



Study of Light Pollution in Urban Lighting in Nisantasi Example

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ABSTRACT

To make urban identity forming components visible by making use of technologic improvements, and to make the city livable for everybody by enhancing aesthetic and charming attraction are becoming important for urban designers. Lighting is becoming an important factor to suit cities to livable places for livings in all comfort conditions. By the improvement of science and technology, to organize the life spaces of livings according to today's comfort conditions are considered more and more important. Urban lighting is affecting both the lighting comfort and livings' (humans, animal, and plants) health in many dimensions. The light used on unsuitable spot, unsuitable direction, unsuitable amount and unsuitable time is defined as light pollution. Within the scope of this study, national and international literature research related with urban lighting is done and basing criteria are identified. In the frame of these identified criteria, Nisantasi example is examined in the context of lighting pollution. Important streets and lanes and important historical and religious structures that gained a seat in public memory are identified. Designing criteria of the lighting tools existing in these identified areas and their suitability according to their spot are evaluated, and measuring their illuminance sufficiency, the issues which are detected as light pollution are stated. In conclusion, the studies done in our country are cited and the issues that are to be done to prevent light pollution are introduced as suggestion.

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1. Introduction

Even if amateur methods were used in lightings with primitive tools, lighting have been a sector by the improvement of technology, and became a professional team work. In the circumstances that vision health and comfort are disregarded, lighting may become an

inconvenience on the contrary of facilitation. In conditions such as wrong lighting apparatus applied in indoor or outdoor spaces, inaccurate adjustment of color, direction and

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intensity of the light, light pollution problem may occur. The store windows, building lightings, traffic lights and advertising boards especially on thoroughfares where shopping is intense create visual pollution in respect to both sight health and comfort, and aesthetic respect (Meier et al., 2015; Falchi et al. 2011). When the daytime lighting tools to light inside are used also in the night by the stores facing the street, a sudden light burst on the building may happen. The armatures lighting the street may be inefficient or of low intensity, and sometimes one of the two adjacent lamps may give out yellow light and the other white. From an outside sight, a completely dark building may suddenly lightened on one of the middle floors and darkened through the upper floors again. Lightened advertising boards applied sometimes on building surfaces and sometimes on street boards are also a part of light pollution. The boards that suddenly change color and intensity to attract people are sometimes so harsh that even they can cause an instantaneous vision loss. Besides, these systems that do not allow homogeneous light distribution seriously damage the urban aesthetic. Doesn't matter outer or inner, if a space isn't lightened correctly, it's not possible to get far healthily there. Thus, there has to be a criterion and a standard in lighting. By virtue of technological opportunities, there is almost no any unlighted street and lanes.

Lighting is a concept that provides the visibility of an object or an environment by sending light on it from a specific light source. It is thought that the principal of lighting concept is light; but the purpose of lighting is visualization of the lightened environment by the light source. These two similar subjects are different concepts from a technical aspect (Sirel, 2001). Lighting has become a necessity to meet the physiological comfort and aesthetic needs in human life (Boyce, 2003).

1.1 Lighting Performance

Not the quantity but the quality of lighting may offer a bigger importance especially in outer space lighting. Reflections and light direction has a big importance in respect to sight comfort. Reflectors of lighting equipment, protection of these reflectors against UV rays, light sources and actuators used in armatures are the factors affecting the lighting (Figure 1). Because of reflectors with low performance and armatures radiating unwanted lights around, difficulties are experienced to catch the required lighting levels beside the energy

loss. Because of light sources that cannot shoot properly according to its function, or because direct light beams from bright surfaces will obstruct the sight, the directions and materials of both equipment and vertical and horizontal outer space surfaces (façades, floor coverings, etc.) should be revised in architectural design.

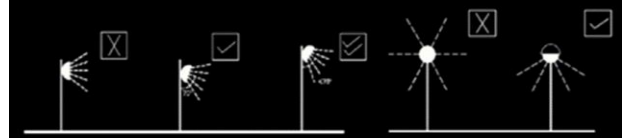


Figure 1. Right and wrong applications of armature (Chamber of Electrical Engineers, 2018)

1.2 Light Production

There are two types of light sources that is required for lighting: Hot (incandescent) and cold (luminescent). The difference of these types are light source's giving out light by means of heat (sun, candle light, lamp), and light sources that are giving out light by electrical and magnetic affects (fluorescent lamp, firefly) (Mills, 2008).

