Al-Azhar Engineering 16th International Conference

Vol. 19 , No. 72, July 2024, 712 - 725

PRECIEVED PATTERNS OF LIGHTS IN URBAN FABRIC: APPROPRATING QUALITIES AND ATTRIBUTES

Mona Y. Shedid*

Architecture Departement,Faculty of Engineering-Benha, Benha University, Benha, Al-Qalyubia, Egypt,

***Correspondence:** monashedid@bhit.bu.edu.eg

Citation:

M. Y. Shedid, " Precieved patterns of lights in urban fabric: appropriating qualities and attributes", Journal of Al-Azhar University Engineering Sector, vol. 19, pp. 1 - 15, 2024.

Received: 04 February 2024

Revised: 15 March 2024

Accepted: 23 March 2024

DOI: 10.21608/auej.2024.268970.1621

ABSTRACT

A vital component of urban architecture, lighting may create a variety of emotions, including excitement, drama, mystery, romance and more. It also plays a major part in establishing welcoming and cozy public spaces. In order to create lively urban environments, public places must be able to promote social contact, a sense of community, and a sense of safety. This is known as conviviality. By providing enough illumination, improving the aesthetic appeal of public spaces, and fostering a sense of security, lighting can contribute to the creation of a convivial atmosphere. This paper examines the relative importance between the pertinent attributes (intensity, direction, color, and effect), their variables and the pattern of light configuration used to appropriate urban design qualities. An online questionnaire is distributed to determine these relations to suggest a heuristic model for each design quality in respect to lighting patterns in an urban area with a predetermined relevance level.

KEYWORDS: Urban design qualities, lighting patterns, lighting attributes and variables.

النسق المدرك لاضاءة الحيز العمراني: مدخل لموائمة الكيفيات والمتغيرات

منى يحيى شديد*

قسم الهندسة المعمارية، كلية الهندسة ببنها، جامعة بنها، بها، القليوبية، مصر.

***البريد الاليكتروني للباحث الرئيسي :** monashedid@bhit.bu.edu.eg

الملخص

تعتبر الإضاءة عنصرًا حيويًا في الهندسة المعمارية الحضرية، وقد تخلق مجموعة متنوعة من المشاعر، بما في ذلك الإثارة والدراما والغموض والرومانسية والمزيد. كما أنها تلعب دورًا رئيسيًا في إنشاء أماكن عامة ترحيبية ومريحة. ومن أجل خلق بيئات حضرية مفعمة بالحيوية، يجب أن تكون الأماكن العامة قادرة على تعزيز التواصل الاجتماعي، والشعور بالانتماء للمجتمع، والشعور بالأمان. يُعرف هذا بالتعايش, ومن خلال توفير الإضاءة الكافية، وتحسين المظهر الجمالي للأماكن العامة، وتعزيز الشعور بالأمان، يمكن للإضاءة أن تساهم في خلق جو بهيج. يبحث هذا البحث في الأهمية النسبية بين السمات ذات الصلة (الشدة، الاتجاه، اللون، والتأثير)، ومتغيراتها ونمط تكوين الضوء المستخدم للنسق المدرك للتصميم الحضري المناسبة. يتم توزيع استبيان عبر الإنترنت لتحديد هذه العلاقات لاقتراح نموذج إرشادي لكل جودة تصميم فيما يتعلق بأنماط الإضاءة في منطقة حضرية بمستوى صلة محدد مسبقًا.

الكلمات المفتاحية : صفات التصميم الحضري، وأنماط الإضاءة، وسمات الإضاءة والمتغيرات.

1. INTRODUCTION

The term "urban lighting" describes how artificial lighting is arranged to illuminate every aspect of an urban setting. In the past, urban lighting was mainly provided for four main purposes: the economy of the nation, the safety of inhabitants, the security of their personal belongings, and the aesthetics of the

nighttime environment. This implied that lighting should be able to support night-time activities both aesthetically and functionally. [1,2]

The illumination of Baroque festivals in the 17th century marked the beginning of human conception of the midnight landscape image and the systematic use of lights in urban space. [2,3] Building lighting gained popularity and convenience following the development of electric lighting in the 19th century, but it was not until the 20th century that electric lighting was used to illuminate both interior and exterior spaces. The 1940s saw advancements in artificial lighting technology, including new industrial materials and developments that allowed for more cost-effective and efficient use of light. Urban lighting became a useful technique for enhancing the security and aesthetic appeal of the nighttime urban environment after the 1940s. Artificial urban lighting was used to illuminate buildings, historical structures, parks, and landscape components in order to enhance the nighttime visual appeal of urban areas, in addition to lighting pedestrian routes and roads for orientation. [4] Up until that point, artificial lighting was utilized as a nighttime safety and security measure for city people. Nonetheless, artificial lighting has increased in aesthetic relevance and symbolic value since the early 1970s. [5] Urban lighting has grown in popularity and use as a result of the introduction of annual festivals in the 1980s and the development of master plans for urban lighting in the 1990s. It is well acknowledged nowadays that light plays a significant role in the creation of the artificial environment and that light affects how people see cities at night. [3,4]

For humans, light is essential because it allows for the development of vision. People view and interact with space through their vision. Sense of the physical environment is also essential for orientation safety. However, people experience psychological effects from light :

