Context-oriented lighting strategy in urban spaces (using space syntax method) case study: historical fabric of Isfahan

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Abstract

Light is a primary element in the field of architecture and urban design. Solid volumes and enclosed spaces, color and texture can only be appreciated fully when they are imaginatively lit, and a skilful designer will use lighting in subtle ways to reveal the elements and also the buildings.

Reaching a suitable solution for Lighting in urban spaces, a process is needed which can encompass all different aspects in the field of lighting. In this way, we used the available data-bases for evaluating different aspects of urban spaces, by taking into account the situation measurement and available evaluations. For context-oriented urban spaces via Space Syntax we used Integration parameter (local and global). By studying the organizer structure and its prioritizing, we could achieve the lighting originated from the context.

In this paper, based on the historical importance of Isfahan city, its historical fabric would be considered. The Research method here is Analytic-descriptive regarding modeling and simulation process. The results of this study are showing that the provided process can be applied practically for lighting by considering the urban context. So this study has practical aspects and it can make a suitable strategy for lighting urban design and planning.

Keywords: Lighting strategy, Organiser structure, Space syntax.

1. Introduction

Light is a primary element in architectural design. Solid volumes and enclosed spaces, color and texture can only be appreciated fully when they are imaginatively lit, and a skilful designer will use lighting in subtle ways to reveal the building.

Lighting levels are dependent on the type of space to be lit and the functions envisaged within it, and are based on perceived understanding of how light levels influence both the functional efficiency of anticipated tasks within the spaces and visual comfort.

Lighting the outdoor environment is different from lighting an interior space. Outdoor lighting provides safety, security, and aesthetics. The night outdoor environment presents the following design challenges:

• The sky at nighttime is always dark, often resulting in greater object contrasts.

• Eye works differently from the way it works at low light levels.

• Lighting can affect people experience in different emotions at night and also feelings of safety and security

• Outdoor lighting can be seen at great distances, and nighttime visual clutter can be distracting and disturbing.

• Nighttime tasks need very specific lighting requirements for performing tasks safely and effectively.

There is an expectation (or need) to control the light added to the outdoor environment; some people want the dark for sleeping, star-gazing, or privacy [1].

Light in addition to its applied uses would have a symbolic point and in many cultures is a holy and important element. In Islam, light is one of God' names, because all light and brightness in universe origins from God. And it also has been repeated as a leader in Holly Quran many times and this repetition means its importance. So we could understand light would show realities and causes directing. In another word, it could show the context of urban and directs human mind. If light could not do this, urban would get on anonymity and could not be able to connect with its context at nights and this issue in historical patterns of a urban, with attention on its historical and identical past would be so complicated.

The darkness has resulted in the situation of unsatisfied urban lighting for functional and aesthetic purposes. IESNA (Illuminating Engineering Society of North America)

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recommended that street lighting could help define urban character and image. These lighting systems may illuminate for streets, sidewalks, bikeway, parks, monuments, buildings, statues, fountains, and landscape. A hierarchy of public lighting should be noted the relative importance and character of cityscapes and enhances their information-giving value. In additions, the sense of community can be improve by consistency and coordination of lighting with the community theme and also integrated into the daytime scenes. Furthermore, successful exterior lighting employs layers of light. Layers of light define the spatial characteristics of the environment with accents on hazards, destinations, and architectural features. Sidewalks, trees, and building facades can be used as reference points and backdrops for such important features as crosswalks and intersections on roadways, or stairs and changes in elevation on pathways. Highlights can also be provided on gathering places and on interesting features such as bridges, statues, or plantings [2].

There are 3 classes of outdoor lighting:

1. The purely utilirian lighting like e.g. road traffic lighting, lighting of industrial complexes or sports facilities, etc. Its main function is to improve the task performance; boundary conditions lie in the promotion of safety and security.

2. Amenity lighting like e.g. the lighting of pedestrian malls, residential streets, floodlighting of public buildings, etc. Visibility aspects are important, but the main function is to promote of the feeling of well-being. Boundary conditions lie in the reduction of the number and severity of criminal acts and in the promotion of feeling secure.

