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ANALYSIS AND STRATEGIES FOR ZONAL LIGHTING DESIGN OF KONYA MEVLANA MUSEUM AND MEVLANA CULTURE CENTRE AXIS

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ABSTRACT

In order to make the cities more liveable at night and to reflect the promised value of the city during the night, zone lighting should be considered rather than single building lighting. Zone lighting design prevents light pollution and provides a more comfortable perception of the desired elements in the city skyline. In this context, the factors affecting zonal lighting design were specified by literature study and stages of such design were determined. The axis of Mevlana – Mevlana Culture Centre, given the tourism potential at night in Konya, which is considered the capital of religious tourism in Turkey, was chosen as a study area and a lighting design proposal was prepared for this zone. According to plans, holistic zone lighting simulation models were created and the city skyline formed by illuminance at night was overviewed.

Keywords: urban, zone lighting, city image

1. INTRODUCTION

Cities have a dynamic structure that lives, develops and changes every moment, as a consequence of different socio-economic functions they undertook throughout history and as a result of technological and political developments [1]. Cultural structures, aesthetic senses, religious themes of the societies living in cities can be considered as important elements that shape cities. The urban identity that affects the image of the city has unique characteristics at different scales in every city [2]. The concept of the cityscape, which is the general impression that a city leaves on people, consists of urban images that people perceive. Urban images are important elements in the perception of the cities' identity [3].

Today many cities, as a result of urban planning decisions, are divided into zones according to their potentials, urban grading, their sizes and spatial organizations [4]. Cities are divided into zones having different functions, such as industrial, residential, commercial and entertainment zones and the relationship between them constitutes the modern city [5]. Creating the impression of the city, regional zones, which are important for the city, should be highlighted.

Efficient and regular functioning of a city depends on its daytime life, whilst its charm and attractiveness depend on its nightlife [6]. Therefore, it is important to discover and comprehend cities during the daytime, as well as at night. The lighting, especially, plays a big role in creating the night view of cities. However, external lighting of buildings one by one causes visual anarchy [7]. Until the end of the 1980s, instead of lighting the whole city, certain places had been targeted under lighting project, whereas at the end of 1980s, comprehensive lighting plans were initiated [8]. In these holistic arrangements, revealing the unique characteristics and urban values of the city is also taken into consideration in lighting.

Urban lighting shapes the urban identity when a city is viewed at nighttime. Urban lighting is not only related with the need of lighting and its techniques, but also covers other elements such as cul-

ture, aesthetics, efficiency and security [9, 10, 11]. In the preparation of master plans for lighting cities with a population of over millions, zone distinctions constitute the most important input and they help to define important elements that would create the city night silhouette. Lighting especially historical areas and creating places that live day and night time contribute to the development of the city [12]. Feeling the spirit of the place and capturing its atmosphere in these areas is quite significant. Buildings, streets and other places supporting this integrity in a zone should all be examined carefully and the lighting plans of the zone should be prepared in line with a specific function. Places living day and nighttime would support also the economic development in the city.

This research focuses on the elements to be considered in lighting plans of historical zones, on the basis of Mevlana – Mevlana Culture Centre which hosts Turkey's the most visited museum and many other historical and cultural structures in Konya province which has a population of over 2 million and which displays a horizontal development.

2. FACTORS TO BE CONSIDERED IN GIVING ZONAL LIGHTING DECISIONS

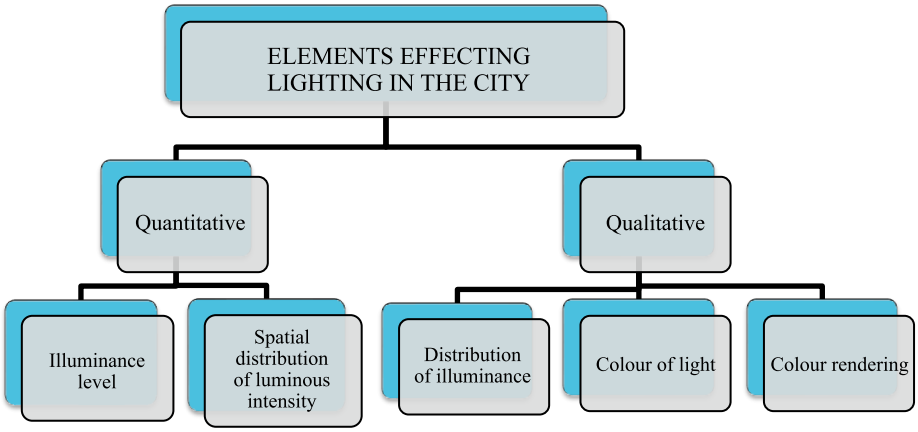
Environmental and social elements, which form the urban identity, have a role in determining the image of the cities [13]. Environmental elements are divided into two groups; built environment and natural environment, whereas social elements are defined by cultural, economic and psychological factors [2, 14, 15]. Since the plans and decisions related with the lighting of certain areas will focus on the desired image to be created, all these elements should be examined.

