فصلنامه مدیریت شهری
(ضمیمه لاتین)
Urban management
No.**46** Spring **2017**
233 - 242
Received *23 Dec 2016*; **Accepted** *11 Nov 2016*

Analyzing mental dimensions and investigating the effects of lighting on the improvement of urban settlements (Case study: Tehran Metropolis)

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Abstract
Light and lighting encompass different dimensions of urban life, thus the harmony and coordination of this process with environment and urban space is of great importance. Due to the importance of mental patterns in urban planning, present article analyzes the relation between mental dimensions of lighting and the spatial improvement of Tehran metropolis.
The present article is developmental and applied in objectives and uses a descriptive-analytic method. At the same time, it takes advantage of statistical techniques such as factor analysis, correlation, t test and regression. The investigations indicate that lighting influences 3 different parameters, tourism, safety, attractiveness of the environment. Undoubtedly, the quality of urban lighting is considered to be especially important in attracting citizens to these textures. Therefore, it is necessary to improve lighting quality in the process of designing our urban textures. Findings show that the residents of the case study area have a low level of satisfaction regarding the quality of lighting.

Key words: *Lighting, Security, Tourism, attractiveness of the environment, Tehran*

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Introduction

Nowadays, we live an outstanding era in which lighting technology has provided artificial lighting designers with great facilities and various media such as film, grand screens and face monitoring. In fact, the condition of built environments, both interior and exterior, is improving at nights. Now, designers, architects, artists and sculptors have discovered an unimaginably developed technology and thus buildings are not merely limited to their day time appearance. Even, it can be claimed that future architecture will be revolutionized by artificial reality methods and new opportunities for controlling the interaction between viewer, tool and space by computer. Intelligent human build its environment inside the order of day and night and simultaneously the borders between real and artificial worlds will dissolve. We must pay special attention to the day light view of optical equipment so that the least damage will be imposed to the irrecoverable texture of buildings. Unfortunately, Tehran, the capital city of Islamic republic of Iran, lacks special principles and standards for urban (and rural) environment lighting at nights, which is a sign of weakness in urban beautification. It can be claimed that the presence of citizens in urban environments at nights and during their leisure time has made lighting an essential element of urban life. Based on these, the present article investigates and studies lighting and its influence on the improvement of urban environment in 1th and 2nd Sadeqie Squares.

Statement of the Problem

City, as the symbol of human culture, has always been the basis for excellence and development of different sciences which provide for public welfare. Scholars of urban sciences have always been concerned with improvement of urban environments. In this regard, light and lighting are considered essential for improving urban environments.

The art of lighting is supposed to be an important field in designing which combines light, color and aesthetics to create masterpieces in interior and exterior spaces. Lighting is considered to be one of the most important subfields of designing, because without lighting visitors and passer-by only visit masterpieces of great architects during day light and then they disappear into darkness. Unless we use fundamental techniques to manifest the beauty of space at night; This manifestation needs many different techniques by which lighting designers create artistic masterpieces.

Light and lighting encompass different processes of urban life, thus the harmony between urban environment and lighting is crucial. Nowadays, we face chaos in urban landscapes and human environments due to weak lighting and negligence to security and beauty. Thus, focusing on optical elements is necessary. In this regard, selecting appropriate lighting facilities can prevent environmental damages and increase its beauty.

New planning approaches (perspectives related to post-modernism) consider aesthetic and functionalism simultaneously. City is created by aggregation of people, therefore, traditional top down approaches have lost their place in urban planning. As Ernestine in his collaborative chain focuses on urban planning with people and not for people; Therefore, the present article uses field work to investigate the relation between lighting and improving urban space.

According to the research topic and objective, the following hypotheses are proposed:

- Can urban lighting be influential in the attractiveness of urban space and buildings?

-Can urban lighting be influential in increasing time spent for shopping and tourism at nights?

-Can urban lighting be influential in increasing security and comfort of tourists at nights?

Method

This applied and developmental research seeks to recognize and achieve a scientific and operational goal for using lighting to improve urban space in Tehran metropolis, 2nd district (1st and 2nd square of Sadeqie).

