APPLICATION OF SPACE SYNTAX, SPACEMATRIX AND MXI MODEL TO EXPLAIN URBAN MATURATION IN COLOMBO

K. D. P. P. Jayasinghe[1], W.M.A. Bandara [2]

[1] Department of Town & Country Planning, Faculty of Architecture, University of Moratuwa, Sri Lanka. Email:
pavipj89@gmail.com
[2] Department of Town & Country Planning, Faculty of Architecture, University of Moratuwa, Sri Lanka. Email:
toaruna@uom.com

ABSTRACT

The applicability of spatial analysis tools in Sri Lankan context is tested through the study. Large number of spatial analysis tools are practicing in urban planning and design. Practicing spatial analysis tools in Sri Lankan context is rare to find. Spatial analysis and understanding of spatial configuration of a city has a great contribution towards decision making process and preparation of development plans. Understanding the maturation of cities is helpful in decision making process. The plans should be prepared for cities by understanding spatial structure and its correspondent functions. Most representative spatial properties in a built environment are street network, buildings, pattern of building form and patterns of land use are regarded as tangible components of urban morphology. Spatial analysis tools are used to analyze these elements to understand the spatial configuration and its related phenomenon. Thus street network configuration, building density and types, land use diversity are not independent variables; tools that are used to analyze these elements have also been combined together in order to understand urban systems comprehensively. It was tested that the interrelationship between the various degrees of the three spatial variables affects a town's maturation process over time. Quantitative analysis of street network configuration, building pattern and density and landuse diversity are representing the spatial configuration well. Space syntax, spacematrix and Mixed Use Index (MXI) are combined into one model through the use of Geographical Information System (GIS) for the analysis. The application of these tools are used to identify urban maturation of Colombo city. The applicability of this methodology in Sri Lankan context is tested out by applying it for Colombo. According to the analysis the result shows the capability of quantifying the spatial properties of built environment in terms of the degree of street network integration, degree of building density, and degree of function mix towards urban maturation process. Colombo has a 79.5% match rate which shows Colombo has a high degree of maturity. Analysis result of spatial analysis tools was compared with the historic evolution data of Colombo city based on previous studies to consent the applicability. Cities get developed and become matured up to different stages over the time and thus it has to be understood in decision making process. This study is a primary step towards the direction of identifying the capability of this method to study urban maturation of Sri Lankan cities. Results shows Colombo is a city with a high maturation and a positive effect on capability of applying these three spatial analysis tools to study urban maturation of Sri Lankan cities.

Keywords: Space Syntax, Spacematrix and MXI model, Urban Maturation

1. INTRODUCTION

Analyzing spatial elements of a built environment has become an essential component in modern Urban Planning and Design. Numerous spatial analysis tools are available at present that are widely used for studies on urban planning and design. The main concern goes towards spatial elements as it is an implication of different other aspects of complex urban systems. Considering spatial analysis methods "Nolli Map" (Nolli, 1948), "Serial Vision" (Cullen1961), analysis on existence of different patterns in built environment (Alexander, 1977) and generalized open spaces into basic geometric forms (Krier, 1979) and Space Syntax (Hillier, 1996) which is the commonly used method for spatial analysis rather than the other methods. According to (Conzen, 1960; Whitehand and Conzen, (1981) the most representative spatial properties in a built environment from the urban morphology tradition are street network, buildings, pattern of building form and patterns of land use; simply (1) the street system, (2) the building system and (3) the land use pattern are regarded as tangible components of urban morphology. Thus street network configuration, building density and types and land use diversity are not independent variables; the tools that are used to analyze these elements have also been combined together in order to understand urban systems comprehensively.

Combine Space Syntax with new method to measure density (Spacematrix) and land use diversity (MXI model) is one of the recent studies carried out during last year by a group of researchers at the Urbanism-Lab (U-Lab), Faculty of Architecture, Delft University of Technology (TU-Delft). It turned out, these methods complement each other and contribute to a more comprehensive understanding of the role of the spatial parameters on socio-economic processes in a city (Berghauser Pont and Haupt, 2012).