3. Decorative lighting like e.g. illumination of Christmas trees, laser beam displays, flood lighting of fountains and trees. Their function is exclusively to enliven the scene [3].

At first, the objectives of illuminating public spaces at night were to enable the extension of many daytime activities into night time, and to allow surveillance for promoting safety. In addition, illuminating public spaces can also create a night time environment in which pedestrians can quickly and accurately identify objects, and maintain orientation.

Since then, night visibility has become a stimulus of rapid movement of urban activities and has been integrally linked to all other aspects of the nation's urbanization and city growth. This night visibility has provided economic and social benefits to the public by being used as a way of promotion of business and industry during night time hours. In addition, new economic and social opportunities in night time can alter every aspect of the urban landscape and activities, and improve the overall nocturnal urban environment, which explores the various ways to enhance safety, aesthetics, and mobility of urban contents.

2. Light and Organizer Structures of Urban Spaces

Knowing the correct urban functions and their organizer structure would correctly help to find a suitable solution for Lighting and the quality of urban spaces would be raised in both visual and operational aspects. As it has been shown in Figure 1, Lighting masterplan, Michlen, Belgium, the organizing structure and the connection between operations have been considered. In other words, the spatial values and the its relation about structure of suitable uses of light in urban spaces, in attention of operational connections have been done. So this key point would be important that if we could understand urban structures, in fact we have reached on a Lighting strategy.

For understanding of organizer structure, there are many ways. One of the suitable ways accepted by the majority of urban planning and architecture scientific society is space syntax. In next section, we would explain this issue and the using ways for composing of Lighting plan strategy.
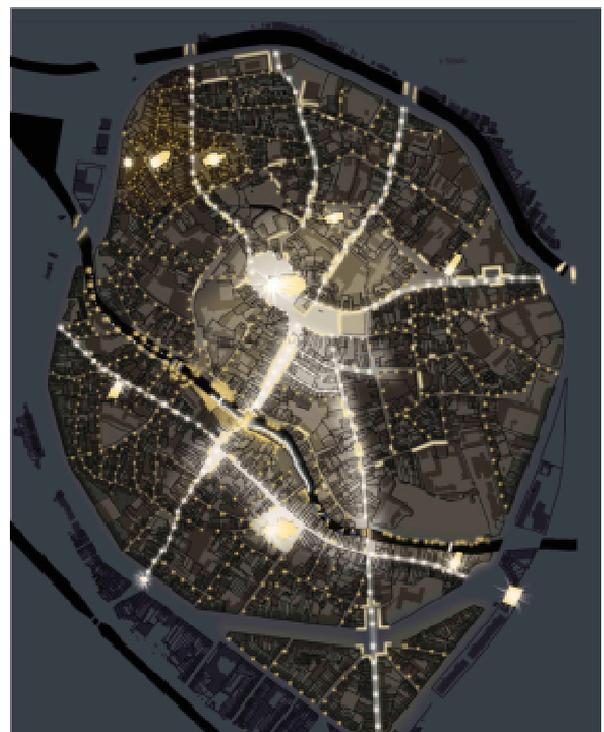

Fig.1 Organizer structure with operational urban connections, lighting master plan, Milchen, Belgium [4]

3. Concept of Space Syntax

Hillier and Hanson published a syntactic theory for the pattern of space and interaction in the built environment in The Social Logic of Space in 1984. From that book they argued that buildings, towns, and cities have complex spatial properties that translate into sociological rules which affect how people relate to one another. They urged that space is not as the background to human activity, but as an intrinsic aspect of everything human beings do. Furthermore space seemed to identify structures which linked the social and the spatial. Consequently, space is able to give expression to social meanings.

Within the framework on both common of physical and social ground in the city, space syntax theory and method has begun. Through the research team led by Bill Hillier and Hanson at the Bartlett School of Architecture and

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Planning, University College London, space syntax has developed since the late 1970s in reading urban configurations.