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In fact, this is a descriptive, analytic and scale-based investigation in which main data are collected using questionnaire and analyzed with SPSS. Accordingly, a questionnaire was designed and distributed among the statistical group (all citizens visiting commercial complexes and pedestrian spaces in earlier hours of night, the lighting system of which was active and visiting was possible). The questionnaires were distributed inside the specified space and among the citizens who were visiting the area and had a concrete experience of the space lighting. A short explanation was offered to increase the accuracy and ease of answering. The total number of sample was estimated according to the probable number of visitors in the specified time period and using Kukran formula with 80% probability of the characteristic being present, 96.1% probability of verbal accuracy and 5% error. Accordingly, the estimation results in a sample of 235, which was increased to 320 to increase the accuracy of results. The questionnaire reliability was estimated using SPSS and Cronbach alpha test. Cronbach alpha value was 0.703 which is more than cut point 0.7. Therefore, the reliability of the questionnaires is acceptable.

The following relation was used to determine the total number of sample:

$$N = \frac{\frac{t^2 pq}{d^2}}{1+\frac{1}{N}(\frac{t^2 pq}{d^2}-1)} = 320$$

$$T = 2 \qquad p = 0/8 \qquad q = 0/2 \qquad d = ./05$$

Data were gathered using library research, questionnaires (open and closed answer questions), field research and observation.

Analytical Model

Figure 1 shows the analytical model which investigates the influence of lighting on 3 important factors of urban environment, namely security, attractiveness and increased tourism.

Literature Review

Ben Boa in the beauty of light (1988) investigated various dimensions of lighting influencing human life and environment and focused on different methods of using light in industry and art. Daylight in architecture by Benjamin Evans (1991) has provided various examples of using daylight in processing and architecture. In architectural lighting design, Garry Sttefy (2002) referred to principles, methods, technical and artistic dimensions of architectural lighting with artificial light and focused on a lighting plan of buildings from beginning to the end. Mitja Prelovsk in his research project, lighting of urban parks (2007) has examined two urban parks in Slovenia and provided some guidance to improve the environment of parks during night which can be extended to similar urban spaces. David Herbert and Norman Davidson (1994) have addressed the role of lighting in decreasing crime and indicated that street lighting has a statistically significant positive relation with decreased level of crime. Igor Knez (1995) has investigated the influence of lighting on temper and examined the influence of different interior lighting with different color and intensity. He claims that

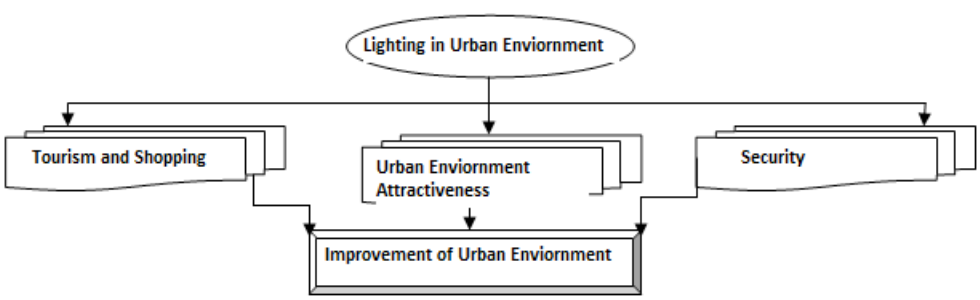


Figure 1. Research analytical model

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lighting has different influence on men and women. Susanne Seitinger (2007) focuses her investigation on large LED display screens and notes that urban lighting still have potential capabilities which needs to be studied and examined. Moreover, she stresses on the need for different expertise in a comprehensive lighting design. Ali Asghar Adibi et al (2006) focus on the general principles of urban parks lighting and refer to the fact that designers need to pay attention to night appearance in designing parks and gardens. This article assumes park lighting to be influential in readability of focal points, signs, passages, development of facilities and security and also in encouraging citizens to use parks at nights.

Nowadays in many important cities of the world, urban managers use lighting consultants and perform different programs to create a relationship between people, light and urban environment and develop a social view to urban lighting. Despite recent developments, urban lighting possesses important ad influential potentials which need to be considered. The present study seeks to address lighting from three different aspects: increasing security, attractiveness and even urban tourism.