Light sources are classified according to light production, its geometrical shape and source and its color (The American Institute of Architects, 2003). Light production is realized by 2 ways: thermic way and discharge of metal vapors and gasses. When it comes to thermic light production, incandescence of substances is understood. The method giving back the received energy by luminescence is light production depending on discharge. Light sources according to geometric shape are classified as superficial, linear or spotlighting. According to light root it's divided into 2 parts as natural light and artificial ligh (Phillips, 2004). When it's mentioned as color of light, the hot white, natural white, and daylight white is meant.

1.3 Glare

There are some issues that are regarded as a problem in lighting. All inadequacies in lighting in general are gathered under the concept of light pollution. The greatest example of light pollution is glare. Glare is reflection of the light more than adequate, causing brightness and sight limitation. The glare created by overlighting turn the environment into uncomfortable.

Glare occurs by the reflection of the light on horizontal direction. The components of glare is separated to 3 classes itself: Discomfort glare, Inadequacy glare, Blinding glare.

Discomfort glare refers to a glimmer that causes discomfort but doesn't prevent sight;

inadequacy glare creates a prevention by distribution of radiated glimmer in the eye and obstructs to pick the details; *blinding glare*: It's a type of glare that obstructs picking the details by distribution of radiated glimmer in the eye not instantaneously but for a period of time.

1.4 Urban Outer Space Lighting

All spaces that are between residential units and are named as hypethral architecture are qualified as Urban outer space. These spaces are common use areas of all people. These environments create light, color, heat and odor components affecting the people (Onuk, 2008).

The lighting issue that has been a binding concept is needed in outer spaces, just like the inner spaces. The need to lighting for the purpose of perceptibility of urban spaces has caused the creation of urban lighting concept. Urban lighting involves both lighting technique, urban designing, and urban aesthetic concepts. Urban value lighting is divided into classes such as building lighting (historical buildings, mosques, modern buildings, etc.), square lighting, pedestrian areas lighting, park and garden lighting, three lighting, water element lighting.

Subject of urban outer lighting: handled by dividing to providing safety and security, knowing the environment, finding way-direction-place, realizing outdoor activities, forming urban identity, and urban embellishing purposes. Engineers, 2018)

Category	Examples
E1:	Intrinsically dark landscapes National Parks, Areas of Outstanding Natural Beauty, etc
E2:	Low district brightness areas Rural, small village, or relatively dark urban locations
E3:	Medium district brightness areas Small town centres or urban locations
E4:	High district brightness areas Town/city centres with high levels of night-time activity

Environmental Zone	Sky Glow ULR [Max %] (1)	Light Trespass (into Windows) Ev [Lux] (2)		Source Intensity I [kcd] (3)		Building Luminance Pre-curfew (4) Average, L [lm/m2]
		Pre- curfew	Post- curfew	Pre- curfew	Post- curfew	
E1	0	2	1*	2.5	0	0
E2	2.5	5	1	7.5	0.5	5
E3	5.0	10	2	10	1.0	10
E4	15.0	25	5	25	2.5	25

Chart 1. Citation from Guidance Notes for the Reduction of Light Pollution of ILE (The Institution of Lighting Engineers) institution: Outer Space Lighting (Chamber of Electric Engineers, 2018)

1.5 Regional Regulations and Lighting Standards

The requests of urban planners or local authorities on providing compliance with a standard should be taken into consideration at the beginning of the project.

Although TS-EN 1301-1 standards for lighting the squares, boulevards, streets and lanes for

general public use, choosing the lighting categories, features of road lightings and calculations, and measures, and TS-EN- 60598-1 standards for general features of lighting armatures and their tests are not binding, TS-EN 12464-2 standards which provides some useful information related to general lighting principles can be utilized. In TS-EN 13201 standard on road lighting, the trace to be followed on road type and lighting type accordingly is as below:

Typical speed of main user km/h	User types in the same relevant area			Sets of lighting situations
	Main user	Other allowed user	Excluded user	
> 60	Motorised traffic		Slow moving vehicles Cyclists Pedestrians	A1
		Slow moving vehicles	Cyclists Pedestrians	A2
		Slow moving vehicles Cyclists Pedestrians		A3
> 30 and ≤ 60	Motorised traffic Slow moving vehicles	Cyclists Pedestrians		B1
	Motorised traffic Slow moving vehicles Cyclists	Pedestrians		B2
> 5 and ≤ 30	Cyclists	Pedestrians	Motorised traffic Slow moving vehicles	C1
	Motorised traffic Pedestrian		Slow moving vehicles Cyclists	D1
		Slow moving vehicles Cyclists		
	Motorised traffic Cyclists	Slow moving vehicles Pedestrians		D3
Walking speed	Motorised traffic Slow moving vehicles			D4
	Cyclists Pedestrians		Motorised traffic Slow moving vehicles Cyclists	E1
	Pedestrians	Motorised traffic Slow moving vehicles Cyclists		E2

Chart 2. Classification of lighting conditions (Chamber of Electric Engineers, 2018)

2. Light Pollution

By the improvement of urbans, light sources have raised. Unsuitable use of light sources and overlighting have adversely affected the people and the environment. Redundantly used light sources have brought out light pollution problem. Light pollution is described as "the use if light at wrong place, wrong direction, wrong time and wrong amount" (Onuk, 2008).

2.1 Reasons of Light Pollution

Outer lightings are security, entertainment and decoration purposed lightings, but redundantly used outer lighting systems cause light pollution.

Lightings causing light pollution are;

- "Road, street and lane lightings
- Wrong and redundant lighting of parks, gardens and sport areas

- Façade lightings of tourist facilities and buildings
- Advertising boards
- Store window lightings
- Lightings for security purposes" (Ansari, 2013).

Also, wrong armature choice and montage cause light pollution (Figure 2). Wrong choice of armatures and misdirection of them cause glaring for pedestrians and creating unneeded amount of light. Choosing the armature and lamp is important to prevent light pollution. Correct armature should be chosen and applied (Figure 3).

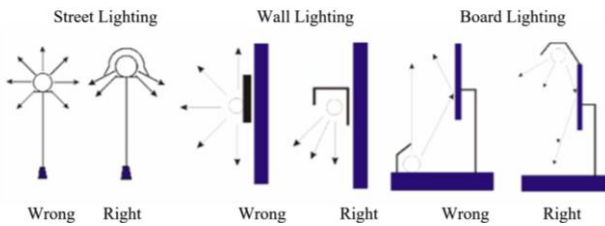


Figure 2. Right and wrong lighting (Dokuzcan, 2006)

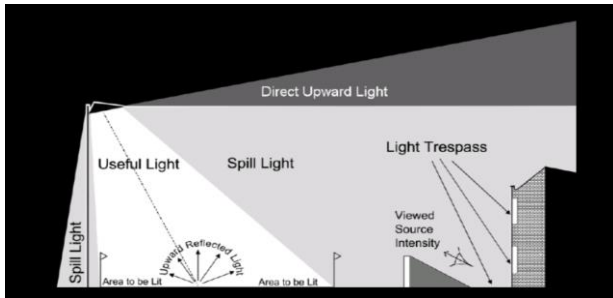


Figure 3. Results of wrong armature application (Onuk, 2008)

2.2 Effect of Light Pollution on Human

There are lots of effects of light pollution in urban life quality (Xiao&Zhang, 2004)

Effects on Local Residents

Wrong armature usage, flash of light reflected from light source on building windows cause brightening of house in the night and make an adverse impact on sleeping people. The most adverse impact of light pollution on human is Melatonin hormone release either not happen, or decrease in bright, lightened environment. Melatonin is a hormone having protective effect on cells and it adjusts the biological rhythm of the body. Since melatonin release decrease on people who are in bright environments during night, it cause permanent damage in cells in time (Ansari, 2013).

Effects on Pedestrians

Lighting is an important factor on security strategy of the city. One feels him/herself safe

while passing through a well-lighted square or park. One wants to perceive the entrance and exit roads of his/her location. Thus, the lighting on areas that are used during night is done according to the night security. But under overlighting, one cannot perceive his/her environment, hence he/she can be monitored. Wrong lighting adversely affect pedestrians for it causes glare.

Effects on Transport System

In case of using wrong lighting armature on road lighting, that may be a reason for losing attention and accidents since it will cause glare and reflection on the driver. Or, while his/her eyes got used to darkness on the road without lighting, sudden reflection on the rear view mirror from the headlamps of the car coming behind may cause glare and transient blindness.