In the preparation of lighting plans of certain areas, studies had been conducted on the factors affecting the visual comfort. However, the most important factor is the light that shapes our perception, its impact on human psychology and the intended image. In order to give the desired psychological effect and visual value in lighting designs, first of all, the historical development of the area should be examined thoroughly, by conducting detailed researches on the area. Cultural values and demographic characteristics of the area and the way it is regarded psychologically by people should be known. This would enable to define the historical identity of the area [14]. After having gained information on the historical identity, the axis, squares and structures that need to be highlighted in the area should be determined. Their order of importance and prioritization will enable to determine the visual hierarchy. In this way, also mainline arrangements regarding the desired atmosphere to be created can be defined. Socio-economic factors are considered as other important elements that form the social structure of urban zones. Functions that determine the trade in the area and economic effectiveness of certain structures in the zone are important issues to be considered in analysing the structure of the zone. Places that are commercially active at night and surrounding areas that ensure the transport to those places should be identified and the lighting axis should be drawn accordingly.

After this examination, the geographical position of the zone in the city should be taken into account and physical conditions that may affect the planning of the zone should be identified. When making decisions regarding zone lighting, general potential and position of the zone within the city should be examined. These can be listed as topography, green areas and water elements which affect visual aspects of the buildings. Among geographic elements, those, which contribute to the zone effect in the background, are taken into consideration for visual hierarchy and the others are evaluated for placement of the lightings. In addition, climatic characteristics within the natural environment should be examined. The climate and topography are influential elements in shaping cities. It is observed that the climate and topography play a role in forming the texture of the city through material selection and in determining the form of structure, like general orientations of buildings, the inclination of roofs. This is evident particularly in historical areas where designs peculiar to a specific location are common [16].

The city is the most significant indicator of human presence, as a result, symbolic elements of the artificial environment, such as buildings, squares, streets, various urban furniture and statues shape the cities. Functions of these elements, the content of their surroundings and background, and their geometric formation should be taken into account in lighting plans. Illuminance to be applied to the facade of the building should be increased according to the architectural function of the structure. Functions of the building, which are accessible to the public, should be taken into account and emphasized through lighting.

Table1. Elements that Affect Lighting in the City [19]



As it is seen in Table 1, lighting in the city is described on the basis of quantitative elements (level of illuminance, luminous intensity (spatial) distribution) and qualitative elements (luminous intensity of a source, illumination colour, colour rendering) [17]. When illuminating a building, we should know the surroundings of the building and the illuminance level of the background because there should not be a very big illuminance difference between the building to be illuminated and the lighting of the surroundings. However, in order to ensure the visual distinction of the target, the building should be separated from the background [7]. Keeping the difference in illuminance low between the two areas will create a positive effect on the city's silhouette. If the surroundings or background of the building is illuminated, the building should have a higher level of illuminance with respect to other buildings, so that it can be distinguished. The building is lighted with a low level of illuminance if the buildings at the background or in the surroundings are to be brought into the forefront. In addition, in lighting plans, historical sites should be prioritized in order to conserve and maintain cultural heritage.