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Theoretical Framework

Lighting

Lighting is more than simply projecting light on things to make them visible. Lighting means conceptual imagination with lights of colors not seen before. Lighting provide light designers, architects and engineers with the possibility to redefine the space and to present controversial and contentious changes in the exterior appearance of real objects and increase their attractiveness and singularity (Gardner, Karl-Moloni, Rafael 2006).

Approaches in Urban Lighting

Definitely, the urban mood is very different during day and night and day time mood cannot be imitated at night. Night has its own special and secretive mood, thus it is obvious that lighting patterns need to be in accordance with the identity and mood of the space. The reflection of city facades, buildings, objects, statues and green spaces have a close relation with their lighting.

Understanding the performance of urban space and its needs helps us in providing more appropriate solution to lighting and improves the visual and operational quality of urban environments. Light as the fourth dimension of architecture reveals length, width, altitude and visual elements around us. In fact, light is a dynamic media for demonstrating visual elements surrounding us and lighting designer decides about which influence he/she wants to make based on the aims of the plan.

There are two general approaches in light designing:

a) Decision making based on creating calming visual effects

b) Decision making based on creating exciting and influential effects (figure2)

Light intensity and the interaction between light, shadow and light color plays an important role in creating the specific effects of the lighting design. Sharp contrast is used to create exciting effects and strengthen the needs of plan, while calming visual effects is achieved by low contrast. Of course, designers can use these approaches on a scale of mild to intense.

Lighting and Security

Lighting increases security in street level, espe-

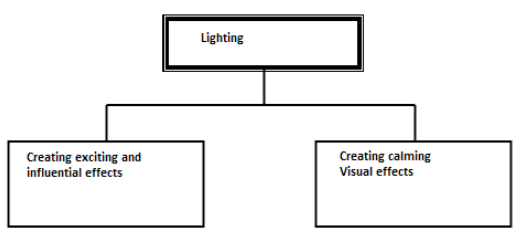


Figure 2. General approaches in lighting

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cially in crowded centers, intersections, crossroads and bridges, and helps us in identifying people and situations we face. Darkness, low light and inappropriate distribution of lighting system at night results in behavioral delinquency and crime. Therefore, darkness blurs features and the first step toward an unprotected and vulnerable space is taken. These spaces will be defenseless because of non-physical reasons. Yet providing lighting and solving the lighting problem, these can be transferred into a protected area and thus the problem of vulnerability will be solved.

Study Area

Tehran province covers an area of approximately 18814 km2 and is located between 34 and 36.5 northern latitude and 50 to 53 eastern longitude. It borders Mazandaran province in the north, Qom province in the south, Semnan province in the east and Qazvin province in the west (www.sso.ir). Tehran city is located between 51 degrees and 17 minutes to 51 degrees and 33 minutes longitude and 35 degrees and 27 minutes to 25 degrees and 47 minutes latitude. It covers an area of more than 640 km2 (fa.wikipedia.org).

Analytical Results

1-Measuring Satisfaction

A questionnaire is prepared to measure the level of satisfaction in inhabitants of First and Second Sadeqie square and to determine all dimensions of lighting quality. Then, the questionnaires and research variables will be examined using statistical tests and factors influencing lighting quality will be recognized.

