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Evaluation of Urban Park Lighting Using Quantitative and Qualitative Methods: A Case Study of Trabzon in Turkey[1]

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Abstract
In this study, it is aimed to reveal the quantitative adequacy of the lighting in urban park areas and the effects of the users on the usage situations of the spaces. In this direction, both quantitative and qualitative methods were used and analyzes were made by developing a different perspective in the study. In the study, in which fieldwork, measurements and observation technique were used together, Meydan Park and Atapark, which are two parks on the same transportation axis, were selected as the study areas and a pilot study was conducted in Trabzon. Of these two parks, Meydan Park is illuminated using the latest lighting types and techniques suitable for today's technology, while Atapark has older types and techniques. As a result, it was seen that these modern and classical lighting differences did not have the expected positive effect on modern techniques. In addition, when lighting techniques are evaluated based on the literature in terms of different spatial components and elements of parks, it has been concluded that the feasibility of different activities is related to lighting. With the observations made at different times, the changing user densities and the continuity of activity day and night were examined. The results showed that the day-night activity continuity changed in parallel with the lighting situation for both parks and the lighting types and techniques were not compatible with the current uses.
Keywords: Lighting, urban park lighting, quantitative and qualitative methods, Trabzon.

1. INTRODUCTION

Light, which is the basic tool in the realization of the act of seeing, is a phenomenon that enables us to perceive the outside world and define objects, and enables us to experience the visual world (Öztürk, 1992; Egan and Olgyay, 2001). Light is provided by an artificial light source in case natural light is not sufficient. The purpose of artificial lighting is to make objects visible at night as well as during the day and to provide conditions close to natural light (Sözen, 2000; Raine, 2001; Şahin, 2011). At the beginning of humanity, from candles and oil burning to the 18th century, daylight was the most basic light source, while artificial light sources entered our lives with the development of techniques and tools (Ganslandt and Hoffmann, 1992; Zelinsky, 2006). The emergence of artificial light sources has brought lighting concepts with it (Sözen, 2000; Şahin, 2011). The concept of illumination can simply be defined as the measurement in lux of the amount of light falling on a certain surface area emitted by the light source (Descottes and Ramos, 2013). With the expansion of the concept of lighting, many scientists have made experiments and developed inventions to illuminate the city and streets. In the last quarter of the 18th century and the first quarter of the 19th century, French, British,

Belgian and German scientists worked feverishly to illuminate the cities (Mazak, 2007). The development of artificial lighting and modern lighting, which was one of the greatest technological achievements of the second half of the 20th century, repulsed the darkness in the cities and changed the meaning of the night significantly and added a new beauty to the cities with lighting (Myerson and Katz, 1990; Brandi and Geissmar-Brandi, 2006; Schreuder, 2008). At the end of the 20th century, life in cities accelerated, this situation increased the expectations of the citizens about the city and a demand for a better quality life in public spaces emerged (Sözen, 2000; Brandi and Geissmar-Brandi, 2006; Şahin, 2011). So much so that urban lighting is considered as a basic infrastructure in developed countries. In this direction, the concept of urban lighting has an increasing importance today (Davoudian, 2019).

Urban parks are open spaces with different functionalities. They take on a binding task between differing uses. With the transfer of green areas, which were once located in large areas on the outer periphery of the city, to the city center, these areas have become a factor that strengthens social life, rather than just being a green area (Emür and Onsekiz, 2008; Özdemir, 2009). The beautiful views that the parks reveal during the day are due to the park elements that make the parks qualified. On the other hand, the night views of cities with suitable lighting systems can be much more interesting, mysterious and magnificent than during the day.

The contribution of night perceptions is great in revealing the ecological, functional and aesthetic functions of urban parks in the city. In this context, a good and correct lighting that reveals these functions will make positive contributions in terms of engraving the city into memories with night images and creating the urban identity with the visual ambiance to be created. As a matter of fact, according to Egan and Olgyay (2001), the properties of light, the awareness of observer experiences are essential in understanding the world of illumination.

From this point of view, in this study, it is aimed to reveal the quantitative adequacy of the lighting made in urban park areas and the effects of the users on the usage situations of the spaces. In this direction, both quantitative and qualitative methods were used and analyzes were made by developing a different perspective in the study. In the study, in which fieldwork and measurements and observation technique were used together, Meydan Park and Atapark, which are two parks on the same transportation axis, were chosen as the study areas. Of these two parks, Meydan Park is illuminated using the latest lighting types and techniques suitable for today's technology, while Atapark has older types and techniques. The effects of this difference were questioned in the study.

1.1. Overview of the Concept of Lighting

Light, which shapes our biological rhythm thanks to our eyesight, is of vital importance for human beings. Light is also a very important design element in architectural planning. Natural and artificial lights, which are an important part of social life, make the best use of an area (Skowranek, 2017; Davoudian, 2019). Lighting principles are a complex combination of art and science, technical knowledge, and emotional perception (Myerson and Katz, 1990). In the lighting technique, very comprehensive scientific data and information ranging from the visual characteristics of the human eye, the various properties of light sources, lamps and skylights, the light reflection and transmission properties of surfaces and materials, aesthetic and architectural concepts, various measurement techniques, and quite complex calculation forms are used (Sirel, 1993).
Lighting design can be defined as the creation of an original lighting scheme that not only depends on the lighting technique, but also constructs the artistic and architectural dimension (Öztürk, 2006). In addition to the technical application and calculation of lighting in architecture, the relationship between the object exposed to light and the environment is handled with an understanding of aesthetic concern, and it offers a holistic solution by using technology in an integrated manner with aesthetics (Şahin, 2012; Halıcıoğlu et al. 2007; Skowranek, 2017). A good architectural lighting is achieved

by successfully evaluating the visual and psychological perception of the human being (Mills, 2018). In this context, it is primarily important to provide visual comfort conditions. Visual comfort in lighting can only be realized when psychological and physiological comfort are together. This can be possible with quality lighting (Manav, 2005; Şahin, 2012). So a good lighting design encompasses flexibility and quality, not just quantity (Lechner, 2014). "Quality lighting is a lighting designed to meet the physiological needs of people as well as their psychological needs". The concept of quality lighting, which examines the spectral sensitivity of the light source used, the color temperature, the direction of the light and the uniformity of the illumination, should consider the effects of these characteristics of the light on the users as a design problem. (Manav, 2005). The main components affecting the lighting quality are shown in Figure 1.

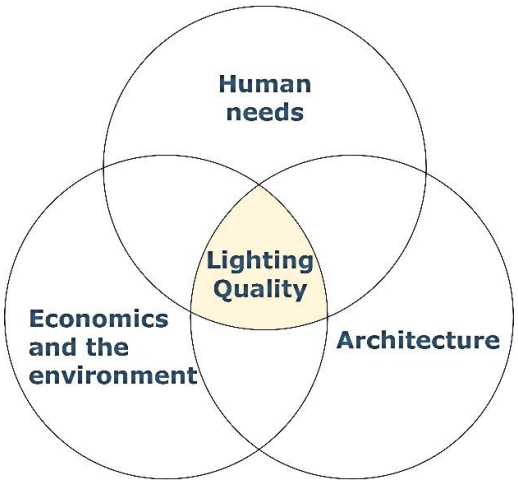


Figure 1. Diagram of the components that make up the lighting quality (IESNA, 2000).