Light boosts the quantity of information that people absorb, which makes them feel more secure. Furthermore, people's psychological well-being and physiological processes are impacted by the color of light. Light color evokes distinct aesthetic and emotional responses, as well as emotions that are both pleasant and unpleasant. Because of all these benefits that light provides to humans, light plays a vital role in urban life. [2]

This paper describes light as a parameter in the built environment because of this .From this point of view the paper will determine the relation between appropriating urban design qualities through pattern of special of light configuration and the relevant attributes (Intensity, direction, color, and effect)

2. Understanding the Psychological Effects of Light and Color on Urban Spaces’s Users

Studies on the subject come to the conclusion that there are certain relationships between how lighting is perceived and how people feel. According to Moyer (1992), objects with bright lighting capture the viewer's attention more than those with softer lighting, which results in systematic relationships between people's emotional responses and perceived lighting characteristics (based on light direction and brightness). He goes on to say that although approaching a highly lighted location makes people feel at ease, there should be lower light fills that create visual bridges in the view since too much contrast between brightly lit areas leads to disorientation. It follows that regulating brightness can influence how individuals move and focus inside an urban area [6].

People who are out for business or who are at home or at work during the day may be drawn to the vibrancy of interactions, presence, and activities that take place along sidewalks at night in public spaces. Research has demonstrated that illumination is an environmental cue that affects people's perceptions and has the power to arouse or elicit pleasant feelings in people [7, 8, 9].

One aspect of design that affects a space's character is the lighting. Furthermore, because architectural elements like lighting can increase arousal or pleasure in response to a location, people's willingness and drive to stay there are correlated with their emotional states. In terms of emotional states, people could be inspired to begin a task, engage with their surroundings, or just feel content and joyful just by being there [7].

Color and light both affect psychological stimulation in the built environment. But as Birren (1969) pointed out, pleasant emotional reactions are not always guaranteed by mere stimulus. Mahnke (1996) highlights the importance of using color and light differently in architectural environments that have unique

purposes. It's crucial to remember that using color shouldn't be limited to evoking a physical response. The right amount of contrast and variation must be balanced for the built environment to have favorable color and lighting effects. According to Crewdson (1953), balance maintains unity in the face of variety. Maintaining interest requires both unity and variation, and striking a balance between these conflicting impulses is essential. While an overemphasis on unity might result in boredom, excessive variation can create a disorienting and unpleasant environment [2, 10, 11, 12].

One of the most crucial components that quickly assisted in establishing legibility, a sense of unity, and a feeling of location is color and light, which also happens to be less expensive than building defined centers. On the one hand, light is necessary for the majority of the information that the visual sense takes in. In the minds of onlookers, light reflects forms, improving visual perception and creating a clear mental image that is readable and appealing in a public setting. Therefore, without light, the concept of color is lost since color and light may provide an area with integrity, a diversity of colors and light that can be carefully chosen to fit the space, and what makes it unique, vibrant, and recognizable To put it another way, the signification of urban places promotes environmental quality and sustainable growth by increasing the area's variety and legibility and creating sentiments of identity, belonging, and legibility. Due to the goalless coloring and lighting of urban regions in today's cities, coupled with their subsequent abandonment, residents have no mental memory of various neighborhoods and places. One of the most important aspects of unknown identity and its application in the urban space is the absence of color and purposeless lighting in urban areas, which are serious problems in the field of urban management [13].

3. Pattern of Lighting in Urban Spaces and their Different Attributes and Aariables

3.1. Pattern of lighting

Light has the role of a stimulant. A viewer's reaction is influenced by the way light is arranged in an area. Because humans are dynamic and constantly changing, a person's feeling or response to an area will vary if the light in it changes. This is true for both the brain's and the eyes' sensitivity to light. The way people perceive an area varies depending on the type of illumination.

The following part will discuss the different pattern of light distribution:

1. Carpet of light: Lighting fixtures that are precisely spaced apart to produce a consistent light fill are what produce this lighting appearance. The light sources are positioned high, beyond people's line of sight. The only light that reaches the square's facades is stray light.
2. Lighting zones: A square can have varying lighting focused on different locations based on the requirements of its many functions. By dividing the square into various zones with a big number of low light sources, one may create a pleasant mood. In this instance, there is no lighting above the facades that encircle the area [2, 14].
3. Pools of light: Installing relatively low-level lights to highlight or create pools of light at useful areas like seats or landscaping that may be connected to them is an alternate technique for lighting squares. Put another way, the square is only occasionally lit since it is not very important. Buildings around the square may have floodlights on their exterior. While highlighting is the main goal of lighting, it's crucial to avoid gloomy, darkened areas [2, 14, 15].

3.2. The Different Lighting Attributes and their Variables

Lighting is essential for numerous aspects of our life, from improving safety and visibility in outdoor settings to adding aesthetic appeal to architectural spaces. To achieve the desired lighting effects and maximize energy efficiency, one must have a thorough understanding of the various lighting qualities and their variations.

The following paragraphs investigate the fundamental features of illumination and the factors that affect them. These characteristics cover a wide range of elements that affect how well lighting systems work and perform. Lighting designers, architects, and engineers can create lighting environments that are both

aesthetically beautiful and functional by understanding these features and variables and making informed decisions.

Light intensity

In order to create pedestrian environments that are secure and safe, light intensity is important. To use the area securely and pleasantly at night, people need a specific level of light. Nominal illumination intensity, close spacing, and specifically designed lighting fixtures intended for outdoor lighting can all contribute to the desired effect of safety and security. The required effects are produced when illumination intensity, direction, distribution, and color are properly combined [2, 16].