Space syntax is based on the concept of spatial configuration which means, in syntax terms, relations between spaces which take into account other relations in various spaces of a system. It can describe some aspects of how we use or experience space and to see how buildings and cities are organized in term of geometric ideas. Moreover, in term of relation between spaces, it can represent the inter-relations between the many spaces that make up the spatial layout of a building or a city. Then, space syntax is an alternative for quantifying and describing urban form influences on spatial formation by decoding a set of spatial properties of the layout (Hillier, [5], Hillier and Hanson [6]) Therefore, space syntax is able to express the property of space in spatial configuration and distinguish social characteristics and their meanings that imprinted and functioned in spatial layouts.

Space configuration measures of relation between spaces in graphs, and theorizes them in terms of their potential to embody or transmit social ideas, and then turns them into measures and representations of spatial structure by linking them to geometric representations of the system of spaces under examination. Providing a measurable scale from segregation to integration, enabled statistical comparison of different spatial forms across cultures, and investigated the average relations for the whole complex. Then, the space syntax program is a tool that present the effect of spatial layout on functioning in the layout and is expressed through the computer program in graph and first theorized them in terms of their potential to embody or transmit social ideas, and then turns them into measures and representations of spatial structure by linking them to geometric representations of the system of spaces under examination [7].

Research using the space syntax approach has shown:

- the state of movement patterns
- the state of security patterns in the city
- the state of relations between main and subsidiary urban centers
- revising the state of spatial segregation in cities
- the state of effects of form on culture[8]

This relationship between the structure of the urban grid and movement densities along lines can be called the principle of 'natural movement'. Natural movement is the proportion of movement on each line that is determined by the structure of the urban grid itself rather than by the presence of specific attractors or magnets. This is not obvious initially, but on reflection does seem natural. In a large and well developed urban grid people move in lines, but start and finish everywhere. We cannot easily conceive of an urban structure as complex as the city in terms of specific generators and attractors, or even origins and destinations, but we do not need to because the city is a structure in which origins and destinations tend to be diffused everywhere, though with obvious biases toward higher density areas and major traffic interchanges. So movement tends to be broadly from everywhere to everywhere else. To the extent that this is the case in most cities, the structure of the grid itself accounts for much of the variation in movement densities [9].
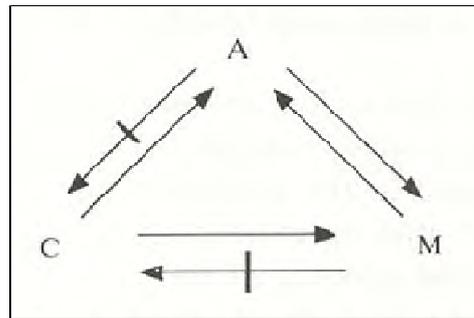

Fig. 2 The Figure is showing the logic of natural movement

1) Attraction pole (A) which affect on movement but not on spatial order
2) Movement (M) which affect on attraction pole and is affected by it but does not have any effect on spatial order
3) Spatial order affects on movement and attraction pole but those do not have any effect on it.
Based on these logics, movement in space is more affected by spaces ordering and their relations with each other [10]

Movement is an aspect of vitality, of the experience of density and diversity that characterize urban life. Thus, generating, distributing, modulating or accommodating movement is at the core of urban planning and design [11]. In terms of urban planning and design, the layout of space first generates movement, then movement-seeking land migrates to movement-rich lines, producing multiplier effects on movement which then attract more retail and other uses, and this leads to the adaptation of the local grid to accommodate the greater density and mix of uses. This dynamic process is called the "movement economy".

The biological concept of a genotype is essentially an informational concept. It describes something like a total informational environment within which the phenotypes exist, in the sense that individual phenotypes are linked into a continuously transmitted information structure governing their form. Through the genotype, the phenotype has transtemporal links with his ancestors and descendents as well as transpatial links with other contemporaneous organisms of the same kind. The genotype is at least partially realized in each individual organism through what might be called a description centre. A description centre guarantees the continuity of the class of organisms in time and their similarity in space. The description centre holds instructions locally on how some initial material is to adapt local energy sources in order to unfold into a phenotype. The description centre does not have to be a particular organ; it may be spread throughout the organism. It is a description centre because it contains a local embodiment of genetic instructions [12].