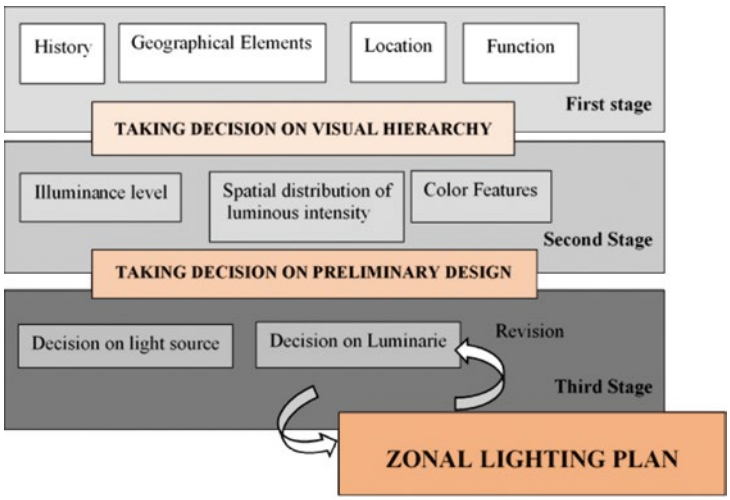
In lighting plans, particular attention should be paid to the geometric forming of the building. Lighting is applied to the facade of the building that is intended to be made visible and the illuminance level of this facade is kept high. Buildings in the shape of square and rectangle, the lighting made from the corners of the building reveals better the form of the building. Cylindrical structures can be illuminated from three directions with three equally powered light sources, placed at equal angle intervals. If the viewpoint is limited, lighting from two directions will be sufficient. In the lighting of structures in different shapes, the most important facade is selected and a higher level of illuminance is applied to this part. In addition, the entrance of the structure, or its special details, is considered in lighting plans.

Halogen lamps, incandescent lamps, metal halide lamps, fluorescent lamps, mercury lamps, high-pressure and low-pressure sodium vapour lamps are light sources, which used in the cities. According to colour rendering, colour temperature and level of the illuminance, the most compatible light source with the design should be selected [18]. In addition to these lamps, today also energy saving LED light sources of the wide colour range are using in urban lighting. Luminaires used in urban lighting can be divided into four types as pole-top luminaires, luminaries mounted on the surface, outdoor bollards, and floodlights. In the selection of luminaires, attention should be paid to energy efficiency and lighting quality. In the selection of luminaires that will distribute the light with preventing glare the light cut-off feature of the luminaire should be examined.

3. ZONE LIGHTING PLAN OF KONYA MEVLANA- MEVLANA CULTURE CENTRE AXIS

Within the scope of the matters considered above, the design process of zone lighting is handled in three stages, as it is seen in Table 2. The first stage is the analysis stage. At this stage, the historical structure, geographical elements of the area and its position in the city with a particular view to the public transport system and the functional value of the area is examined. After this examination, the visual hierarchy is identified; illuminance levels and colour relationships among different parts in the area are decided. Afterwards, the design stage starts.

Table2. Stages of Zone Lighting Design



In light of the data obtained from the assessments and the standards regarding external lighting, the luminaires and the lighting sources are decided.

When deciding on the lighting elements, it is also necessary to consider the places where the element is to be fixed. After the preliminary design is completed, calculations are made for evaluation. After the completion of preliminary design, calculations are made for evaluation. DIALux programme [19] was utilized here because it has open access and the luminaires that belong to companies are identifiable. Thanks to the computer programs that are currently used, today it is possible to make revisions repeatedly during the design stage, thus the best result is achieved after having experimented many variations. At this stage, thanks to the realistic visual images, the ambience desired to be created is captured.

Konya Mevlana-Mevlana Culture Centre axis and its surroundings are selected as a case study field as shown in Fig. 1. The reason why this area is chosen is that it has the most potential of being alive day and night time thanks to its imaginative structure stock but it cannot fulfil its potential due to the light pollution caused by lighting applied to single buildings. With the hierarchy to be created in the illuminance of this area, it is aimed to make the area more liveable at night.