Direction of Light

The direction of light influences a scene's depth and its capacity to add or subtract texture. The positioning of lighting fixtures can have the following effects on the appearance of metropolitan areas:

- Up lighting: It casts shadows on ceilings or vertical surfaces. An uplight concealed by undergrowth or behind a rapidly spreading plant may soon be obscured by foliage.
- Down lighting: It offers the ability to create lighting effects—wash, graze/texture, halo, silhouette dappled light detail, and color—while concealing fixtures. It can also give strong accent lighting or gentle fill light.
- Front lighting emphasizes an object's details and leans toward drama. It removes shadows, flattening the appearance of the object. Depending on how far away the fixture is from the object, texture can either be emphasized or reduced.
- Back lighting creates a stark contrast that highlights an object's outline while erasing all detail and texture. It makes the scene more interesting. In addition, it can highlight a shape by employing the "halo" approach, finish a shape begun by front lighting, or provide depth by isolating an object from the background. Backlighting produces drama by removing color and detail and revealing only form when using the silhouette technique.
- Side lighting produces deep shadows and adds texture. Either these shadows enhance the scene or detract from it. Think about how the scene will change with shadows.

Since down lighting replicates how humans see objects and scenes that are illuminated by the sun, it produces the most realistic image. Additionally, while concealing fixtures, down lighting offers the chance to produce lighting effects including wash, graze/texture, halo, silhouette, dappled light, detail, and color [17].

Color attributes

Effective visual design expression is necessary to transform the darkness into an appealing brilliant composition. A good visual design requires keen observation, creativity, and the appropriate application of compositional elements [17].

- Hue: An attribute of any hue that sets it apart from others. Hue denotes a blend of many hues, such orange-red, yellow-green, or dark blue-purple.
- Concentration or Chroma: The intensity or saturation level of a color is represented by its chroma. A color's chroma is its degree. The chrome scale advances to the maximum saturation level at each color level from neutral gray, represented by the zero number.
- Color value: A color's relative brightness or darkness is its value. White is the base color for bright colors, while black is added to slightly colored hues to create darker colors [7].

4. Urban Design Qualities and Environmental Perception

People are constantly taking in and processing information that they have taken in from their environment. The study of environmental perception examined the several ways in which people obtained information from their surroundings. According to Rapoport [18], human perception was divided into the following three primary categories:

1. Environmental Evaluation and Preference - involving perceiving, knowing and thinking, the basic processes whereby the individual knows his environment.

2. Environmental Cognition – the way in which people understand, structure and learn the environment and use mental maps to negotiate it.

3. Environmental Perception – referring to the direct sensory experience one would have the environment.

It is clear from these three emphasized processes that "nature of the stimuli, the physiology of perception and the state of the organism – expectancy, attention, motivation, selectivity or adaptation" all have an impact on perception. These processes interact during perception rather than occurring independently, resulting in the overall derived experience of one's surroundings. Direct sensory experience is the primary way that humans perceive their surroundings, and it is frequently the type of environmental perception that is studied the most in academic studies. Kevin Lynch is credited with pioneering the significance of planning for human visual needs and mental mapping of one's surroundings in his groundbreaking works in The Image of the Urban area [19].

Kaplan had noted that while complexity and legibility are related to a high-quality visual environment, there should be moderation in the amount of variation and complexity. [20]

Nasar also put up a theory that expands on Lynch's notion of the urban space's readability. In reference to the "urban space appearance as evaluated by the public who experiences it" [21], he made suggestions about how the visual structure of the urban space could improve the structure's imagebility.

Since the urban environment is a dynamic combination of human activity and natural elements, factors such as distance, time of day, season, "static and moving" objects, and mental state should all be taken into account to preserve consistency. Lynch said that even while the shape of the urban environment is changing, the physical forms of the core five constituent elements should remain identifiable. Lynch had studied the urban form during the day, when obstacles or the physical placement of objects could only affect visibility. However, when analyzing how the urban form appeared at night, the lighting master plan would be the main tool to increase the prominence of these elements and determine their lighting design strategy or illumination level. Therefore, in order to incorporate this into the design of the master plan for urban lighting, the existing approach does not address the concerns regarding how each piece would seem throughout the day or how illumination would change that appearance. Lynch also emphasized the significance of identifying fundamental urban components, which would be important in forming the master plan for urban lighting, in indicating the hierarchy of design and the relationships among the different shapes that are illuminated [22].

Moreover, numerous scholarly investigations have demonstrated the significance of environmental visual design and its correlation with environmental quality. In order to determine the factors that people would consider essential to the design of high-quality urban areas, **Table 1** compiled a number of scholarly results.

Table 1. Urban design qualities and their different characteristics.

Urban design quality	Characteristics
Coherence	Organize into clear areas; Few distinct reigions Repeating themes and unifying textures Limited number of contrasting textures
Complexity	Richness of elements ; Different visual components Greater richness or variety would encourage exploration
Legibility	Distinctiveness Memorable components that help with orientation Legible space would allow ease in navigation
Mystery	Desire to explore a place would be enhanced if there were promise of more offerings in the visual scene.
Imageability	It is the characteristic of a place that distinguishes it as distinct, recognized, and unforgettable.
Enclosure	It is the degree to which streets and other public places are visibly bounded by buildings, walls, trees, and other components. Spaces with a room-like quality feature vertical pieces whose height is proportionate to the width of the space between them.
Human Scale	It refers to the size, texture, and articulation of physical parts that correlate to the size and proportions of humans, as well as the speed at which humans walk.