But, as it's mentioned above, the lighting has to be handled as a whole. NisantasiTevsvikiye Street, which is Istanbul's one of the most vivid and moving streets with its big store windows and advertising boards, necessitates to be evaluated and criticized in terms of light pollution

3. Material and Method

In this study, the circumstances causing light pollution are determined by the help of photometer and building scaled and urban scaled photodocumentation method. Conditions such as light bursts, color variations, irregular light distribution that are causing negative conclusions in respect to urban aesthetic and sight comfort are investigated on site and documented. This study which many circumstances such as façade lightings on buildings, parts left in dark or under extreme lighting, advertising boards continuously changing color and intensity, store windows all designed independently from each other, street lighting tools using various colors are examined have the characteristics of a document on light pollution in Nisantasi Tevsvikiye Street (Figure 4).

3.1 Sample Area



Figure 4. Teşvikiye Street (studied by authors)

In particular, the slope of this section between the Vali Konağı Street and Bronze Street is excessive. Due to this inclination, roadway and pavement pass through the basement of many buildings. At the moment, the lower floors of the buildings on the street are served as shops, restaurants and cafes, while the upper floors are used as residential and residential buildings. The street is different from the first time it was founded, it is the front plan with shopping and entertainment life. Nowadays, not only the Nişantaşı street district community but also high income group of İstanbul residents use the street.

4. Research results

4.1. Examining Teşvikiye Street Lighting in Respect to Light Pollution

Nisantasi Teşvikiye Street, which has a more elite position comparing to other districts in İstanbul, is examined on the basis of light pollution because of both its being old, and people are spending too much time outside during day and night. The light system at the afore mentioned space is evaluated from both its aesthetic contribution to the buildings, and from comfort and health respect to the livings. First of all, to make a general situation analysis on the area where lighting study to be done and to understand the expectations at the environment will be a healthy start (Figure 5). Zoning the entire area according to different functions and expectations, and defining these zones in many layers such as necessities, purposes, architectural approaches, and social purposes is necessary.

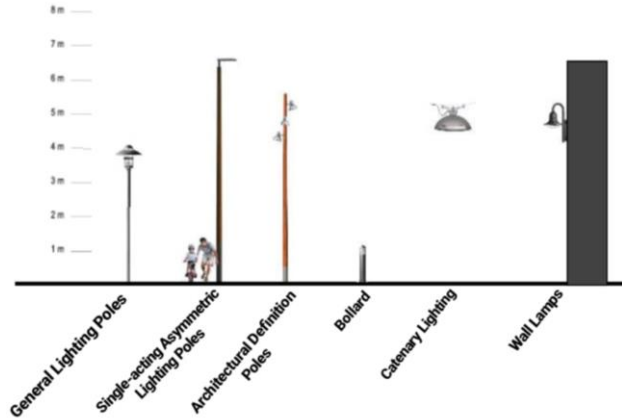


Figure 5. Possible lighting equipment types in the project

4.2 Overlighting

It is detected that lighting system applied at some parts along the street was pretty much over a normal application (Figure 6). And that has provided existence of a poor quality environment, effecting the comfort conditions of people. Human eye is getting tired because of overlighting, and making wondering around or spending time outside less healthy. The visuality of extreme is again disappearing.



Figure 6. Overlighting (photo by authors)

4.3 Storefront Lightings

Vitrified lightings are making up an important amount of light pollution on Teşvikiye Street. Since there are no any legislation or obligatory criteria for storefront lightings, everybody has lightened their storefronts with the colors they wanted as they liked. And that created an important amount of light pollution sourced from storefronts along the street (Figure 7).



Figure 7. Storefront Lighting (photo by authors)

4.4 Façade Lighting

Façade lighting is recently growing in importance, and serious designing projects are being prepared for this. With façade lighting both comfort is provided by lighting the outer spaces, and aesthetic is provided by making buildings that have specific and historical features visible. It is seen at the examinations made on the street that; while an aesthetic view was provided in some buildings by using façade lighting, there wasn't any lighting provided for some buildings, creating serious light pollution caused by a dark view at those parts (Figure 8).