With its history dating back to B. C. 7000, Konya has been an important settlement area for many civilizations. Mevlana Museum works as the tourism centre of Konya province, which was the capital of the Anatolian Seljuk Empire. Alaaddin Hill as a tumulus constitutes the centre of the flat city and Mevlana Museum is 1.5 km away from this area that hosts Seljukian citadel ruins. While Mevlana Museum holds the urban historical fringe, this range is very active in terms of tourism and trade. The 1.5 km Mevlana – Mevlana Culture Centre axis flourishes this tourism trade centre and covers significant areas for those who come for religious tourism. Tramline passes in the middle of this axis and there is a connection to the city centre through the highway. This area includes also significant examples of traditional residential texture. Mevlana Tomb and Museum, Selimiye Mosque, Yusuf Ağa Library,

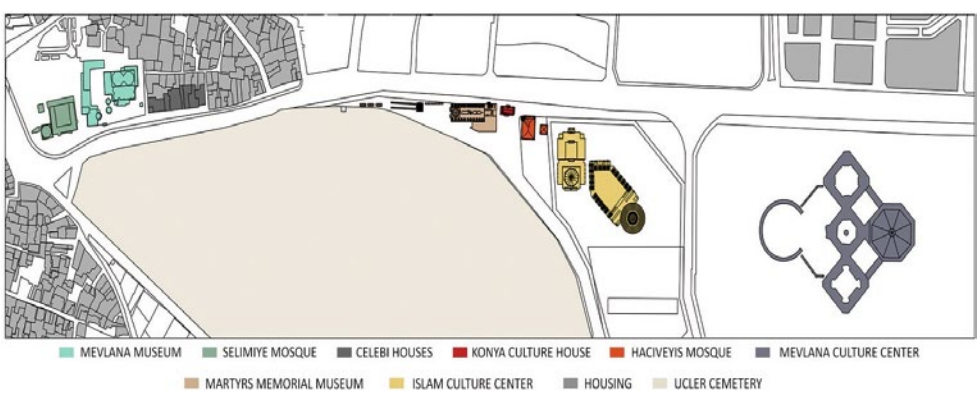


Fig. 1. Zone plan of Konya Mevlana-Mevlana Culture Centre axis

Martyrs' Cemetery, Konya Culture House, Hacıveyis Mosque, Islam Culture Centre, Mevlana Culture Centre and Çelebi Houses are identified as important structures of this area. Historical and structural characteristics of the buildings in this area are examined and their hierarchical order is determined accordingly.

The Tomb of Mevlana is the most important tourism centre in the area. Inside the Tomb which presents traces of Seljuks, there is a prayer room, semahane (the building where Mevlevi dervishes perform the sema) and sadirvan (fountain) built during the Ottoman period. The tomb that is called as "Green Dome" in Mevlana Museum is the most distinctive element, as a visual symbol. The height of the tomb is 25 meters.

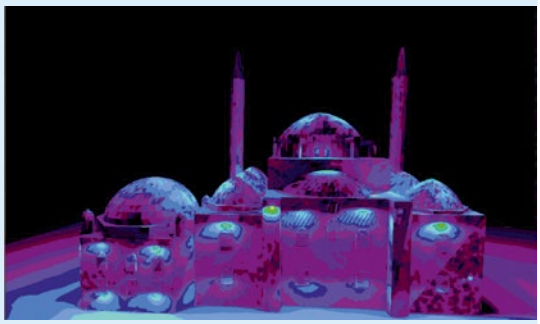
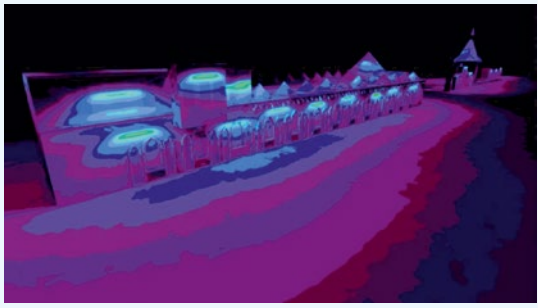
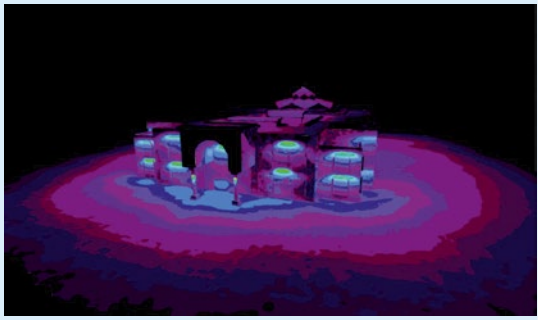
A classic Ottoman work, Selimiye Mosque (Sultan Selim Mosque) dates back to 1567. The mosque was built of cut stone. It has a big dome that is surrounded by a small full circle and half-circle domes. The dimension of the mosque is 50 meters by 50 meters by 25 meters. It catches the sunlight through two lines windows. The Martyrs Memorial Museum is built on a land of 5,000 m^2. At the entrance of the Memorial, there are shops selling souvenirs, road with flags symbolizing the States established by Turkish People and a dome for welcoming. Konya Culture House is a structure of the Republic period, constructed in the first half of the 20^{th} century. It was originally built as a residence. After being restored, today it serves a Culture House. Its construction material is brick. It has a hipped roof as a top cover and two composite roofs placed above the extensions of the inner sofa. The eaves of the three-storey structure stick out 0.5 m from the structure. Hacıveyis Mosque is a work of the late Ottomans period (19th Century). The Mosque was built of stone material. The minaret was built of smooth cut stones and the top is made of bricks. The mosque that has wooden pillars and a hipped roof is still in use and registered. Islam Culture Centre is composed of two structures; panorama and Mevlevi lodge. The travertines used on the facades are light and dark colour. The traditional material used in Seljuk architecture, such as wood, tile and brick is used here. It has a crown door with muqarnas and arched windows made of solid stone. Hilton Garden Inn Hotel is located behind the Islam Culture Centre. The four-storey structure is reinforced concrete. Since it is not a multistoried structure, it doesn't ruin the silhouette of the historical area. Mevlana Culture Centre is located one kilometre far from the Mevlana Museum and it is across the Islam Culture Centre. There are the foyer, exhibition halls, cafes, library and research centre, congress and performance halls in an area of 108 thousand m^2 [20].