5. Objectives and Hypotheses

The purpose of the paper is to determine the relative importance between the lighting attributes—that is, intensity, direction, color, and effect—and the appropriation of urban design qualities through a pattern of special light configuration.

This relates to the study hypothesis that emphasizes the lighting pattern in urban spaces with a prioritized level of significance. To investigate the relative importance between lighting patterns and various attributes and variables found in urban spaces, a set of research questions was created.

6. Method

The following methods were adopted:

1. Based on the assessment of the literature, determine and pick urban design qualities that are connected to visual perception.
2. Using a variety of theories and concepts, identify the various lighting patterns along with their attributes and variables.
3. The relative relevance of lighting patterns related to urban design features, as well as the value of lighting attributes and lighting variables related to the higher-ranked lighting pattern, were ranked based on an online questionnaire.
4. Urban tickets as a collective score table for each quality.
5. A heuristic model that has been proposed for each quality in respect to lighting patterns in an urban area with a predetermined relevance level.

6.1. Participants

The population sample under study should be chosen to deduce statistically valid generalizations about a specific trait of this group in order to preserve the representativeness of the research sample. The target population, comprising 35 participants in each study subgroup, was the focus of the sample, which was orientated based on the job description of "urban design specialist and architect." **Table 2** indicates that there were 60 participants in the final sample, 27 of whom were men and 33 of them were women. Four experience groupings were represented in the sample: five to ten years (n = 23), eleven to fifteen years (n = 12), sixteen to twenty years (n = 8), and more than twenty years (n = 17).

Table 2. Descriptive background parameters of the questionnaire.

Position Title		Architect	Specialized urban design
Gender	Male	11	16
	Female	21	12
Years of Experience	5 – 10 years	10	13
	11 – 15 years	7	5
	16 – 20 years	3	5
	More than 20 years	8	9

6.2. Stimuli

The primary objective of the online questionnaire was to ascertain the relative importance between lighting patterns and various variables present in urban spaces and urban design qualities. The prior literature review's questionnaire design must be taken into account in order to achieve this goal. There are nine sections covered.

Section one: General Data: includes participant’s gender, job and years of experience.

Second two: This section has been divided into eight successive parts.

- The first section involves evaluating the relative importance of lighting patterns related to urban quality (complexity) from each participant's point of view. These patterns, which are divided into three categories as previously mentioned and were found through the literature review mentioned in the theoretical section, are carpet of light, lighting zones, and pools of light, respectively. The relative importance of the lighting patterns was assessed using a matrix table, and each participant was asked to score the importance on a scale of 1 to 5, with 5 representing the highest level of importance.
- Part two: For the lighting pattern that is ranked higher, each participant should rank the relative relevance of lighting attributes (intensity of light, direction of light, color of light, and effect technique). The relative importance of the lighting attributes was determined using a matrix table, and each participant was asked to rank the features in order of priority, with 1 being the least important and 5 being the most essential.
- Part three: For the lighting pattern that is scored higher, each participant should assess the relative relevance of the lighting intensity variables (high, medium, and low). The lighting intensity was ranked in order of relative importance using a matrix table, where 1 represents the least important factor and 5 represents the most essential.
- Part four: from each participant's perspective, rank the relative importance of lighting direction variables, such as "up lighting and down lighting," in relation to the higher ranked lighting pattern. The relative importance of the direction variables was calculated using a matrix table, and each participant was asked to rank the variables' relative value on a scale of 1 to 5, with 5 being the most important and 1 being the least.
- Part five: Each participant should rank the relative importance of the lighting color variables (hue, saturation, and color value) relevant to the lighting pattern that they believe to be the most important. The relative importance of the color variables was calculated using a matrix table, and each participant was asked to score the variables' relative value on a scale of 1 to 5, with 1 being the least important and 5 being the most.
- Part six: For each lighting pattern that is ranked higher, each participant should rank the relative importance of the lighting variables (wash, graze/texture, show texture, halo, silhouette, shadows, glow and detail, and color). The lighting variables were ranked in order of relative importance using a matrix table, where a number between 1 and 5 denotes the least and maximum importance, respectively.
- Part seven: As previously mentioned, this section asks participants to rank the relative importance of four lighting attributes that are related to urban quality (complexity). These attributes are intensity of light, direction of light, color of light, and lighting technique. The lighting attributes were identified through the literature review mentioned in the theoretical part. The relative variables of the lighting features was determined using a matrix table, and each participant was asked to rank the importance on a scale of 1 to 5, with 5 representing the most importance.
- From section three to section eight: revolve around the same concept, however each one deals with a different urban quality.

Section nine: This section has been divided into three successive parts.

- The first component involves assigning a value on a scale of 1 to 5, with 5 being the most essential, to each participant's assessment of the relative importance of the lighting attributes related to the lighting pattern: carpet of light.
- In the second phase, participants rate the relative importance of lighting attributes related to the lighting pattern by assigning a value between 1 and 5, where 1 represents the least important and 5 represents the most significant lighting zone.
- Part 3: assigning a value on a scale of 1 to 5, where 5 represents the most importance, to the lighting attributes that are pertinent to the lighting pattern, namely the pools of light, from each participant's point of view.