1.2. The Role of Lighting in the Perception of Urban Space

Outdoor lighting has both a functional and aesthetic consideration and has become a professional field in recent years (Lechner, 2014; Skowranek, 2017). Lighting is very important in terms of urban planning and landscape design. So much so that the terms of the lighting master plan, urban lighting concept have emerged in the discussions with the future of cities in recent years (Brandi and Geissmar-Brandi, 2006). Especially since the beginning of the 21st century, urban lighting master plans have attracted more and more attention with the effect of many factors such as developments in lighting technology and branding of cities (Davoudian, 2019).

According to Gemalmaz (2008), the formation of urban image and mental maps of the city can be realized by perceiving the day and night image of the city. Urban elements, which are made visible by a natural light source during the day, can be made visible at night with the help of artificial light sources. In this direction, the importance of artificial light to be used at night in the formation of the perception of urban space emerges.

With urban lighting, it is aimed to ensure safety, security and human welfare in cities, to prevent crime, to recognize the environment and to find a way-direction-place, to realize outdoor activities, to enrich the cities economically and aesthetically, and to create a city identity. While the structural and artistic values that reflect the past and cultural accumulation of the cities are visible in all their splendor during the day, they deprive the city of all its beauties when it gets dark. They need to be illuminated so that their presence can be seen at night (Sözen, 2000; Öztürk 1992; Schreuder, 2008; ILE, 2005; Brandi and Geissmar-Brandi, 2006). In addition, there are indirect contributions to urban lighting with commercial showcase and advertising lighting (Sözen, 2000).

With the development of different light sources, the need to control insufficient or excessive amount of light in illumination has been faced. Thus, experts started to work

on determining how much light is needed for which situations and which lighting forms should be applied. Thus, standards have been developed (Ganslandt and Hoffmann, 1992). The standard measurement for lamps is lumen. The amount of illumination provided by a lamp is measured in lux, which is the number of lumens per square metre. Indicated by lighting standards, codes and recommended lighting levels (lux) around the world (Raine, 2001; Cuttle, 2015).
There are leading global organizations on lighting technical issues such as CIBSE (Society of Light and Lighting (SLL)), IALD (International Association of Lighting Designers) and IESNA (Illuminating Engineering Society of North America) worldwide (Steffy, 2002). The illuminance level values determined by IESNA for different elements and spaces in order to provide visual comfort in lighting and to ensure that users can move safely are given in Table 1.

Table 1. Illuminance level values for different area or activity types (Harris and Dines, 1988).

Area/activity	Outdoor facilities	Lux (lx)
Bikeways and walkways	Bikeways	5
	Park walkways	5
	Pedestrian tunnels	20
	Pedestrian overpasses	2
	Pedestrian stairways - Light surfaces - Dark surfaces	 200 500
	Path, steps away from home	10
Planting materials	Backgrounds, fences, walls, trees, shrubbery	20
	Flower beds, rock gardens	50
	Trees, shrubs	50
Other	Parking areas	20
	Playground	50
	Building exterior Entry - Active use - Locked or infrequent use Building surrounds	 50 10 10
General lighting		5

2. MATERIAL AND METHOD

2.1. Material

Meydan Park and Atapark, which constitute the main material of the study, are located in the central district of Trabzon province. Trabzon is a city established in the Eastern Black Sea region between 40-33 and 41-07 north latitudes and 39-07 and 40-30 east longitudes, on the coast of a natural port of the Black Sea, at the beginning of the transit route to Asia and the Middle East. Trabzon province, with a surface area of 4685 km^2, covers 0.6% of the country's territory. Trabzon province is surrounded by Rize in the east, Bayburt in the southeast, Gümüşhane in the south, Giresun in the west, and the Black Sea in the North (Anonymous, 2014; Kızılaslan, 2007). Among the study areas, the boundaries of Meydan Park are Gazipaşa Street in the west, İskele Street in the north, and Uzun Street in the south. On the eastern border of Meydan Park is the old town hall and other structural elements used for commercial purposes. Atapark is bordered by Şenol Güneş Avenue in the east, Lütfullah Street in the west, İnönü Avenue in the north and İnönü Avenue (Tanjant Avenue) in the south (Figure 2).

Plans of Meydan Park and Atapark, maps, satellite images, graphics, various charts, diagrams, books, photographs taken regularly using Fujifilm HS30 Digital camera from study areas, measurements made with CEM DT-86 Digital Mini Luxmeter in study areas, field studies review notes, visualizations of areas prepared in Adobe Photoshop CS4 program, etc. Documents are other materials used in the research.

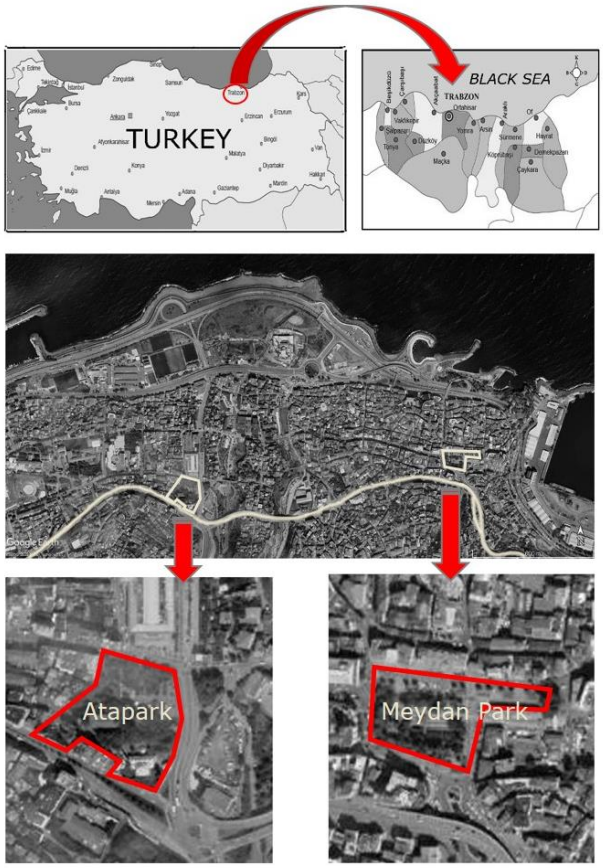


Figure 2. Study areas

Meydan Park is established on an area of 5400 m^2 and includes sitting and resting areas, walking axes, and the ceremonial area where the Atatürk Sculpture is located. Atapark was established on a total area of 7767 m^2 with 4939 m^2 of firm soil area, 2115 m^2 of net green area, 4939 m^2 of firm soil area used by business firms, 72 m^2 of flowerbeds and 713 m^2 of children's playground (Kızılarslan, 2007). When the historical processes of these parks are examined, it has been observed that they have been used as parks since the earliest times of the city of Trabzon (Aksoy, 2005; Doğan, 2009). The characteristics of the parks in terms of location, access and use have given these parks the characteristic of being urban. Today, Meydan Park is a transition area that provides access to other points of the city, a gathering point, an area that allows recreational activities such as sitting-resting, watching and eating-drinking. Figure 3 shows some recreational activities held in Meydan Park. Atapark strengthens its location with the presence of important structural elements such as mosques and libraries, which have great value and functions for the city, and these urban elements play a major role in determining the area uses and users of the park. Atapark offers recreational activities such as sitting and resting, eating and drinking, ceremony, children's playground and entertainment, watching the visual landscape value created by the green texture, water areas and some animals. Figure 4 shows some recreational activities held in Atapark.