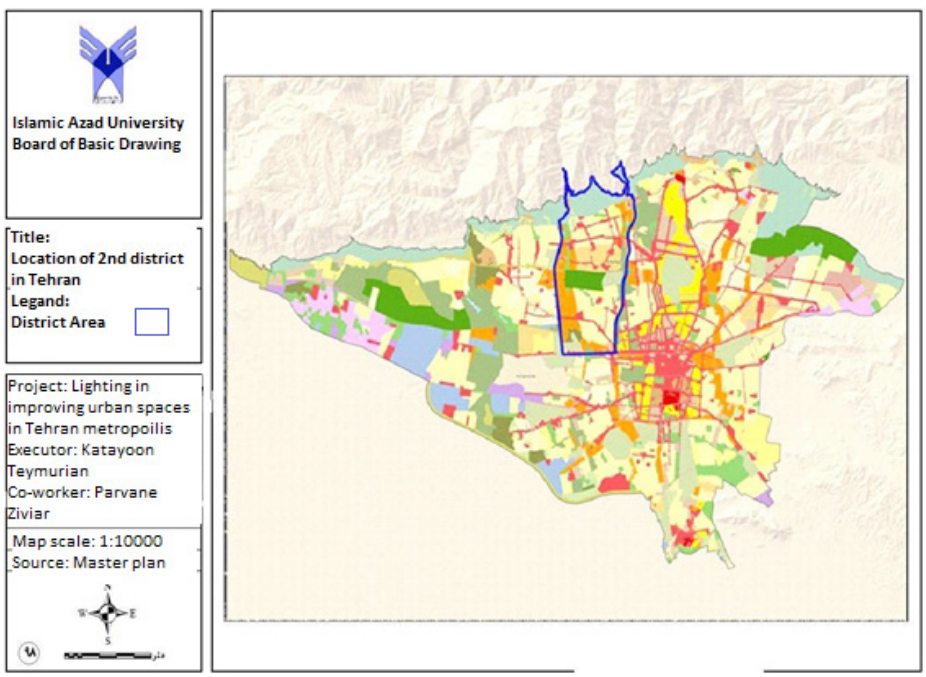
Reliability and Cronbakh alpha of each variables question were calculated with $\{1-\frac{\Sigma s_i^2}{s^2}\}\, R_a=\frac{j}{j-1}$ using software.

Results show a Cronbakh alpha of more than 0.7 which is acceptable. Moreover, the Cronbakh alpha of each research questions was calculated and resulted in 0.786 which is greater than 0.7. Therefore, the research reliability is statistically significance.

2-Measuring satisfaction of lighting system quality

To recognize the level of satisfaction, the mean score of each index was presented (according to the Likert 7 point scale).

Investigating the lighting system indexes indicates that night vision with a mean of 3.9 has



Map 1- geographical location of Tehran 2nd district

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Map 2. Geographical location of Sadeqie to Satar-khan Bridge

Satisfaction Index	Mean Score	Standard Deviation
Physical feature of lighting elements	2.8	2.45
Color variability of lighting	2.5	2.33
Number of lighting elements	2.7	2.34
Lighting plan	2.6	3.12
Lighting Harmony with environment	2	2.71
Night vision	3.9	2.65
Feeling safe in main streets with lighting	3.2	2.34
Feeling safe in side streets with lighting	2.1	2.21
Lighting effect and the desire to stay in city for shopping	2.9	2.13
Lighting effect and the desire to stay in city for recreation	3.4	2.99

Table 1. Mean score of satisfaction of lighting system

the highest level of satisfaction, while lighting harmony with the environment has the least level of satisfaction.Generally, it can be concluded that satisfaction level of lighting system is lower than the mean score.

3-Recognizing fundamental factors in satisfaction of lighting system

We then investigated satisfaction level of lighting system and analyzed it using factor analysis and thus extracted fundamental factors. In this regard, 10 research indexes of the questionnaire were examined to extract the factors. KMO level of this investigation shows 0.793 and Batlett test has a significance level of 0.00 which shows data acceptability for factor analysis. Tabacgink and Fidel claim that variables with a factor loading greater than 0.32 are significant. Kumeri and Li suggest a range of values for interpreting the relation between variables and factors. They consider factor loading of 0.71 and more to be perfect, 0.71 to 0.63 very good, 0.63 to 0.55 good, 0.55 to 0.45 quite good, 0.45 to 0.33 weak.

10 items are determined based on the special

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amount and scree plot from which 3 factors are extracted. According to table 2, these factors explain 75.323 percent of the variance and show their strength in the analysis.

According to table 2, factors used to measure and examine satisfaction level can be proposed as follows:

First factor: most of loading in this factor is placed on indexes such as physical feature of lighting, color variability of lighting, number of lighting elements and etc. thus it is called "environmental attractiveness".

Second Factor: most of loading in the second factor is shown to be on indexes such as feeling safe in main streets, feeling safe in side streets and alleys, and etc. therefore it is called "security resulted from lighting".