Achieving hidden relations in urban elements and spatial relations understanding, is a complicated issue, but the important point is that in organic cities, which do not have geometric orders, but a special spatial logic is dominated on it that this spatial logic is hidden in it and make identity for city. Based on literature review, lighting in urban spaces with the space syntax, just one researching

sample in 2006 by An-Seop Choi and his colleagues in the name of" Application of the space syntax theory to quantitative street lighting design" has been done.

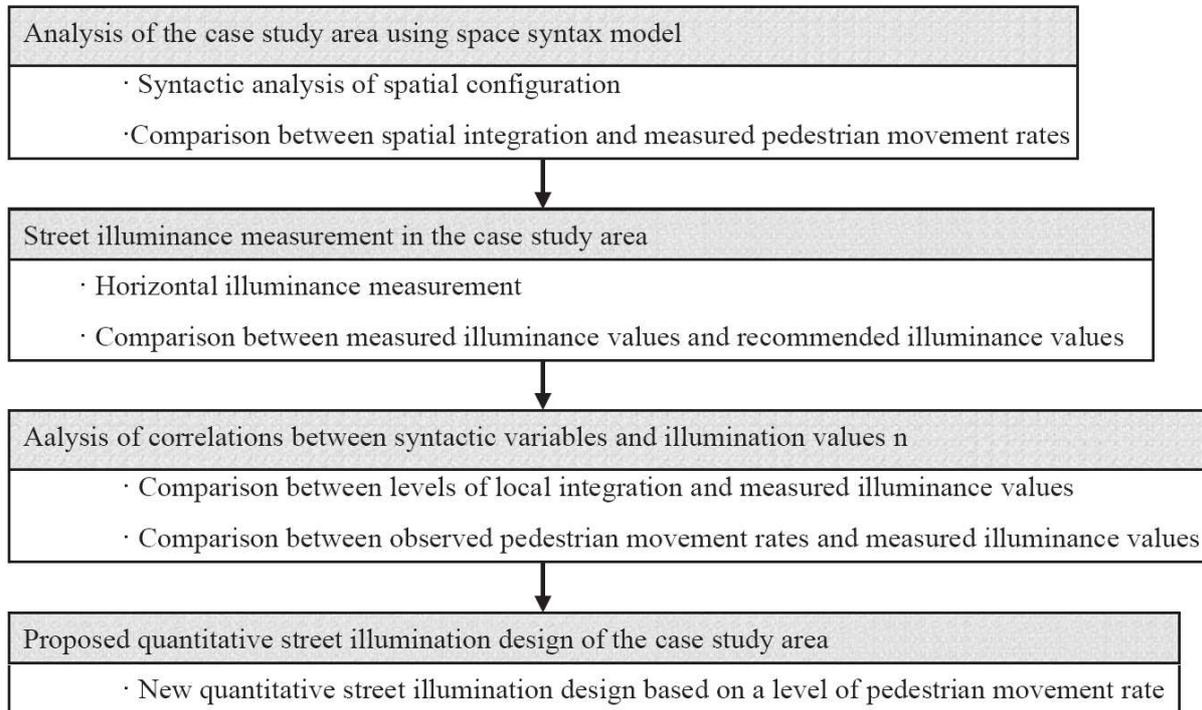For this, An-Seop Choi and his colleagues have used this process for their study.