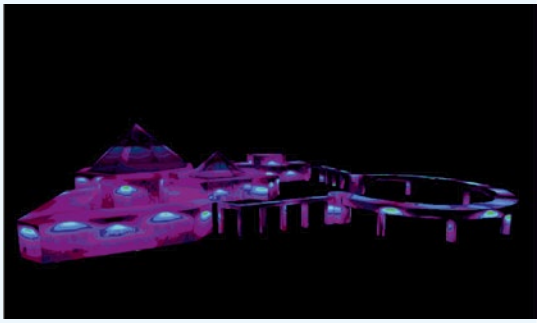
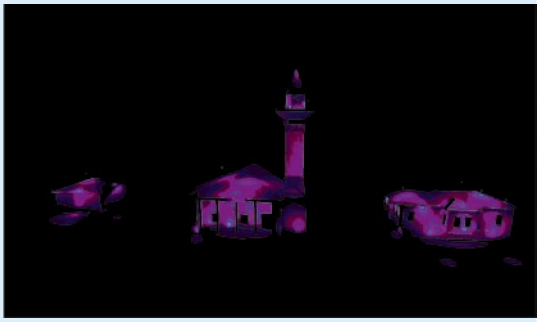
4. LIGHTING DESIGN PROPOSAL FOR KONYA MEVLANA- MEVLANA CULTURE CENTRE AXIS

In the hierarchical order of lighting in the area, the historical Selimiye Mosque comes second after Mevlana Museum. Selimiye Mosque is followed by Martyrs' Museum, Islam Culture Centre and Mevlana Culture Centre with their cultural standing. In the next stage, there is Hacıveyis Mosque and Culture House. In accordance with this hierarchical order among the buildings, without leaving the buildings on the main street in the background, illuminance level necessary enough to lighten the tram and main street is used as a base. As to the historical cemetery area opposite to Mevlana Museum, lighting is provided with floodlights placed on the fences, making apparent the borders of the cemetery without entering into the internal part. The floodlights placed on the inner side of the fences, lighten the borders so that the presence of a cemetery in the area is realized at night. In the lighting design of the zone, first of all, the most suitable light colour for the facade of the building is chosen. In order not to create a view that is different from the daytime, the details of the facades and roofs are illuminated in a particularly noticeable way. In order to make certain parts visible and noticeable at night, as they are in day time; roof details such as dome, minaret and the details on the facade such as columns, eaves, cornices, bay windows and motifs are emphasized through lighting. In order to highlight the building entrances, a higher level of illuminance is applied to these parts. As a result of this study, lighting decisions and simulation results of lighting design are presented in Table 3.

