the theory will take palce, more insight will be gained by focusing on the city of Bucharest.

5. PRELIMINARY CONCLUSIONS

The general assessment on Bucharest according to which the centralized intervention in Bucharest was brutal, is emphasized by this study also. This was found to be true in the spatial syntax metric. The focus on fast accomplishment of plans for 5 years has played a large impact. The ruptures among parts of the city are heavily felt in the traffic, neighborhoods connection, perceived image over the route planning. If the central parts maintained good values, surviving the radical interventions, nowadays it is under the new planning ideas changing with each mayor.

Another finding of this study is that spatial vulnerability exists in Bucharest. According to the conclusions made by other researchers *(Hanson, 2000, Legeby, 2007)* it is reflected by the maps of local and global integrations which show a sensitivity of population as a result of too chaotic planning interventions.

The interpretation of the results is greatly limited. Some reflection and a better evaluation is needed as the situations appear too different from the most of studies conducted till now in the field of spatial syntax. This limitation may be overlapped by integrating a more specific software. One may speculate (and validate) that even Gemil (2007) who conducted a study Bucharest preferred to make comments only a small part of the city, differences from the theory being high.

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