Analysis of the case study area using space syntax model
· Syntactic analysis of spatial configuration ·Comparison between spatial integration and measured pedestrian movement rates

Street illuminance measurement in the case study area
· Horizontal illuminance measurement · Comparison between measured illuminance values and recommended illuminance values

Aalysis of correlations between syntactic variables and illumination values n
· Comparison between levels of local integration and measured illuminance values · Comparison between observed pedestrian movement rates and measured illuminance values

Proposed quantitative street illumination design of the case study area
· New quantitative street illumination design based on a level of pedestrian movement rate

Chart No. 1 The process of Lighting plan study in Seoul- South Korea [13]

Considering the context has an effective role on urban lighting space syntax could be used for spatial understanding and its relations with social-spatial logic. So by the integration parameter, space syntax could analyze spatial relations that these analysis would Cause an understanding in context and also spatial organizer structure and logic of space.

The property of 'intelligibility' in a deformed grid means the degree to which what we can see from the spaces that make up the system - that is, how many other spaces are connected to - is a good guide to what we cannot see, that is, the integration of each space into the system as a whole. An intelligible system is one in which well-connected spaces also tend to be well-integrated spaces. An unintelligible system is one where well-connected spaces are not well integrated, so that what we can see of their connections misleads us about the status of that space in the system as a whole. We can read the degree of intelligibility by looking at the shape of the scatter. If the points (representing the spaces) form a straight line rising at 45 per cent from bottom left to top right, then it would mean that every time a space was a little more connected, then it would also become a little more integrated - that is to say, there would be a perfect 'correlation' between what you can see and what you can't see. The system would then be perfectly intelligible [14].

The larger number of intermediary spaces needed for forming an intelligible picture of the whole city indicates that local structures in Iranian cities are deeper, and therefore more isolated in comparison with local structures in English cities. It can be suggested that the range of these intermediary spaces adds a cultural parameter to the sense of intelligibility. Typologically different cities become intelligible differently depending on how their local areas are structured and embedded in the global system. The problem of intelligibility, in fact, appears when there is incongruity between the spatial behavior of the urban system and the cultural habits and anticipations of the inhabitants or visitors[15].
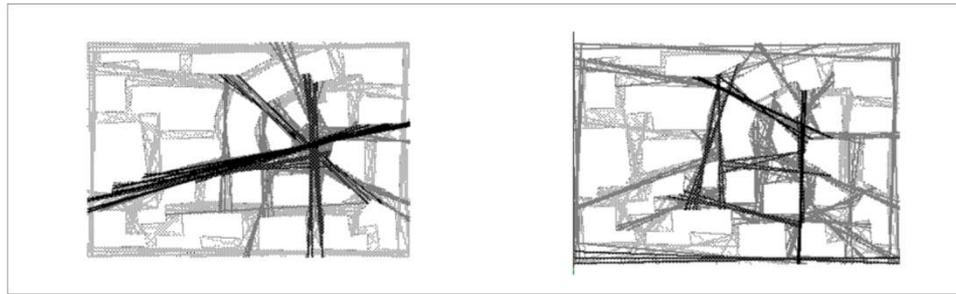
Fig. 3 this picture explains two different fabrics, as it is obvious in the left fabric has more intelligibility. So the relation of fabric connections and integration has higher R- square in contrast with the right fabric[16]

4. Space Syntax Analysis (Case Study: Isfahan)

The city of Isfahan was selected as case study. because, Isfahan, a major city in central Iran, was the splendid capital of the Seljuq and Safavid dynasties whose legacies established Iran (formerly Persia) as the cultural heart of the eastern Islamic world in terms of language (Persian), art, and architecture. The Safavid period (1502 1736) was particularly decisive for shaping the city, whose beauty was so great that world travelers purportedly dubbed it "Half the World [17].