6.3. Procedure

The reference data was gathered using an online questionnaire. Research conducted one-on-one interviews with each participant. A table and a questionnaire made up the data gathering page. The respondents were guaranteed secrecy by the questionnaire. Participants were asked to provide information about their backgrounds, gender, positions, and years of experience on the first page.

The respondents were asked to respond to multiple questions regarding the relative significance of lighting patterns and the various characteristics and elements that affect the aspects of urban design. A five-point rating system was applied to each question's response. 1 was "not at all" and 5 was "very much" on the rating system. Numerous preference studies made use of this rating scale.

7. RESULTS AND DISCUSSION

7.1. Data handling and processing

This section is split into two parts: the first is the sorting of the questionnaire findings by specialty, and the second is the comparison of the specialist selections to confirm the choices made by the specialists.

7.2. Data handling and processing

The questionnaire's answers and conclusions will be shown through charts that order each of urban design quality in relation to a lighting pattern in an urban area with a predetermined level of relevance based on the opinions of experts, as shown in **Fig. 1**

Fig. s a

7.3. The Urban quality tickets

The following part demonstrates the value of urban tickets as a tool for urban designers and architects when they need to design lights in urban spaces, as shown in **Fig. 2.**

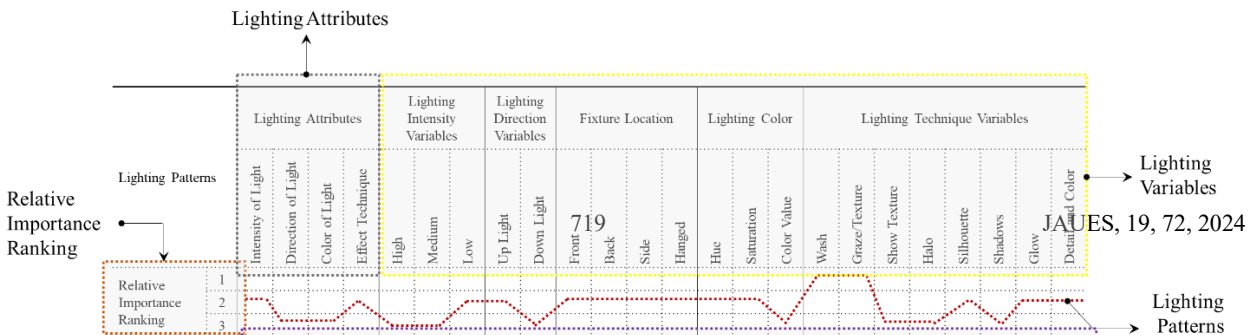

Fig. 2. The Urban quality tickets.

Based on the questionnaire analysis and results an urban quality ticket is designed for each urban design quality, as shown in **Fig. 3, 4, 5, 6, 7, 8, 9**

Lighting Patterns		Lighting Attributes				Lighting Intensity Variables			Lighting Direction Variables		Fixture Location				Lighting Color			Lighting Technique Variables							
		Intensity of Light	Direction of Light	Color of Light	Effect Technique	High	Medium	Low	Up Light	Down Light	Front	Back	Side	Hanged	Hue	Saturation	Color Value	Wash	Graze/Texture	Show Texture	Halo	Silhouette	Shadows	Glow	Detail and Color
Relative importance ranking	1																								
	2																								
	3																								
Carpet of Light		1	0.8	0.6	0.4	1	0.8	0.6	0.8	0.8	1	0.6	0.8	1	0.6	1	0.6	0.8	0.4	0.8	0.6	0.4	0.6	0.6	0.6
Lighting Zones		1.2	1	1.2	0.7	1	1.2	0.7	0.5	1.2	1.2	1	0.5	0.5	0.5	0.7	1.2	0.5	1	1	1.2	1	1	1	1.2
Pools of Light		1.2	2.4	1.8	1.8	1.2	1.8	2.4	0.6	0.6	1.2	1.8	1.8	2.4	2.4	1.2	1.8	0.6	1.8	2.4	3	3	3	0.6	2.4

Fig. 3. The Urban quality ticket for complexity.

Lighting Patterns		Lighting Attributes				Lighting Intensity Variables			Lighting Direction Variables		Fixture Location				Lighting Color			Lighting Technique Variables							
		Intensity of Light	Direction of Light	Color of Light	Effect Technique	High	Medium	Low	Up Light	Down Light	Front	Back	Side	Hanged	Hue	Saturation	Color Value	Wash	Graze/Texture	Show Texture	Halo	Silhouette	Shadows	Glow	Detail and Color
Relative importance ranking	1																								
	2																								
	3																								
Carpet of Light		2.4	0.6	3	1.8	3	2.4	0.6	3	2.4	2.4	1.8	2.4	1.2	2.4	1.8	3	1.2	1.8	0.6	2.4	3	0.6	2.4	3
Lighting Zones		1.2	0.5	0.7	1	0.7	1	1.2	0.7	1	1	1.2	0.7	0.5	0.5	0.7	1.2	0.7	1	1.2	0.5	1	1.2	0.2	0.5
Pools of Light		0.8	1	0.4	0.6	1	0.8	0.8	0.8	0.8	1	0.4	0.6	0.8	0.6	1	0.6	0.8	0.4	0.8	0.6	0.4	0.6	0.6	0.6

Fig. 4. The Urban quality ticket for coherence.