Spatial analysis and understanding of spatial configuration of a city has a great contribution towards decision making process and preparation of development plans. Brömmelströet and Stolk (2007) asserts that although most of the cities are professionally planned, many are poorly successful in creating vital and lively urban life, which may be regarded as a kind of a worldwide urban challenge. Hence it is important to understand how cities become balanced over the time by the means of lively and vital places. Cities have their own evolving logic (Hillier, 2006). That must be understood to promote a spatial layout that generates better socio-economic performance to tackle this current urban challenge (Ye and Van Nes, 2013).

Although contemporary planning practices were increasingly oriented towards emerging spatial analysis methods, applications of such methods are rare in Sri Lankan context (Munasinghe, 2003). In such a situation the need of introducing effective spatial analysis methods for current planning practices is identified. This study attempts to focus on newly introduced method by Ye and Van Nes (2013) to study 'Urban Maturation' using spatial analysis tools in Sri Lankan context to cater the identified need by applying this method to Colombo Municipal Council area.

Understanding the maturation of cities is helpful in decision making process. The plans should be prepared for cities by understanding spatial structure and its correspondent functions. Some cities have come up to a balanced situation in terms of their spatial elements and functions while some cities are in the process to achieve that. Some cities have been developed for a long period of time while others remain in infant level. These differentiations in urban systems should be understood and taken into consideration when preparing development plans for cities as the situations differ from one to another and plans should be simultaneously changed with those situations.

The objective of this study is to test the applicability of spatial analysis tools to explain the urban maturation in Sri Lankan context.

2. METHODOLOGY

This study is done based on the method that was applied in Dutch and Chinese towns to measure the Urban Maturation. Colombo city is selected as the study area regarded to several reasons. To conduct this study the selected case should be a city with detailed records of street network, building density in terms of floor numbers and built up area, and building functions or land use diversity. Apart from that the historical data on evolutionary stages of spatial elements and spatial form over decades is a requirement. Colombo city is the case selection concerning availability of these data and as a consequence of being a city which has a well-known evolution over the time.

First the spatial elements are analyzed using space syntax, spacematrix and MXI model. The results from each analysis tool are combined through GIS (Geographic Information System) and output reveals Urban Maturity Index. Evolution of Colombo is studied to identify the changes of its spatial form with the time sequence. Maturation of Colombo city is understood based on these spatial changes in real world situation. Maturity Index prepared using spatial analysis tools are compared with this to examine the applicability of these tools to identify the Urban Maturity.

3. RESULTS

Comparing high middle and low values resulted from spatial integration, building density and land use diversity, Colombo has considerable urban areas with high values regard with all three parameters. In terms of spatial integration 34.3% areas, building density and type 71.0% and land use mix 75.5% areas have high values.

Table 1: Various values of three spatial variables in Colombo city

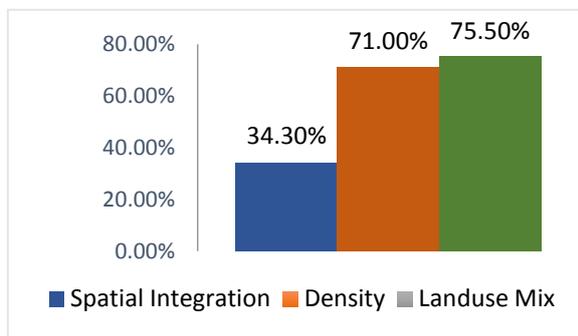| City	Values	Spatial Integration	Density	Landuse Mix
Colombo	Low	328 (32.2%)	155 (15.1%)	55 (5.7%)
	Middle	342 (33.5%)	142 (13.9%)	181 (18.8%)
	High	350 (**34.3%**)	727 (**71.0%**)	729 (**75.5%**)

Figure 1: Distribution of high values of three spatial parameters in Colombo city

Figure 3 shows the analysis result from combined output of three spatial analysis tools through GIS. Darker cells illustrate the areas with high values in terms of urbanity while blue colour cells show lower values. 53.92% cells contain high values, 42.16% contains middle values, and 3.92% contains low values. These figures illustrate that CMC area consists of more than 50% of areas with high urbanity.
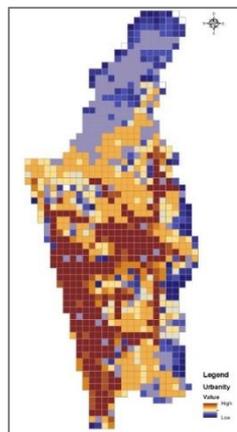