Third Factor: in the third factor, most of loading is placed on tourist related indexes. Thus it is called "tourism presence".

4-Pearson correlation coefficient

To analyze the variables, the Pearson correlation coefficient results, mean and standard deviation are presented separately. In fact, the present plan uses Pearson coefficient to show the correlation between different factors related to lighting system satisfaction. Results indicate a significant correlation between extracted factors and citizens satisfaction level.

5-Determining predictors of satisfaction level

Stepwise regression was used to identify the most important and influential factors of satisfaction. Here total 4 number is used to identify the most important predictor. Therefore, satisfaction of lighting system is a variable of 3 aforementioned factors and table 4 shows the results of their examination in regression analysis framework. These 6 factors indicate 75.323 percent variance satisfaction of the lighting system quality in the study area. According to table 4, it can be claimed that environmental attractiveness factors predict satisfaction level in the first and second Sadeqie square inhabitants better, while other elements such as safety and tourism explain satisfaction to a great degree.

Conclusion

Research hypotheses proposed based on the questionnaire are examined using central limit and parametric test of mean (T test). In this test, $H_0: \mu \leq 3$ و $H_1: \mu > 3$ hypotheses are used as the basis for analysis and the effect of lighting variables on the 3 other variables is determined based on these. Accordingly, t test table is as follows.

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Variables	Factor		
	1	2	3
Physical feature of lighting elements	0.689		
Color variability of lighting	0.687		
Number of lighting elements	0.624		
Lighting plan	0.611		
Lighting Harmony with environment	0.567		
Night vision		0.501	
Feeling safe in main streets with lighting		0.729	
Feeling safe in side streets with lighting		0.703	
Lighting effect and the desire to stay in city for shopping			0.682
Lighting effect and the desire to stay in city for recreation			0.675
Special Amount	19.834	17.872	16.329
Variance percent	28.201	24.912	22.801
Variance sum	75.323		

Table 2. Fundamental factors in satisfaction of lighting system
Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization

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Variables	Pearson correlation coefficient	P-value
Environmental attractiveness	0.712	0.000
Safety	0.611	0.000
Tourism	0.301	0.000

Table 3. Pearson correlation coefficient

Factors (predictors)	R^2	Adjusted R^2	Beta	t	Level of significance
Environmental attractiveness	0.662	0.660	0.732	19.22	0.00
Safety	0.532	0.532	0.562	15.34	0.00
Tourism	0.515	0.511	0.559	15.01	0.00

Table 4. predictors of the satisfaction of lighting system quality

	T statistics	Level of significance	Mean difference of each variables with 3	Confidence interval 95%	
				Higher limit	Lower limit
The effect of lighting on Environmental attractiveness	834.36	0.00	5640.4	3245.4	6547.8
The effect of lighting on Safety	683.12	0.00	4657.5	3467.2	5654.5
The effect of lighting on increasing Tourism and shopping	623.65	0.00	4143.8	3387.4	5312.6

Level of significance for all variables is less than 5 percent, thus there is a statistically significance difference between the variables and 3. Looking at t column, it is obvious that the mean score for all four variables is more than 3. The 5th column shows mean difference of each variable with3.

Therefore, it can be concluded that lighting is highly influential in increasing welfare and safety, attractiveness of buildings and spaces, time spent on shopping and tourism at night. In this regard, the research hypotheses are proven.

Finally, it can be concluded that urban environments should be areas in which people gather and interact. Undoubtedly, the quality of urban views greatly influence citizens tendency toward these textures. Therefore, in designing our urban textures we have to consider improving quality of urban view. Improving quality of urban view is far from a one-dimensional view of urban elements. In other words, all physical and human factors must be considered simultaneously in designing urban views. There are many urban textures in which only physical factors like vegetation, urban furniture, etc. are considered. These plans fail due to negligence to human needs. Lighting is considered to be one of these human needs which results in security, increased urban attraction and tourists' presence in urban areas.

Any Lighting plan includes features which somehow influence the designing process. Objectives achievement, implementation and plan acceptability depends on these features to a great degree. These features can be classified into environment, characteristics of the light source, audience mentality and oldness.

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