The lighting plan designed for Mevlana Museum aims to apply the lowest level of illuminance to the background, a higher level of illuminance to the surroundings of the main structure and the highest level of illuminance to the main structure. Thus, it is aimed to create an image of the structure integrated with its environment. The borders and the entrance doors of the museum are highlighted. When we look at Mevlana Museum, the most strik-

Table 3. Decisions on the Lighting of Buildings and Simulation Results of the Lighting Design

	LIGHTING DECISIONS	SIMULATION RESULTS
		
MEVLANA MUSEUM	• 10 W LED light sources under the domes • 12 W LED light sources on the Green Dome • 30 W floodlights with an angle of 180 degrees placed to lighten exterior walls of the border • 100 W floodlights with an angle of 30 degrees, placed on the floor to lighten the facade • 200 W floodlights for the entrance door • 150 W floodlights for the higher parts of the roof	
SELIMITYE MOSQUE	• 4·200 W outdoor spotlights placed on the floor for the front facade, 2·150 W outdoor spotlights for the side facades • 100 W floodlights with an angle of 30 degrees for big and high domes; 50 W floodlights for medium-size domes; 20 W floodlights for small domes; 40 W floodlights for half-circle domes • 3·10 W floodlights with an angle of 45 degrees for the side surfaces of medium-size domes; 3·25 W luminaires for the minaret	
MARTYRS MEMORIAL MUSEUM	• 100 W floodlights with an angle of 30 degrees placed on the floor across the facade, to lighten the facade • 50 W luminaires with an angle of 180 degrees placed on the floor for the flags • 8·50 W floodlights with an angle of 45 degrees for the dome of the welcoming area, 8 W LEDs are placed around the top of the dome • 20 W luminaires placed inside the dome for the passage axle under the dome • 150 W floodlight placed on the floor with an angle of 45 degrees for the entrance line • 8·50 W floodlights placed with an angle of 30 degrees around the big octagonal dome on the roof; 10 W floodlights placed with an equal angle from three directions for the small domes	
ISLAM CULTURE CENTRE	• 2·100 W floodlights with an angle of 45 degrees for the entrance door, 2·70 W floodlights for the front facade, 60 W floodlights placed in front of windows on the side facades • 5 W floodlights from three directions with an angle of 45 degrees for the small domes in the roof part • 10 W LEDs for the top of the conference hall in the roof • 25 W lighting placed underskirts of the roof in the shape of a star; one 50 W floodlight placed upon the skirts	

	LIGHTING DECISIONS	SIMULATION RESULTS
	0.10 0.50 2.00 5.00 20.0 75.0 300.0 1000.0 5000.0 15000.0	
MEVLANA CULTURE CENTRE	• 5 W LEDs placed around the glass roof on the breaking points • 200 W floodlights with an angle of 30 degrees placed on the roofs for cylindrical volume • 200 W floodlights with an angle of 30 degrees for the facades • 200 W floodlights looking towards down with an angle of 30 degrees placed on the top of the columns at the entrance • 250 W light source with an angle of 45 degrees for the facade with the entrance door	
HACIVEYIS MOSQUE AND CULTURE HOUSE	• 150 W floodlights with an angle of 30 degrees for the facade of the mosque • 5 W LEDs for semi-open entrance; 5 W led lighting the surface to be hided in the eaves of the fountain • For the minaret 25 W floodlights with an angle of 45 degrees lighting from three directions • 50 W floodlight with an angle of 45 degrees for the facade below the minaret • 150 W floodlights with an angle of 30 degrees to lighten the facades of the Culture House • 5 W led placed on the eaves of the roof to lighten the surface of the facade towards down	

ing part is its green dome and since it is accepted as the symbol of the city, the first point that attracts attention at night should be the same point that draws the attention during day time. The simulation study done with DIALux programme reveals that the illuminance level of this dome can increase up to 75 lx. The average illuminance level of the minarets is observed to be around 20 lx. In facades, the level of illuminance on surfaces of the facades varies between 30 lx and 50 lx. As to the exterior walls defining the borders, an illuminance level of 10 lx is obtained.