Figure 3. (a) Watching and entertainment light and water shows, (b) eating and drinking, (c) sitting-resting and (d) Ceremony area in Meydan Park (from left to right)

Figure 4. (a) Watching and sitting at the light and water shows, (b) Children's playground and entertainment, (c) eating and drinking and (d) ceremony area in Atapark (from left to right)

2.2. Method

The basic fiction on which the study is based includes interconnected studies carried out in various steps. The method consists of the following steps (Figure 5).

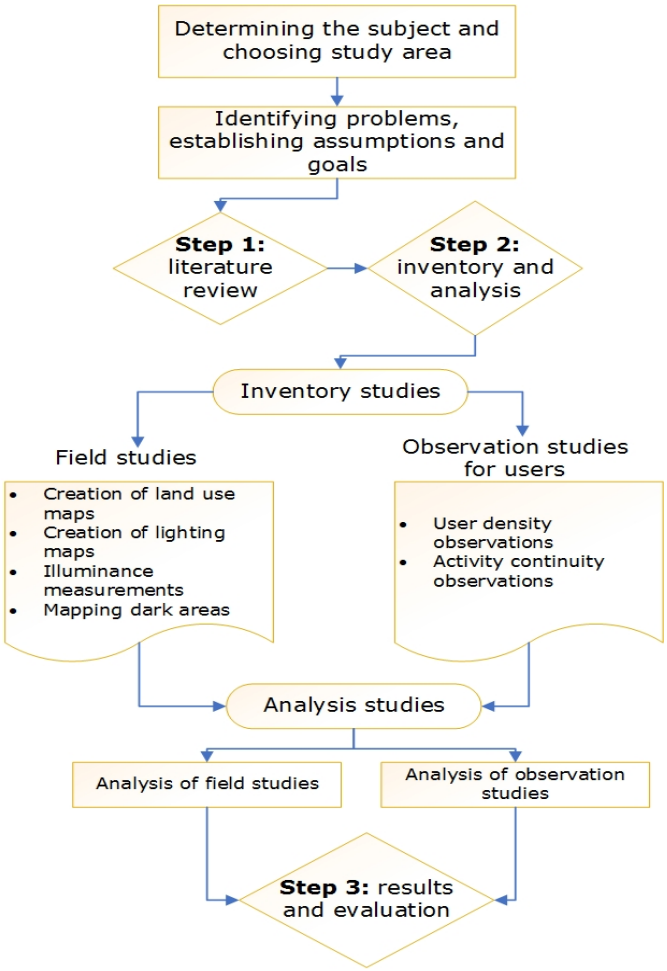


Figure 5. The conceptual framework of the study and the flow chart of the method

2.2.1. Identifying Problems, Establishing Assumptions and Goals

Within the scope of the study, the problems identified in the fields of study are listed below:

- Day and night activities are not continuous in terms of providing good vision conditions, which is the main purpose of lighting,
- The lighting is not suitable for differentiating activities,
- Lighting is insufficient to provide physiological and psychological comfort,
- The techniques that should be applied in the lighting designs of parks, which are among the urban outdoor spaces, are not taken into account in the applications,
- Lack of awareness about the benefits that the visual quality value of night lighting, which is one of the important parts of the city, will bring to the city and the citizens.
- Lack of public awareness of the positive contributions of good lighting,
- Safety and security, which are the most important of the lighting purposes of the parks, cannot be achieved due to insufficient lighting levels,
- The lack of aesthetics in the lighting design and planning of the parks, which are among the most important open green spaces that reveal the urban identity,
- Insufficient illuminance of the areas in the parks, differences and limitations between day and night use and users.

Based on the basic assumption that "In order to reveal these problems and to offer suggestions that can be a solution to these problems, the lighting criteria of urban parks can be examined by performing field studies and user observations in two sample urban park areas, and analyzing the data to be obtained as a result of these studies";

Hypothesis 1: "If the study areas are classified in terms of different spatial components and elements and evaluated in terms of lighting techniques based on the literature, the relationship between the feasibility of the activities and the lighting can be examined", Hypothesis 2: "If the areas are observed at different times, varying user densities and day-night activity continuities can be examined" the hypotheses listed as follows have been tested with field studies and user-oriented observation studies.

2.2.2. Inventory and Analysis

2.2.2.1. Inventory Studies

In order to reveal the current status of the study areas, field studies and observation studies for users were carried out in the study areas.

2.2.2.1.1. Field Studies: Field studies were carried out to see the current situations in Meydan Park and Atapark, which are the study areas. Both parks are divided into zones according to their current land use. After the zoning study, all kinds of values, area uses, lighting elements, measurement studies for the determination of the light situation, light and dark areas were examined.

2.2.2.1.2. Observation Studies for Users: Observation studies were carried out in order to determine the area usage densities according to the area usage determined for the parks by the users of the mentioned parks. Yaman (2007) stated that the lighting design in outdoor lighting systems is difficult due to reasons such as equipment selection, different luminaire structures, excessive external factors, light distribution curves of luminaires and different reflection coefficients of the areas to be illuminated, and mentioned that it is difficult to accurately match the calculation results in outdoor lighting. For this reason, the researcher emphasized that the density of movement in the areas to be illuminated should be known and the appropriate level should be selected. Yenioğlu (2010) advocated that the density difference between day and night use in the activity areas in the park should be taken into account and the lighting design should be made accordingly. In line with this literature information, it was concluded that it is important to observe the area usage densities in the analysis of the lighting designs in the study areas and the observation technique was applied.

Observation technique, which is one of the oldest and most basic research methods, has a very strong validity claim. It deals with human behavior to the extent that it is observable and objective (Adler and Adler, 1994; Gillham, 2008). Observation is to record the behavior of individuals by observing them in a plan. Observation technique is used when it is necessary to investigate the behavior of individuals in their natural environment. This technique involves collecting data in a systematic and meaningful way (Smit and Onwuegbuzie, 2018). While many people answer questions about themselves as they want to appear, the technique of observation reveals what is. In the study, the observation technique was applied in the study, since this neutral and controlled determination of the observation technique will express the uses and users in the most accurate way.

In the observation study, in order to evaluate the variability of the situations in a controlled manner and to make the determinations in a healthy way, the study areas were visited at regular intervals. The studies were carried out between 18:00-20:00, 20:00-22:00 and 22:00-00:00 in June, July and August 2013, during the summer period when the use of the park is most intense due to the favorable environmental conditions.