The urban space of central part of Isfahan was analyzed after drawing axial lines (the longest lines which provide view and accessing) by Axwoman software (extension software to ArcGIS9.3) and the results show the main structure and hierarchical order of spatial values. As a result, the spatial values resulting in understanding of context in terms of spatial and topologic relations can be extracted. In Figure 4 which is showing global integration map in Isfahan, spectrum blue to red, shows the increasing of global integration.
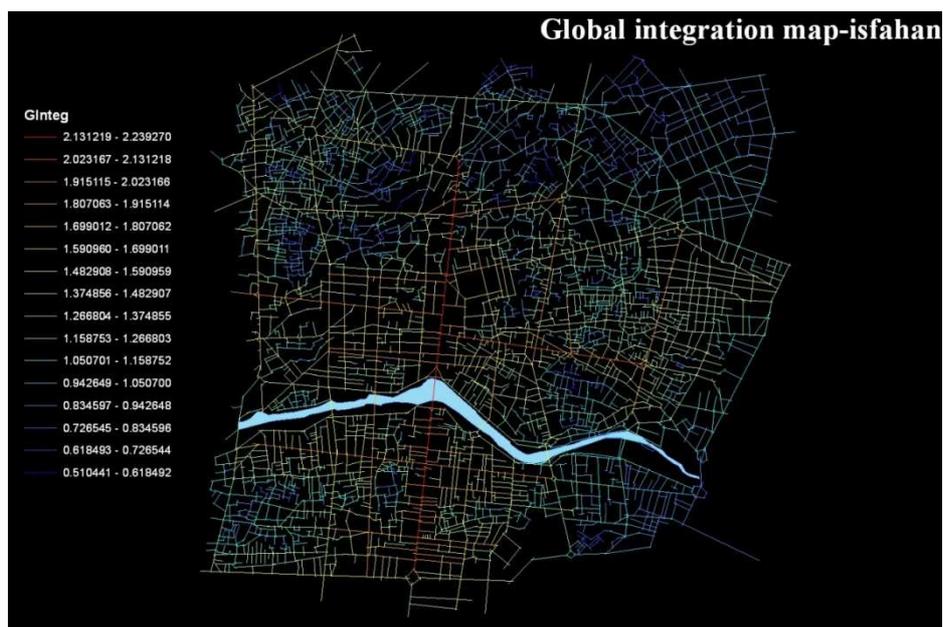

Fig. 4 Integration map of historical fabric of Isfahan, as it is clear the" Ghahar Bagh" axis has the highest global integration value

The results of analysis have shown axis of Chahar-Bagh as the main north-south axis and also Amadgah-Sharif Vaghfi axis (East-West) have higher global integration value. In the above Figure it has been shown. Red (higher) to blue (lowest) spectrum shows the value of global integration in urban spaces. Thus, in this way one can identify the organizer structure by integration of urban functions. Therefore high traffic spaces (natural movement theory) and land-use which need this population (movement economic theory) are shown in this structure. Also using numbers of cross roads and local integration, could help composing lighting strategy.