Lighting Patterns		Lighting Attributes				Lighting Intensity Variables			Lighting Direction Variables		Fixture Location				Lighting Color			Lighting Technique Variables							
		Intensity of Light	Direction of Light	Color of Light	Effect Technique	High	Medium	Low	Up Light	Down Light	Front	Back	Side	Hanged	Hue	Saturation	Color Value	Wash	Graze/Texture	Show Texture	Halo	Silhouette	Shadows	Glow	Detail and Color
Relative importance ranking	1																								
	2																								
	3																								
Carpet of Light		2.4	2.4	2.4	1.8	2.4	1.8	0.6	1.8	1.2	2.4	0.6	1.8	0.6	2.4	2.4	3	3	1.8	2.4	1.2	1.2	1.2	2.4	3
Lighting Zones		1.2	1.2	0.5	0.2	1.2	0.5	0.2	0.2	1.2	1.2	1.2	1	0.2	0.5	1	1.2	0.2	0.2	0.2	0.5	1	1.2	1.2	1.2
Pools of Light		0.8	1	0.8	0.8	1	0.8	0.8	0.8	1	1	0.4	0.6	0.8	0.8	0.8	0.6	0.6	0.6	0.6	0.6	0.8	0.8	0.6	0.6

Fig. 5. The Urban quality ticket for legibility.

Lighting Patterns		Lighting Attributes				Lighting Intensity Variables			Lighting Direction Variables		Fixture Location				Lighting Color			Lighting Technique Variables							
		Intensity of Light	Direction of Light	Color of Light	Effect Technique	High	Medium	Low	Up Light	Down Light	Front	Back	Side	Hanged	Hue	Saturation	Color Value	Wash	Graze/Texture	Show Texture	Halo	Silhouette	Shadows	Glow	Detail and Color
Relative importance ranking	1																								
	2																								
	3																								
Carpet of Light		0.6	0.8	0.8	1	0.6	0.8	1	0.6	0.6	0.6	1	0.8	0.8	0.8	0.8	0.6	0.8	1	0.6	0.6	1	0.8	0.6	0.6
Lighting Zones		1.2	1	1.2	0.7	1	1.2	0.7	0.5	1.2	1.2	1	0.5	0.5	0.5	0.7	1.2	0.5	1	1	1.2	1	1	1	1.2
Pools of Light		0.6	2.4	1.8	2.4	1.2	2.4	3	1.8	2.4	0.6	2.4	2.4	1.2	3	1.8	2.4	0.6	0.6	3	3	3	3	0.6	0.6

Fig. 6. The Urban quality ticket for mystery.

Lighting Patterns		Lighting Attributes				Lighting Intensity Variables			Lighting Direction Variables		Fixture Location				Lighting Color			Lighting Technique Variables							
		Intensity of Light	Direction of Light	Color of Light	Effect Technique	High	Medium	Low	Up Light	Down Light	Front	Back	Side	Hanged	Hue	Saturation	Color Value	Wash	Graze/Texture	Show Texture	Halo	Silhouette	Shadows	Glow	Detail and Color
Relative importance ranking	1																								
	2																								
	3																								
Carpet of Light		1.2	1.2	1.2	1	1.2	1.2	1	1.2	1.2	1.2	1.2	1.2	1.2	0.2	1.2	1.2	0.2	0.2	1	1	1.2	1.2	1.2	1.2
Lighting Zones		1.8	2.4	2.4	3	1.2	1.8	1.8	2.4	2.4	1.8	1.8	1.8	1.8	1.8	2.4	3	1.8	2.4	2.4	2.4	2.4	1.8	2.4	3
Pools of Light		1.8	2.4	2.4	3	1.2	1.8	1.8	2.4	2.4	1.8	1.8	1.8	1.8	1.8	2.4	3	1.8	2.4	2.4	2.4	2.4	1.8	2.4	3

Fig. 7. The Urban quality ticket for imagaebility.

Lighting Patterns		Lighting Attributes				Lighting Intensity Variables			Lighting Direction Variables		Fixture Location				Lighting Color			Lighting Technique Variables							
		Intensity of Light	Direction of Light	Color of Light	Effect Technique	High	Medium	Low	Up Light	Down Light	Front	Back	Side	Hanged	Hue	Saturation	Color Value	Wash	Graze/Texture	Show Texture	Halo	Silhouette	Shadows	Glow	Detail and Color
Relative importance ranking	1																								
	2																								
	3																								
Carpet of Light		1	0.8	0.6	1	1	0.8	0.6	1	1	1	0.4	0.6	0.8	0.6	0.8	0.8	0.4	0.4	0.6	0.4	0.6	0.6	0.8	1
Lighting Zones		1.8	2.4	1.8	2.4	2.4	1.8	1.2	2.4	2.4	1.8	2.4	2.4	1.8	1.8	1.2	2.4	1.2	2.4	2.4	2.4	1.8	1.8	1.2	2.4
Pools of Light		0.7	1.2	0.7	1.2	1.2	0.7	0.5	0.5	1.2	0.7	0.7	1.2	1.2	0.5	1.2	1	0.2	0.2	0.5	0.2	0.7	0.7	0.7	1.2

Fig. 8. The Urban quality ticket for enclosure.