2.2.2.2. Analysis Studies

2.2.2.2.1. Analysis of Field Studies: With the field study, the area uses in Meydan Park and Atapark were determined, the lighting elements were determined, measurement studies and the determination of the light-dark areas were carried out to reveal the amount of illumination of the areas.

Plans obtained from Trabzon Municipality Parks and Gardens Directorate were used to determine the lighting elements in the parks. The lighting plan and detail sheets for Meydan Park could be obtained, but there is no plan for Atapark lighting. For this reason, in order to create the lighting map, the corner point of the park was taken coordinates on the construction plan of Atapark, the locations of the lighting elements were determined by means of a steel tape measure and the lighting map was created by processing on the plan. Illuminations were evaluated on the basis of activities by revealing the activities carried out in the areas.

Measurement studies to determine the illuminance levels in the study areas were carried out at many points, separately in each activity area. The measurements were carried out according to the condition of the elements in the areas, on the ground, on the surface and parallel to the ground. Measurements were made in August 2013 between 19:00 and 00:00.

In the light of all these determinations, land use maps, lighting maps, and dark area maps were created and analyzed.

2.2.2.2.2. Analysis of Observation Studies for Users: The study areas were visited in the last two weeks of June, July and August 2013 on a daily basis and alternately on Mondays, Tuesdays, Wednesdays, Thursdays, Fridays and Saturdays. In order to analyze the variability of user density and activity continuity according to different space uses at different times, three sets of observation and photographing studies were conducted between 18:00-20:00, 20:00-22:00 and 22:00-00:00. Usage densities in the areas determined by zoning in field studies were recorded daily at 18:00-20:00, 20:00-22:00 and 22:00-00:00 hours intervals. A user observation chart has been created in order to systematically record the determinations hourly, daily and monthly.

User density was recorded as "high density", "medium density" and "low density" according to the number of people density in each zone at the specified hour intervals. The classification of these densities was carried out by determining the number of people per m^2 at the time intervals determined in each activity area. Since the parks are visited on a rotational basis (Monday-Wednesday-Friday in the first week and Tuesday-Thursday-Saturday of the second week), 6-day records were created for each month. These 6-day records were analyzed and monthly results were obtained. The analyzes were made by adding and averaging the scores of the statements recorded with the expression "high density" as 3, "medium density" as 2, and "low density" as 1 point.

Continuity of activity was recorded as "Activity continues", "Activity is changing", "Activity is partially ongoing" and "No activity", according to the status of the activity at the specified time intervals in each zone. Similarly, the analyzes were made by adding and averaging the scores of the statements recorded by accepting the statement "Activity continues" as 4, "Activity is changing" as 3, "Activity is partially ongoing" as 2, and "No activity" as 1 point. In this way, general determinations could be made from the records made on the density of users and the continuity of activities within the zoned areas.

3. FINDINGS AND DISCUSSION

3.1. Findings Related to Analysis of Field Studies

3.1.1. Findings Concerning the Analysis of Area Uses

When the parks, which have different uses and activities in field studies, are evaluated in terms of uses and activities;

- In Meydan Park, roads and stairs with pedestrian and vehicle circulation, open and semi-open sitting areas, historical buildings and businesses in the immediate vicinity, a show platform where light and water shows are exhibited (it is also used as a ceremonial area), light and water shows are exhibited, ornamental pools, Atatürk Sculpture, TS and Eyof 2011 emblem and plastic

objects placed in the area on the days of important organizations and planting areas were included.

- In Atapark, there are walking paths with pedestrian circulation, open and semi-open sitting areas, children's playground and animal cages for children, an ornamental pool where light and water shows are exhibited, a ceremony area with Atatürk Sculpture and historical cannon, Serander and planting areas.

With these determinations, land use maps of the study areas were created (Figure 6).

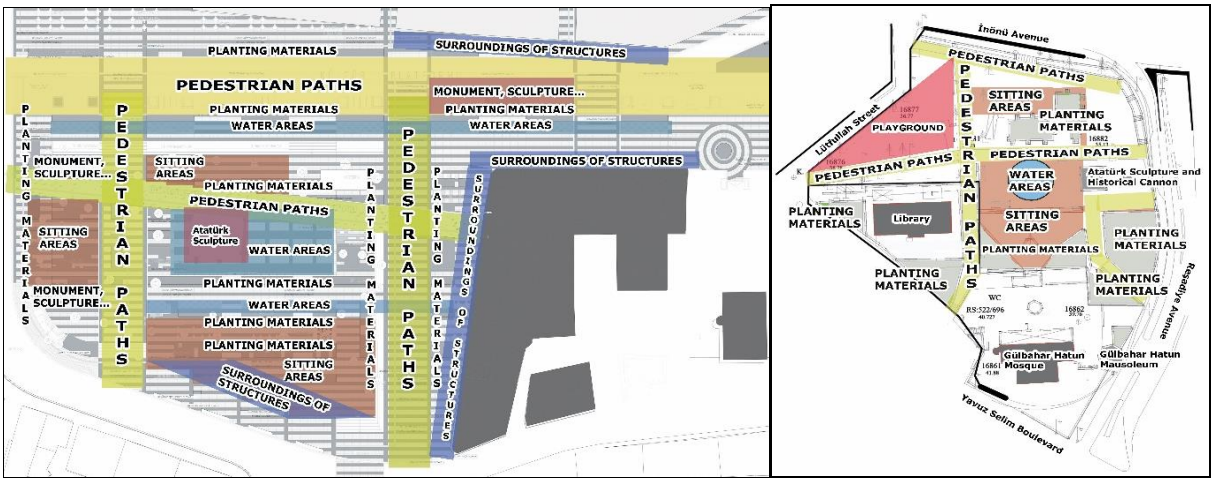


Figure 6. Land use maps of Meydan Park and Atapark

3.1.2. Findings Regarding the Analysis of Lighting Elements

There are projector lighting (7 m), park lighting (4 m), green area lighting (92 cm) and ground lighting in various sizes in Meydan Park. In Atapark, on the other hand, tall lighting elements are generally used, and there are single, double and triple lighting elements. In addition to these, there are led lamps randomly wrapped around the trees, especially in the planting areas around the sitting areas. The lighting maps of Meydan and Atapark are given in Figure 7.