So, by taking into account the existence of organizer structure with urban operation would be recognized by the attention to historical context of Isfahan. This would make a relation between designer and context, based on the space syntax theory. In other hand, based on this logical analysis we could find second analysis about spatial relation with Lighting which would be used to support our plan. In analytical maps, it would be shown by connections, values of global and local integration, which could help designer to know the context of planning and also could affect organizer structure. In Figure 7, organizer structure has been shown by the attention of urban spaces in 3 categories: main, middle and minor, which could be used for composing a strategy for lighting strategy
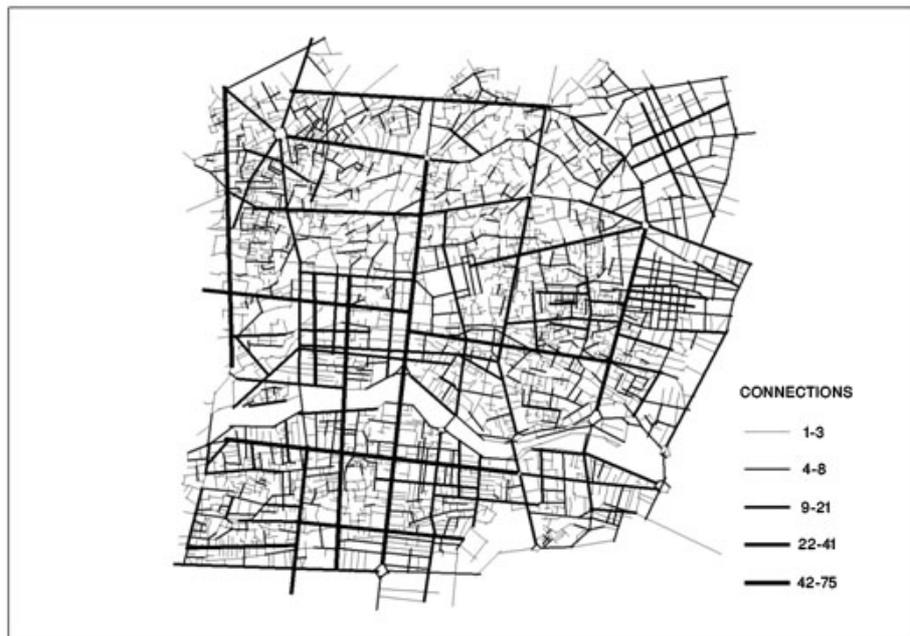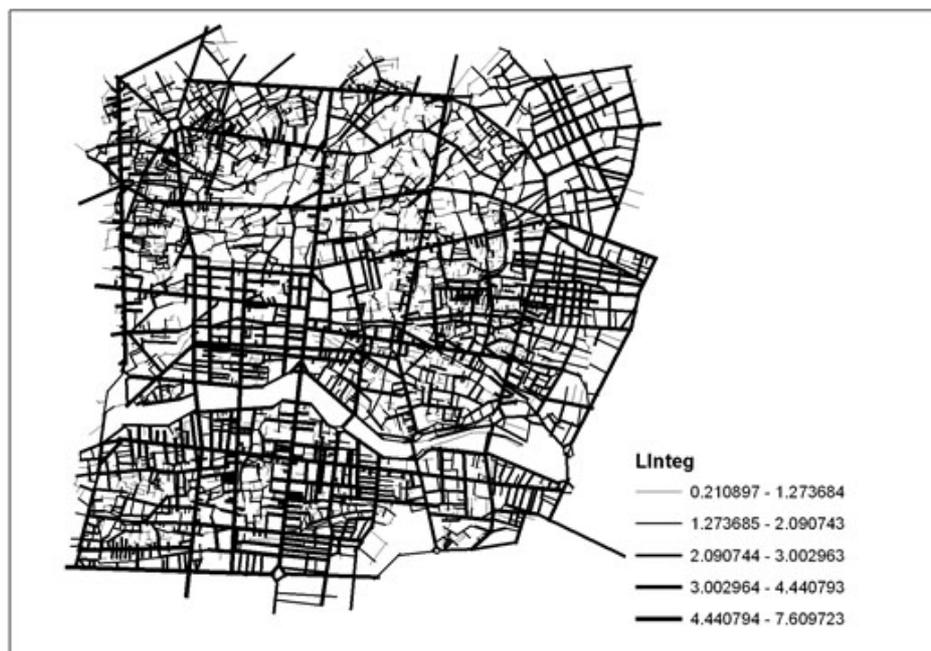