Figure 8. Façade Lighting (photo by authors)

4.5 Inadequate Lighting

A quality life for living beings is only possible if they live in a well-lighted environment. Inadequate lighting both make the environment it exists unlivable for human beings, and it creates several health problems in time. Again, it blots out the visibility of important aesthetic elements situated at the mentioned space. According to the evaluations made on the street, the light on some areas appeared more than the normal (Figure 9). And this has removed the natural aesthetic elements situated there, and caused visual pollution.



Figure 9. Inadequate Lighting (photo by authors)

4.6 Street and Lane Lightings

In respect to light pollution, Tesvikiye Street contains many elements in itself. Whilst different armature types and different sized poles are required for lighting for people, road lighting, directive lightings and three lightings, a rambling lighting system is used without taking any of the requirements into considerations. Different sized poles are used for the same

purpose. Armatures radiating different color light are used. Some of the armatures light, some do not. Since the positioning of armatures isn't appropriate, radiation of the light is blocked by the trees in front of them. Again, the trees on the pavement along the street aren't lightened, and they also blockage the light radiated from the poles (Figure 10).



Figure 10. Street and Lane Lightings (photo by authors)

4.7 Advertisement Purposed Lightings

Advertisement purposed lightings are making an important element of light pollution in Tesvikiye Street (Figure 11). Because there is no any obligatory legislation for these lightings, a casual lighting is used. Whilst advertisement purposed lightings should be chosen according to the day and night conditions, the choice is generally done according to daytime conditions. The armature and light amount chosen according to daytime conditions are radiating overlighting in the night. And this destroys the aesthetic by creating light pollution, and prevents a comfort living by damaging the sight quality via overlighting. Again, choosing the lights for this purpose in several colors, and directing them inappropriately are causing glare and over pollution.



Figure 11. Advertisement Lightings Figure Lightings (photo by authors)

4.8 Light Pollution Measuring Results of Tesvikiye Street Lighting

The values received as a result of measurements done on the street have shown that they are rather low than the aimed luminous level and regulatory values. This situation creates light pollution for both street residents and drivers using vehicle. It has been observed that the brightness level changes at

very short intervals in measurements made at certain intervals. Lighting levels being under or over standart over the area effect negatively users comfort in current situation. The current illumination system made randomly along the street as it was considered non-compliance with any criteria. The street should have a luminous level of 200 lux on average, but it was measured some places 2 lux other places 245 lux, this is very problematic condition (Figure 12, 13).



Figure 12. Measurement results



Figure 13. Measurement results

5. Conclusion

The importance of urban lighting hasn't been understood enough yet in Turkey. It's still found adequate that lighting is a vital need related to eyesight and that's fine if you have it at a level to ensure sight. Because of that understanding, it is not accepted as an important element of lighting in and as a part of urban design. Recently, the lighting of only important buildings and some others who are accepted as a city symbol are considered.

For a truly understanding of importance of lighting in urban design and to ensure improvement at this direction, this subject should be given as a lecture in academic area as a part of design and project should be prepared.

It has been tried to make some buildings visible by lighting in Tesvikiye Street, but these studies are not being done according to a standard or rule. And this doesn't provide that intended aesthetic view. Urban lighting should be addressed as a whole, urban based master plans should be prepared, and obligatory regulations should be prepared by making use of symbolical examples from the world cities in this respect.

At project designing process which is developed by taking urban lighting as part of the design, it should be designed and applied in compliance with urban lighting regulations. Important buildings situated in Tesvikiye Street disappeared in nightfall, and architectural features of them can't be recognized. It has to be the most important element of urban design to bring into view historical and specific buildings that have important place in urban memory. These lightened buildings should be made a more livable place for living beings in respect to aesthetic and comfort.

To ensure the expected performance in urban lighting, the coatings used on the buildings have a significant importance. Taking outer space lighting into consideration, using appropriate coating material suiting to light at building design should be ensured.

The aim of urban lighting should be making historical, aesthetic and quality features of the subject space visible, and since every city's, district's, neighborhood's, street's human accumulation features are different, different lighting criteria should be formed for these areas and applications should be done according to these criteria.

According to international standards, street lighting intensity should be 100 lux. In the measurements done on Tesvikiye Street, it is detected nonhomogeneous 2 to 245 lux light amount, somewhere overlighted, somewhere inadequate. An adequate lighting should be targeted providing an adequate homogeneous lighting which is appropriate to human health, and taking the present lifestyle and comfort conditions of human beings into consideration, and this status should be assured with legislative regulations.

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