Lighting Patterns		Lighting Attributes				Lighting Intensity Variables			Lighting Direction Variables		Fixture Location				Lighting Color			Lighting Technique Variables							
		Intensity of Light	Direction of Light	Color of Light	Effect Technique	High	Medium	Low	Up Light	Down Light	Front	Back	Side	Hanged	Hue	Saturation	Color Value	Wash	Graze/Texture	Show Texture	Halo	Silhouette	Shadows	Glow	Detail and Color
Relative importance ranking	1																								
	2																								
	3																								
Carpet of Light		2.4	1.8	1.2	2.4	2.4	1.8	1.2	2.4	2.4	2.4	1.8	2.4	1.8	2.4	1.8	2.4	2.4	1.2	1.2	1.2	1.2	1.8	2.4	2.4
Lighting Zones		0.8	0.8	0.6	1	0.8	1	0.8	0.6	0.6	0.8	0.4	0.6	0.8	0.6	0.8	0.8	0.6	0.8	0.6	0.6	0.6	0.6	0.4	0.6
Pools of Light		0.5	1.2	0.2	0.7	0.7	0.7	0.7	1	1.2	1	0.5	0.2	1.2	0.2	0.7	0.5	0.2	0.2	0.2	0.2	0.2	1.2	0.2	1.2

Fig. 9. The Urban quality ticket for human scale.

7.4. The heuristic model and their relation with the urban design qualities and lighting patterns and their various attributes and variables

The heuristic model will discuss the relative importance between the urban design qualities, lighting patterns and their attributes and variables. It includes:

- Urban design qualities: Complexity, coherence, legibility, mystery, imageability, enclosure and human scale.
- Lighting patterns: Carpet light, lighting zones and pools of light.
- Lighting attributes: Intensity of light, direction of light, color of light and effect technique.
- Lighting variables: Intensity of light: High, medium and low, direction of light: Up lighting (front, back, side & hanged) and down lighting (front, back, side & hanged), color of light: Hue, saturation and color variables and effect technique: wash, graze/texture, show texture, halo, silhouette, shadows, glow and detail and color.

It has accordingly validated the objective of the paper that tested the relative importance between urban design qualities and lighting patterns and their different attributes and variables based on the questionnaire analysis as shown in **Fig. 10.**

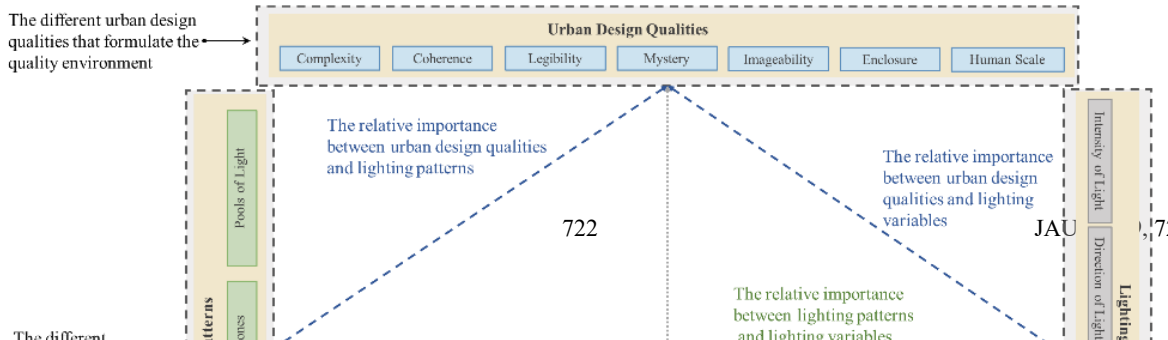

Fig. 10. The heuristic model.

7.5. The relative importance between the different elements of the heuristic model

This model based on the urban design tickets and demonstrates the relative importance between the urban design qualities, lighting patterns and their attributes and variables.

Aim of the model:

1. Can act as a tool for the designer to find the possible combination between the four pillars altogether or the fabric and each of them separately.
2. More elaboration of understanding the complexity of the different relations.

Fig. 11 shows the heuristic model different parts. It consists of the following:

1. Four tables: The first one (upper horizontal table) consists of the different parameters of urban design qualities. The second table (left vertical table) consists of lighting patterns and their different parameters. The third table (lower horizontal table) consists of 25 lighting variables. Finally the fourth table (right vertical table) consists of four lighting attributes.
2. The arrows represent the relative importance between the urban design qualities, lighting patterns and their attributes and variables. These relations are based on literature review and questionnaire with the experts.