Fig. 5 Connection map value
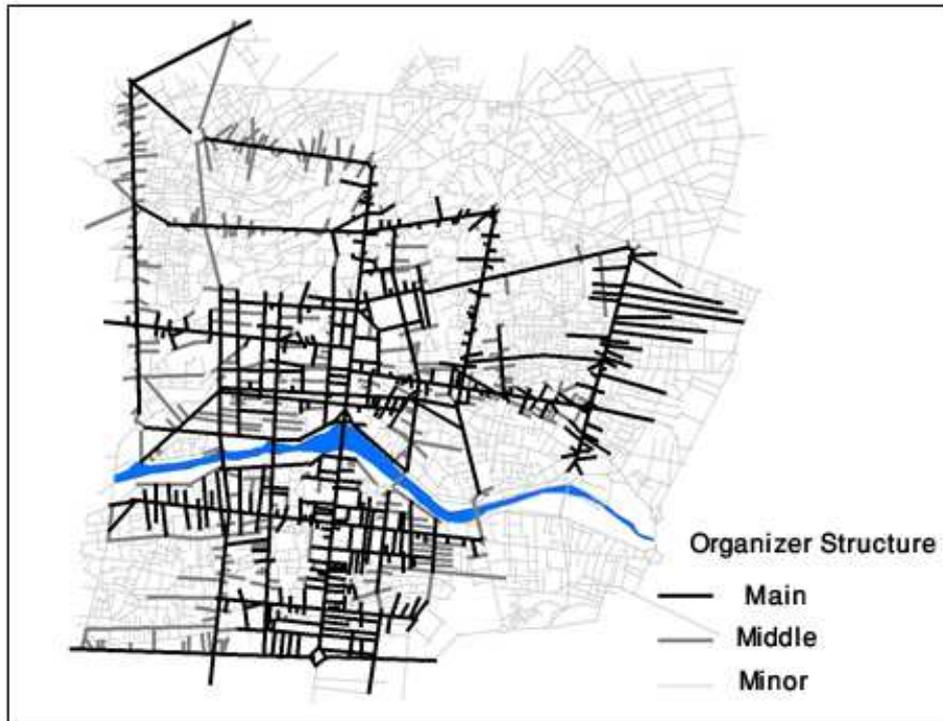

Fig. 6 local integration map (R3)

Fig. 7 Organizer structure map, based on global integration values

5. Conclusion

Urban lighting has increased urban landscape and improves the overall nocturnal urban environment, which explores the various ways to enhance safety, aesthetics, and mobility of urban contents [18]. It is because illumination has increased the ability to perceive and to identify environments after sunset. However, besides being visual clues of spatial perceptions, it is a definer of moods and behaviours of people who passing by. Good lighting of a particular space can be attracted pedestrians to stop by and consider those objects in detail. It can affect the street in how is perceived and used.

For this research we need a method which could explain context-oriented urban space and the complicated patial relations in an easy way. Space syntax is a suitable method for assessment of spatial relations and it could be useful in understanding organizer structure of urban spaces and also the effects of planning choices on organizer structure of urban spaces. Based on researches have been done, and miss existing a process for a strategy for urban lightning, a process would be suggested for urban spaces lighting by space syntax.

In the proposed process, for context-oriented urban spaces via space syntax we used Integration parameter (local and global). In continues we will have directing which this issue would be analyzed by intelligibility parameter of space syntax method. Also design alternatives would be analyzed by space syntax. By studying the organizer structure and its prioritizing, we could achieve the lighting originated from the context.
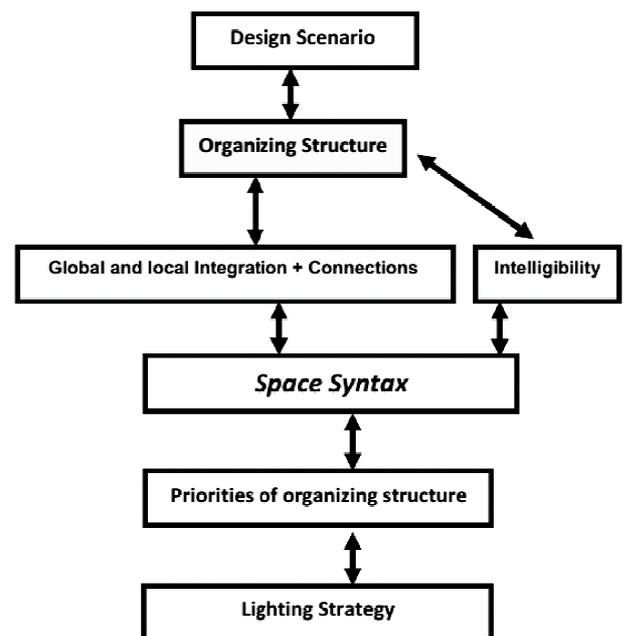
The main point in this model is that firstly it stands the scenario base and secondly these processes are two-way and fluid. This study considered urban Lighting regarding a structural viewpoint. The main point is that the scale of this method is urban, so this method would be used in urban Lighting masterplan.

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