The illuminance level to be applied to Selimiye Mosque, both to it's dome and facade surfaces, should be high. However, since they are side by side with the Mevlana Museum, the level of lighting of the Selimiye Mosque should not exceed the Mevlana Museum. In the lighting plan of Selimiye Mosque, it is ensured that elements that are higher than human height like domes or minarets do not disappear in the dark and they are noticeable. In deciding the placements of lighting tools, it is aimed not to give any damage to the historical facades. According to the results of the simulation, the average illuminance levels seen on the domes of the Selimiye Mosque are around 10 lx and on the facades are 30 lx. On the side facades, this rate decreases down to 5 lx. On the high minarets, an illuminance level of (3–5) lx that would not disturb and strain eyes is obtained.

The souvenir shops in front of the Martyr's Memorial Museum are made visible at night. In order to highlight the flags and make them appear higher and solemn, lighting from the floor upwards is applied. The lighting design pays attention also to the form of the roof and entrance door. At the Martyrs' Memorial, the average illuminance level of small domes is between 7.5 lx and 10 lx and the big dome is between 10 lx and 20 lx. On the surfaces of facades, this level reaches to 30 lx.

As to the Islam Culture Centre, a lighting plan in harmony with the cultural characteristics of the building is prepared. Facades and windows are made visible by means of lighting tools embedded in the land at certain intervals. The lighting highlights and emphasizes the entrances. It is aimed to enhance the perception of entrances at nighttime through LEDs placed at the door entrances and inner welcoming halls. The lighting applied to the roof ensures the perception of the detail's layer; the stars. While the average illuminance level of the front facade is around 20 lx, the illuminance level

Fig. 2. Integrated modelling images through the street of the zone lighting design

of side facades is a maximum of 7.50 lx. This level varies between 3 lx and 7.50 lx at the roof.

The lighting plan for Mevlana Culture Centre aims to make visible the roof that is in the shape of a cone. In addition, entrance and surfaces of facades are made visible and circulation areas are emphasized. In the lighting of Mevlana Culture Centre, the facade surfaces facing the road have a maximum illuminance level of 30 lx. The illuminance level of the roof in the shape of a cone varies between 5 lx and 10 lx. The illuminance level of the structures that remain in the back of the road is lower than of those that face the road.

As to the lighting of Hacıveyis Mosque, the illuminance level of the facades that are more simple and plain is kept low. The attention is paid to the visibility of the mosque's roof, minaret and fountain. The same principle is applied also to the Culture House. Consequently, in Hacıveyis Mosque and Culture House; the average illuminance level of the facade surfaces varies between 5 lx and 7.50 lx. This level is 3 lx on the dome and 7.50 lx on the minaret balcony. Images of integrative modelling from the road of the zone lighting design are presented in Table 3.

As a result of these studies, the impact created by zone lighting on the models from a holistic perspective was examined and evaluated. The images presented in Fig. 2 belong to the final design. However, main design decisions have been revised many times until these results were obtained.

5. RESULTS

After master lighting plans of cities are prepared, zone lighting plans should be prepared by evaluating and taking into account the lighting of buildings together with their surroundings, rather than the lighting of single buildings. If there is a historical or cultural centre in the area, a hierarchical order should be established. When taking decisions regarding zone lighting, public transport lines should be evaluated along with buildings in the city. The lighting of such places should be done in compliance with the standards of road lighting.

At this point, Mevlana Museum and Konya Culture Centre which developed and expanded the tourism axis in the city were examined and accordingly a lighting design that would contribute to further development of the region was made. A systematic proposal is developed, instead of the previous lighting approach, which was causing light pollution by lighting only transport axis and buildings in an inordinate way. In order to create the same effect of daytime, the details seen on facades by day were highlighted through plain lighting, similar to the daylight. In this way, this axis as a Culture Valley would contribute in a positive way to the image of the city.

One of the main reasons why such lighting decisions are not taken with a holistic approach in cities is that these places are under the responsibility of different institutions or individuals and lighting is not evaluated from the perspective of urban identity. At this point, the municipalities should conduct studies for specific regions and set down limits for the lighting of buildings. The lighting of a city should not be considered only as of the lighting of streets, in fact, a holistic approach should be developed. Afterwards, the building owners should submit their lighting plans to the municipalities and obtain approval. Lighting plans should also be add-

ed as an important input to street reinforcement projects.

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