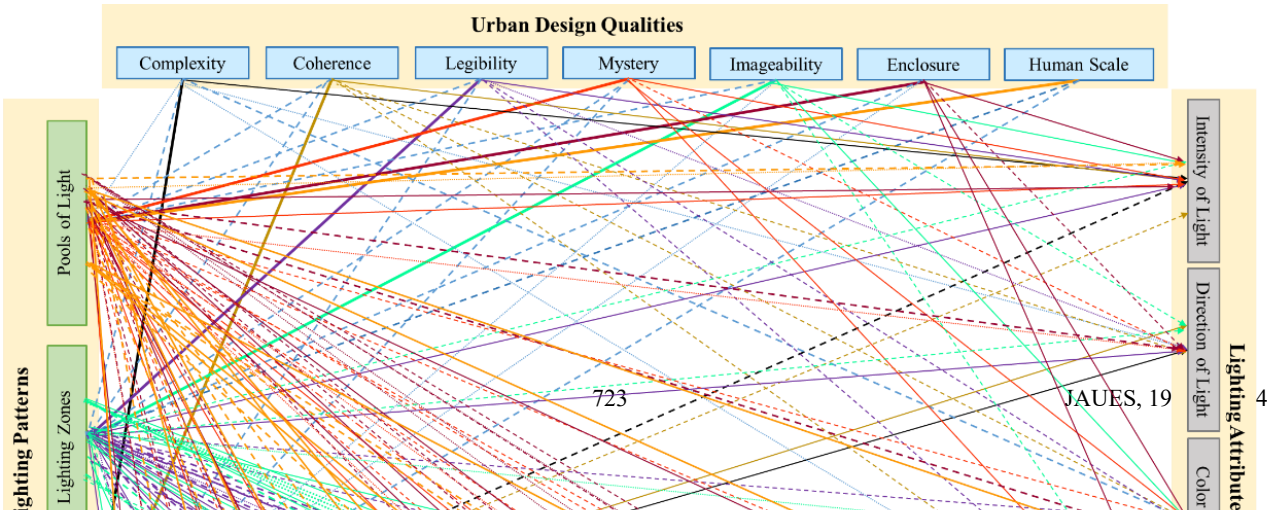

Fig. 11. The heuristic model of the relations between urban design qualities, lighting patterns and their attributes and variables .

Conclusions

The paper highlights the significant role of lighting in urban spaces in increasing the quality of urban life as well as people's social interactions through determinig the determine the relative importance between appropriating urban design qualities and light patterns and the relevant attributes (Intensity, direction, color, and effect) and variables.

Through an online questionnaire, a group of experts were asked to rank the relative importance between urban design qualities and litting patterns and their various attributes and variables. **Fig. 1** summed the final results.

Next, urban quality tickets are designed as a collective score table for each quality. In addition a heuristic model was created based on the theoretical fundamentals and and the analysis of the questionnaire.

References

[1] Rea, M. S., 1993. Lighting handbook (8th ed.), New York: Illuminating Engineering Society of North America.

[2] Ünver A., 2009, People's Experience Of Urban Lighting In Public Space, Master's Thesis, City And Regional Planning

[3] Narboni, Roger, 2004, Lighting the Landscape: Art, Design and Technologies, Birkhäuser, Germany.

[4] Sirel, Ş., 2006, Aydınlatmanın Geçmişi, Professional Lighting Design Türkiye, Sayı:7, Ağustos Yayın Tanıtım, Istanbul, Turkey.

[5] Ritter, J. ,2008, Master Planlar – Durum Değerlendirmesi, Professional Lighting Design Türkiye, Sayı:12, Ağustos Yayın Tanıtım, Istanbul, Turkey.

[6] Moyer, J. L., 1992, The Landscape Lighting Book, John Willey & Sons, Inc., New York.

[7] Esmaeili, M., 2018, The Effect Of Lighting On Emotional States And Behavioral Intentions In Urban Transitional Spaces, Master's Thesis, University of Tehran Tehran, Iran.

[8] Ciani, A. E., 2010, A study of how lighting can affect a guest's dining experience, Master's thesis, Iowa State University.
[9] Summers, T. A., & Hebert, P. R., 2001, Shedding some light on store atmospherics: influence of illumination on consumer behavior, Journal of Business Research, 54(2), 145-150.
[10] Birren, F., 1969, Light, Color, and Environment, New York, Van Nostrand Reinhold Co.
[11] Mahnke, F. H., 1996, Color, Environment, and Human Response: An Interdisciplinary Understanding of Color and Its Use as a Beneficial Element in the Design of the Architectural Environment, John Wiley and Sons.
[12] Crewdson, F.M., 1953, Color in Decoration and Design. Wilmette, IL: Frederick J. Drake
[13] Negar T., Maryam F., 2014, The Role of Light and Color in Urban Beautification and its Impact on the Perception of Citizens, World Journal of Environmental Biosciences, ISSN 2277- 8047
[14] FGL, Fördergemeinschaft Gutes Licht, 2002, Urban Image Lighting, Frankfurt, Germany
[15] Phillips, D., 2002, The Lit Environment, Bath Press, Glasgow, UK.
[16] Panda A.K., Mishra B.G., Mishra D.K., Singh R.K., 2010. Effect of sulphuric acid treatment on the physico-chemical characteristics of kaolin clay. Colloids Surf A Physicochem Eng Asp 363(1-3): 98–104.
[17] Moyer, J. L., 2013, the Landscape Lighting Book (3rd Edition), John Wiley & Sons, Inc., Hoboken, New Jersey.
[18] Rapoport, A., 1990, The meaning of the built environment: A nonverbal communication approach. University of Arizona Press.
[19] Lynch K., 1960, The Image of the City. M.I.T Press, USA, Massachusetts.
[20] Kaplan, S. and Wendt, J.S., 1972. Preference and the visual environment: Complexity and some alternatives. Environmental design: Research and practice
[21] Nasar, L. J., 1998. The Evaluative Image of the City. USA: Sage Publications.
[22] Paskovic, A., 2012, Urban Lighting: Planning for Public Spaces in Vancouver’s Southeast False Creek, Queen’s University Kingston, Canada.