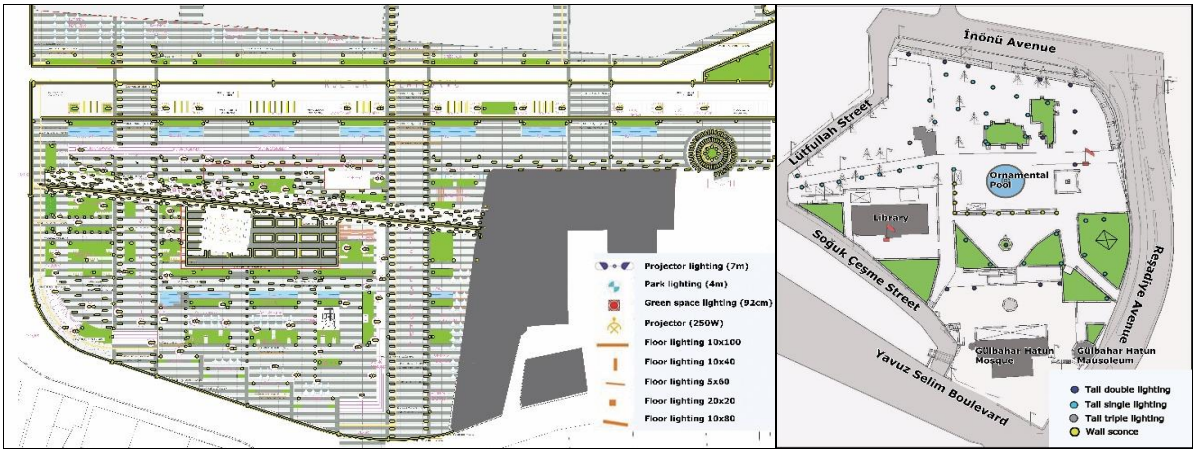


Figure 7. Lighting maps of Meydan Park and Atapark

3.1.3. Findings Concerning the Analysis of Illuminance Measurements

3.1.3.1. Findings Related to Measurement Studies

Measurement studies to determine the illuminance levels in Meydan and Atapark were carried out at 52 points in Meydan Park and at 86 points in Atapark, separately in each activity area (Figure 8). The measurements are according to the condition of the items in the fields; ground, surface and parallel to the ground and the measurement results are given in Table 2-3.

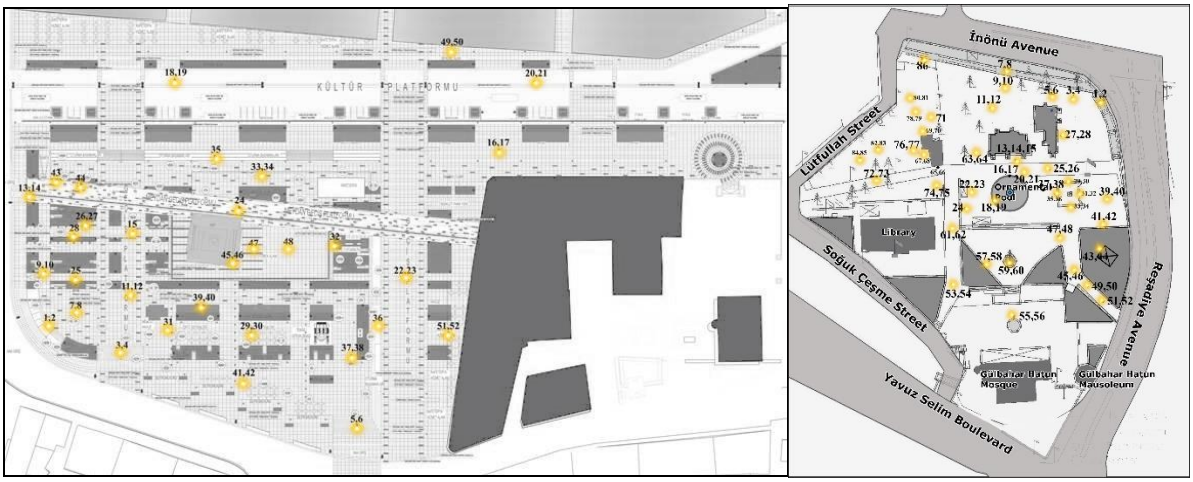


Figure 8. Measurement points map of Meydan Park and Atapark

Table 2. Meydan Park measurement results

Measurement Point	Location of Measurement Point	Height of Measuring Point (m)	Illuminance Level (lx) (min-max)	Explanation
1-6	Stairways	0, 1.5	1.6-4.4	Ground, Parallel to the ground
7-8	Around the stairways	0, 1.5	1.4-3.1	Ground (under the lighting post), Parallel to the ground
9-24	Pedestrian path	0, 1.5	0.1-44.0	Ground, Ground (under the lighting post), Ground (between two lighting post), Parallel to the ground
25	TS emblem	0.7	4.4	Surface
26-38	Sitting areas, Around the sitting areas	0, 0.45, 0.7, 1.5	0.2-61.0	Surface, Surface (on bench), Surface (above the table), Surface (on the stair), Ground, Parallel to the ground
39-40	Ornamental pool	0.7, 1.5	1.1	Surface, Parallel to the ground
41-42	Business firms	0, 1.5	0.3	Ground, Parallel to the ground
43	Information board	1.5	18.0	Surface
44	Around the fountain	0.7	3.3	Surface
45-46	Atatürk Sculpture	0.45	0.0-16.7	Surface, Surface (front of the armature)
47-48	Water and light shows area	0, 1.5	0.3-0.7	Ground, Parallel to the ground
49-52	Surrounding of constructions	0, 1.5	0.6-2.0	Ground, Parallel to the ground

Table 3. Atapark measurement results

Measurement Point	Location of Measurement Point	Height of Measuring Point (m)	Illuminance Level (lx) (min-max)	Explanation
1-2, 7-8, 47-48	Stairways	0, 1.5	0.0-14.2	Ground, Parallel to the ground
3-6, 9-10, 45-46, 49-54, 72-73	Pedestrian path	0, 1.5	0.1-30.0	Ground, Ground (under the lighting post), Ground (between two lighting post), Parallel to the ground, Parallel to the ground (between two lighting post), Parallel to the ground (front of the lighting post)
11-12, 57-60	Sitting area	0, 0.45, 0.7, 1.5	9.3-20.0	Surface (on bench), Surface (on the table), Ground (under the lighting post), Parallel to the ground, Parallel to the ground (under the lighting

				post)
13-15	Clock tower	0, 0.7, 1.5	0.1-0.2	Surface, Ground, Parallel to the ground
16-23	Around the ornamental pool	0, 0.7, 1.5	0.1-13.8	Surface (on the table), Ground, Parallel to the ground
24	Plant	1.5	1.3	Parallel to the ground
25-26, 65-71	Around the business firms	0, 1.5	0.0-63.0	Surface, Ground, Parallel to the ground
27-28, 41-42	Bench	0, 1.5	0.0-1.1	Surface (on bench), Ground, Parallel to the ground
29-38	Atatürk Sculpture	0, 0.7, 1.5	0.0-3.2	Surface, Ground, Parallel to the ground
39-40	Historical cannon	0.7, 1.5	0.6	Surface, Parallel to the ground
43-44	Serander	0, 1.5	1.3-1.8	Ground, Parallel to the ground
55-56	Mosque	0, 1.5	4.4-7.5	Ground, Parallel to the ground
61-62	Library	0, 1.5	0.1	Ground, Parallel to the ground
63-64	Around the pergola	0, 1.5	1.7-3.5	Ground, Parallel to the ground
74-75	Around the animal cages	0.7, 1.5	0.2-0.9	Surface, Parallel to the ground
76-85	Children's playground	0, 1.5	0.1-6.7	Ground, Ground (under the lighting post), Parallel to the ground, Parallel to the ground (under the lighting post),
86	Fountain	0.7	1.2	Surface

3.1.3.2. Findings Regarding the Detection of Dark Areas

As a result of the measurement studies for Meydan Park and the observations in the field, it has been revealed that some areas in the park are not sufficiently illuminated. When the results are examined, it is seen that the measurement results at 41-42 measurement points made parallel to the ground and in front of the business firms located in the southern part of the park are 0.3 lux. Similarly, at the measurement points 5-6 on the stairs, the illuminance levels were measured as 2.7 and 1.6 lux, with the measurements carried out parallel to the ground and the ground. It has been observed that these values are far from the 5 lux value that should be on the pedestrian paths. The results at measurement points 16-17, on the other hand, were measured as 6.2 and 6.3 lux, but were very close to the limit value and were found to be insufficient due to the environmental conditions.