Figure 2: Result from spatial analysis

Ye and Van Nes (2013) assert that it is possible to conclude that in a natural Urban Maturation process the degrees of building density and land use mixture increase over time. Indication of more cells obtaining higher values in all three measurements at the same time is a representation of an area with a high maturity. Analysis result shows that Colombo has a high accumulation of building density and land use diversity with well-integrated street networks and accordingly, it can be concluded that Colombo is a

city with high maturity. Further, match rate of Colombo city is calculated to validate this result.

Table 2: Match rate of Colombo

	Ci (cells with values from middle urban areas + cells with values from highly urban areas)	Cj (cells with middle values from the spatial integration analysis + cells with high values from the spatial integration analysis)	Match Rate (Ci/Cj)
Values	550	692	79.5%

Match rate of Colombo is 79.5%. Both high values from the spatial integration analysis and the high match rate show an area's high degree of maturation (Ye and Van Nes 2013). With the result of 79.5% of match rate it shows that Colombo has a high degree of maturation.

Changes of spatial forms of Colombo city during past eras were identified according to the studies which had been undertaken to investigate the evolution of urban areas focusing on changing configurations in their spatial forms.

In the study by Bandara and Munasinghe, (2007), the changes of spatial form are identified according to the historical evolution of the city over the time. Different areas adjoined with the administrative zones over those periods were considered as the spatial extent of expansion of the city Comparing spatial forms and their expansion in different periods of time some areas were identified which are developing from the beginning and got matured over the time. Those areas were started to develop and became to being lively and vital areas throughout a long period of time.

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Identified matured areas are based on expansion of city form over a long period of time. Colombo Fort, Pettah, Cinnamon Gardens, Slave Island, along the Galle road, Galle Road, Maradana Road, towards Grandpass and Modara.

Figure 3: Identified matured areas through historic evolution data

The result from Spatial Analysis is moreover similar with the matured areas identified through historic evolution data. Although Colombo Port area is identified as a matured area over a long period of time, it is identified as an area which consists of middle level of urbanity. The reason behind that is, the area is a mono functional area only with port related activities. Additionally, although upper part of the Colombo is identified as a cluster with low urbanity values in real ground situation, those are highly functional, lively areas same as the other areas with high urbanity values. The reason behind that is identified as the area is getting very low integration values in space syntax analysis.

Along the Galle Road, Baseline Road, Cinnamon Garden area, Slave Island area shows the same result in both the analysis. This illustrates that this Spatial Analysis method is applicable to identify the Urban Maturation in Sri Lankan context but not in all situations it gives the exact result compatible with real ground situation.

4. CONCLUSION

Spatial Analysis tools can be used to identify the Urban Maturation processes and it has developed a spatial index to measure the urban maturation process using space syntax, space matrix and MXI model. This method was applied to CMC area and tested out its applicability for Sri Lankan context. Analysis result shows the capability of quantifying the spatial properties of built environment in terms of the degree of street network integration, degree of building density, and degree of function mixed towards Urban Maturation process. Colombo has a 79.5% match rate which shows it has a high degree of maturity and Spatial Analysis result showed the most lively and vital areas in terms of urbanity. Even though the results correspond with historical evolutionary data and capable of explaining the maturation, it requires more case studies in different urban contexts to further reveal and test the applicability of this technique. It should be noted that there are differences between the result and real ground situation as well and the method is applicable up to a certain extent. In a further stage it is important to study the motives on this disparity of actual situation and the spatial analysis results.

This study is in the initial stage and limited for a one single case study due to the main limitation; unavailability of required large number of data. If it is applied to many cases, it will reflect a better outcome that will leads to understand the applicability and to develop a maturation index for cities to compare their stage of maturity. To conclude, although this study is in initial stage, it explains the availability of wide range of applications of Spatial Analysis tools for different levels of decision making in Sri Lankan context. Further the study suggests that this can be used to determine the degree of influence on city plans that is required on spatial elements in order to direct the city towards its matured stages in relation of being lively and vital places.

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