As a result of the measurements made for Atapark, it was determined that some areas were not sufficiently illuminated. When the results are examined, it is seen that the results vary between 0.1-6.7 lux at the measurement points 76-85 in the children's playground. However, it is known that the sufficient illumination level in children's playgrounds should be 50 lux. Similarly, the values of the Atapark the measurement points between 30-40 in the area where the Atatürk Sculpture and historical cannon are located are between 0.0-3.2 lux and below the general illumination level of 5 lux. The dark areas map of Meydan Park and Atapark, created in line with these results, is shown in Figure 9.

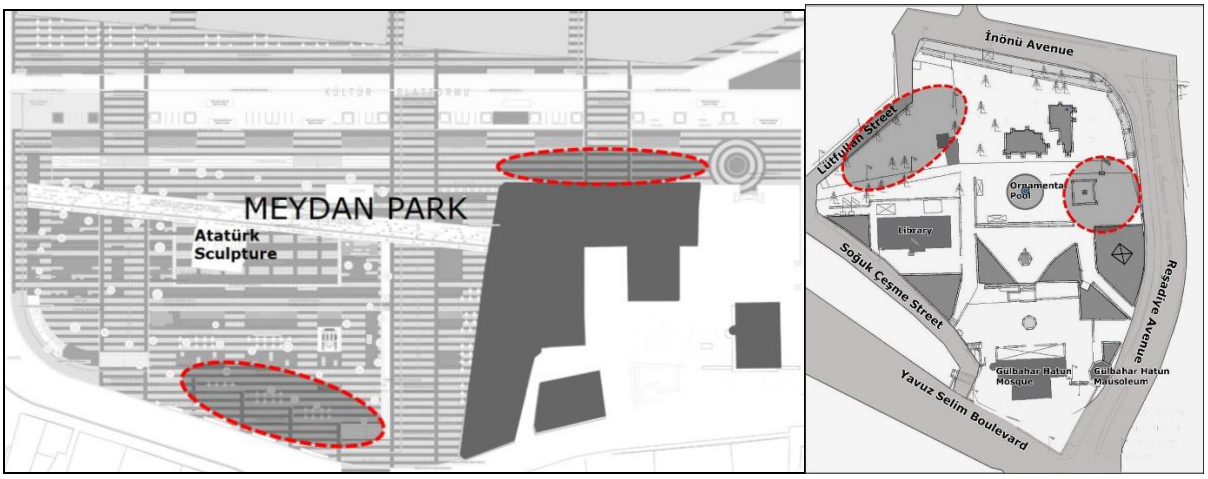


Figure 9. Dark areas map in Meydan Park and Atapark

3.2. Findings Regarding the Analysis of Observation Studies for Users

Daytime observations of user density and activity continuity in Meydan Park and Atapark were made before the lighting elements were active. Monthly determinations were made from daily daytime determinations by obtaining monthly results from daily values. Then, the results were analyzed and the maps revealing the general situation were prepared. Maps of the results are shown in Figure 10.

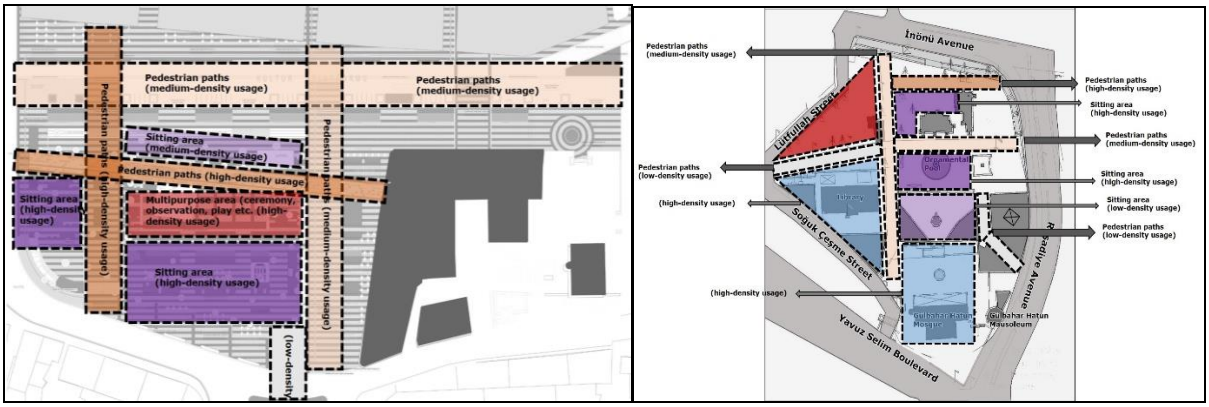
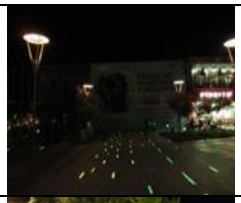
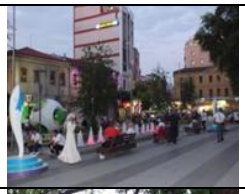


Figure 10. Daytime density map for Meydan Park and Atapark according to activity areas

In the working areas divided into zones according to the differing uses, monthly determinations were made from the observations of user density and activity continuity, and monthly results were obtained from daily values.

For Meydan Park, the averages of user density and activity continuity according to the observations in June are given in Table 4. According to the results, it is observed that the average user density in the pedestrian path and stairs, surrounding of constructions, water areas, sculpture, historical artifacts and plastic objects zones decreased as the hour progressed, while the user density in the sitting areas and planting areas zones is moderate. This is a result of the correlation of uses in these zones.

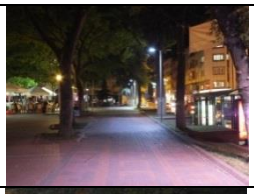
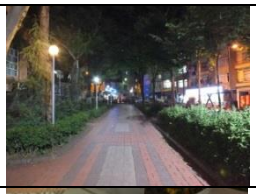
Table 4. Average values of the user density and activity continuity observations of Meydan Park for the month of June

		Time period 18:00-20:00			Time period 20:00-22:00			Time period 22:00-00:00		
		Photo*	UD	AC	Photo*	UD	AC	Photo*	UD	AC
Activity Areas	PS		● ● ●	□ □ □ □		● ●	□ □ □ □		●	□ □
	SA		● ● ●	□ □ □ □		● ●	□ □ □ □		● ●	□ □ □ □
	SC		● ●	□ □ □ □		●	□ □ □ □		●	□ □
	WA		● ●	□ □ □ □		● ●	□ □ □ □		●	□ □ □ □
	SH		● ●	□ □ □ □		● ●	□ □ □ □		●	□ □
	PA		● ● ●	□ □ □ □		● ●	□ □ □ □		● ●	□ □ □ □

PD: Pedestrian paths and stairs, SA: Sitting area, SC: Surrounding of constructions, WA: Water areas, SH: Sculpture, historical artifacts and plastic objects, PA: Planting areas, ● : Low density, ● ● : Medium density, ● ● ●: High density, □ :No activity, □ □: Activity is partially ongoing, □ □ □: Activity is changing, □ □ □ □: Activity continues, * Photos are representations of a moment in the specified time intervals.

The averages of user density and activity continuity for Atapark according to the observations in June are given in Table 5. According to the results, it is seen that the average user density in the pedestrian path and stairs, sitting areas, children's playgrounds, sculpture, historical artifacts and plastic objects zones decreased as the hour progressed, while the average user density in the water areas and planting areas zones was moderate. This change in the sitting areas from these zones can be explained by the concentration around the water areas. In addition, this parallel change in ornamental pool and planting areas is a result of the related uses in these areas.

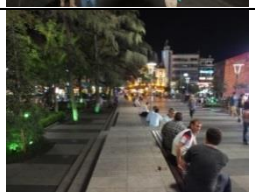
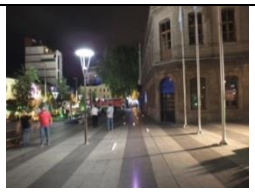
Table 5. Average values of Atapark's user density and activity continuity observations for the month of June

		Time period 18:00-20:00			Time period 20:00-22:00			Time period 22:00-00:00		
		Photo*	UD	AC	Photo*	UD	AC	Photo*	UD	AC
Activity Areas	PS		● ●	□ □ □ □		●	□ □		●	□ □
	SA		● ●	□ □ □ □		●	□ □		●	□ □
	CP		● ● ●	□ □ □ □		● ●	□ □ □ □		●	□ □
	WA		● ●	□ □ □ □		● ●	□ □ □ □		● ●	□ □ □ □
	SH		●	□ □		●	□ □		●	□
	PA		● ●	□ □ □ □		● ●	□ □ □ □		● ●	□ □ □ □

PD: Pedestrian paths and stairs, SA: Sitting area, CP: Children's playground, WA: Water areas, SH: Sculpture, historical artifacts and plastic objects, PA: Planting areas, ● : Low density, ● ● : Medium density, ● ● ●: High density, □ :No activity, □ □: Activity is partially ongoing, □ □ □: Activity is changing, □ □ □ □: Activity continues, * Photos are representations of a moment in the specified time intervals.

The average user density and activity continuity for Meydan Park according to the observations in July are given in Table 6. Looking at the results, it is seen that the usage areas in the activity areas are concentrated in the sitting areas, water areas and planting areas zones between 18:00 and 20:00 in July. The low density in other zones is a result of being in Ramadan on the observed dates. It is seen that the areas concentrated between 20:00 and 22:00 are sitting areas, water areas, planting areas and surrounding of constructions. This is a result of the eating and drinking activity taking place between these hours. Between 22:00 and 00:00, it is seen that the usages are concentrated in the sitting areas and planting areas zones. This is a result of the interrelatedness of the uses of these areas.

Table 6. Average values of the user density and activity continuity observations of Meydan Park for the month of July

		Time period 18:00-20:00			Time period 20:00-22:00			Time period 22:00-00:00		
		Photo*	UD	AC	Photo*	UD	AC	Photo*	UD	AC
Activity Areas	PS		● ●	□ □ □ □		●	□ □		● ●	□ □ □ □
	SA		● ● ●	□ □ □ □		● ● ●	□ □ □ □		● ● ●	□ □ □ □
	SC		●	□		● ●	□ □		●	□ □
	WA		● ● ●	□ □ □ □		● ● ●	□ □ □ □		● ●	□ □ □ □
	SH		● ●	□ □ □ □		●	□ □		●	□ □
	PA		● ● ●	□ □ □ □		● ● ●	□ □ □ □		● ● ●	□ □ □ □

PD: Pedestrian paths and stairs, SA: Sitting area, SC: Surrounding of constructions, WA: Water areas, SH: Sculpture, historical artifacts and plastic objects, PA: Planting areas, ● : Low density, ● ● : Medium density, ● ● ●: High density, □ :No activity, □ □: Activity is partially ongoing, □ □ □: Activity is changing, □ □ □ □: Activity continues, * Photos are representations of a moment in the specified time intervals.

The average user density and activity continuity for Atapark according to the observations in July are given in Table 7. The results show that the zones of pedestrian paths and stairs and sculpture, historical artifacts and plastic objects were low density between all observed hours.

This situation shows that according to the results of Meydan Park, its users come to Atapark to do an activity, and Meydan Park is considered as a transition place.

Table 7. Average values of Atapark's user density and activity continuity observations for the month of July

		Time period 18:00-20:00			Time period 20:00-22:00			Time period 22:00-00:00		
		Photo*	UD	AC	Photo*	UD	AC	Photo*	UD	AC
Activity Areas	PS		●	□ □		●	□ □		●	□ □
	SA		● ●	□ □ □ □		● ● ●	□ □ □ □		● ●	□ □ □ □
	CP		● ●	□ □ □ □		● ● ●	□ □ □ □		● ●	□ □ □ □
	WA		●	□		● ● ●	□ □ □ □		● ●	□ □ □ □
	SH		●	□ □		●	□ □		●	□
	PA		●	□		● ●	□ □ □ □		● ●	□ □ □ □

PD: Pedestrian paths and stairs, SA: Sitting area, CP: Children's playground, WA: Water areas, SH: Sculpture, historical artifacts and plastic objects, PA: Planting areas, ● : Low density, ● ● : Medium density, ● ● ●: High density, □ :No activity, □ □: Activity is partially ongoing, □ □ □: Activity is changing, □ □ □ □: Activity continues, * Photos are representations of a moment in the specified time intervals.

For Meydan Park, the averages of user density and activity continuity according to the observations in August are given in Table 8. According to these results, it is seen that the average user density in the sitting areas and planting areas zones for the month of August is very density during the observation hours.

The usages in the activity areas were generally observed as medium density and high density between all observation hours, and low density surrounding of constructions.

Table 8. Average values of the user density and activity continuity observations of Meydan Park for the month of August

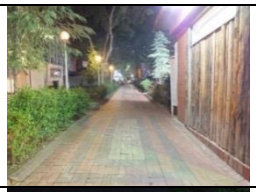
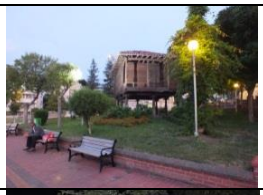
		Time period 18:00-20:00			Time period 20:00-22:00			Time period 22:00-00:00		
		Photo*	UD	AC	Photo*	UD	AC	Photo*	UD	AC
Activity Areas	PS		● ● ●	□ □ □ □		● ●	□ □ □ □		● ●	□ □ □ □
	SA		● ● ●	□ □ □ □		● ● ●	□ □ □ □		● ● ●	□ □ □ □
	SC		● ● ●	□ □ □ □		● ●	□ □ □ □		● ●	□ □ □ □
	WA		● ●	□ □ □ □		● ●	□ □ □ □		● ●	□ □ □ □
	SH		● ●	□ □ □ □		● ●	□ □ □ □		● ●	□ □
	PA		● ● ●	□ □ □ □		● ● ●	□ □ □ □		● ● ●	□ □ □ □

PD: Pedestrian paths and stairs, SA: Sitting area, SC: Surrounding of constructions, WA: Water areas, SH: Sculpture, historical artifacts and plastic objects, PA: Planting areas, ● : Low density, ● ● : Medium density, ● ● ●: High density, □ :No activity, □ □: Activity is partially ongoing, □ □ □: Activity is changing, □ □ □ □: Activity continues, * Photos are representations of a moment in the specified time intervals.

The averages of user density and activity continuity for Atapark according to the observations in August are given in Table 9. According to these results, it is seen that the user densities in the pedestrian path and stairs, sculpture, historical artifacts and plastic objects zones decreased and partially continued or did not continue for the month of August.

It is observed that the density in the water areas and planting areas zones continued high density at all time intervals. The parallel change of uses in these activity areas is a result of the interrelatedness of these activity areas.

Table 9. Average values of Atapark's user density and activity continuity observations for August

		Time period 18:00-20:00			Time period 20:00-22:00			Time period 22:00-00:00		
		Photo*	UD	AC	Photo*	UD	AC	Photo*	UD	AC
Activity Areas	PS		●	□ □		● ●	□ □ □ □		●	□ □
	SA		● ●	□ □ □ □		● ● ●	□ □ □ □		● ●	□ □ □ □
	CP		● ● ●	□ □ □ □		● ● ●	□ □ □ □		● ●	□ □ □ □
	WA		● ●	□ □ □ □		● ● ●	□ □ □ □		● ● ●	□ □ □ □
	SH		● ●	□ □ □ □		●	□ □		●	□
	PA		● ●	□ □ □ □		● ● ●	□ □ □ □		● ● ●	□ □ □ □

PD: Pedestrian paths and stairs, SA: Sitting area, CP: Children's playground, WA: Water areas, SH: Sculpture, historical artifacts and plastic objects, PA: Planting areas, ● : Low density, ● ● : Medium density, ● ● ●: High density, □ :No activity, □ □: Activity is partially ongoing, □ □ □: Activity is changing, □ □ □ □: Activity continues, * Photos are representations of a moment in the specified time intervals.

4. RESULTS AND EVALUATION

In this study, the lighting design problems in urban park areas were presented and the data obtained as a result of these studies were analyzed and evaluated by performing field studies and user observations in two sample urban park areas in order to offer suggestions that could be a solution to these problems. As a result, it has been determined that Meydan Park and Atapark, which have different lighting types and techniques, do not cause great differences in terms of safety and economy. When lighting techniques are evaluated based on the literature in terms of different space components and elements, it is concluded that the feasibility of different activities is related to lighting. With the observations made at different times, the changing user densities and the continuity of activity day and night were examined. When the results obtained in this direction were examined, it was seen that the continuity of the day-night activity changed in parallel with the lighting situation for both parks. While the activities around better illuminated water areas did not change in terms of density, it was observed that

the activity density decreased in some areas such as poorly illuminated sitting, sculptures, historical artifacts and plastic objects, while the continuity of the activity changed. It has been observed that the zoning studies and lighting types and techniques applied in Meydan Park and Atapark are not compatible with existing uses. This situation also negatively affects the use of areas and limits the time to benefit from the areas. User observations have also clearly demonstrated this situation. All these results point to the concept of lighting design. It was observed that the modern and classical lighting differences, which caused us to choose these two parks at the beginning, did not have the expected positive effect on modern techniques. This study emphasizes once again that the essential thing should be correct lighting design applications, not different lighting types and techniques. In other words, when appropriate lighting techniques are not applied to the activity areas, the feasibility of the activity will not be positively affected, no matter what element is used.

As Kurdoğlu et.al (2009) mentioned, outdoor activities provide positive contributions to people's physical, psychological and social health, social behaviors and personal skills. In this context, it is important that the activities held during the day in urban park areas can also be carried out at night. For this, parking areas should have a properly designed and sustainable lighting system in terms of function, aesthetics, safety and security, and economic and ecological functions. In this context, Sümengen et al. (2017) argued that the qualitative needs of the environment are met with the least impact, and that low-energy lighting should not result in low-quality lighting. Especially the efficient use of energy is extremely important. The light sources used should be environmentally friendly, economical and ecological. As Kurdoğlu et.al (2018) states, it is very important to ensure environmental awareness and ecological balance through effective energy use for the creation of sustainable cities. As a matter of fact, as Lechner (2014), Livingston (2021) and Bulhaz et al. (2022) emphasize, sustainable architecture and sustainable design are not an option, but a necessity, at the point where human-induced environmental problems have reached today. The destruction of natural resources, global climate change, etc. cause serious damage to the environment, and as a result of these activities, humans have to implement sustainable design for our planet and future generations. Sustainable and ecological lighting design should also fulfill functions such as promoting the environment, finding a way-direction-location, enabling the realization of outdoor activities and creating a city identity. While doing these, the lighting design should be open to the innovations and new technologies brought by our age. While doing these, the lighting design should be open to the innovations and new technologies brought by our age. Today, with interesting lighting illusions made with new technologies, important elements of the city such as bridges, city walls, historical buildings, etc. can be brought into interesting appearances. Undoubtedly, this has a positive contribution to the identity of the city. At the same time, with the lighting scenarios produced in the computer environment by means of the software for lighting used today, it is possible to calculate what kind of ambiance the areas will have before the lighting is done. These software should be used in projects and their use should be expanded. Another point is that creating virtual worlds with digitization becomes more and more interesting in the age of metaverse, where design has become valuable and important in computer technologies, artificial intelligence universe and virtual world. In the metaverse environment, day and night effective appearances will become very important in the near future.

Today, the biggest problem in lighting design is unplanned applications, as confirmed in the examples of Meydan Park and Atapark. Lighting designs cannot go beyond the effort to create an aesthetic image. This situation can cause light pollution, which is a bigger problem when the whole city is considered. As a matter of fact, light pollution has become a major concern for the ecosystem, especially in the last 10 years (Cao et al. 2022), as reported in many studies (Descottes and Ramos, 2013; Lian et al. 2021; Sung, 2022; Kaushik et al. 2022). For a correct lighting design, area uses should be revealed and plans should be made in line with special criteria compatible with these uses. The

lighting designs of urban parks should be made by the landscape architects who design the parks. In addition, it would be a correct approach to put forward the application projects as a result of a coordinated work with electrical engineers due to their expertise.

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