EFFICIENCY OF ARTIFICIAL LIGHTING FOR VISUAL PERCEPTION OF HISTORICAL FAÇADE

Niran Al Shaikhli
Associate Professor of Architecture, Architectural Engineering Department, Faculty of Architecture and Design, Middle East University, Jordan.

Hanan M. Ahmad
Professor of Architecture, Architectural Engineering Department, Khwarizmi University Technical College, Jordan.

ABSTRACT

Light distinguishes the physical configuration of a historical monument facade and highlights its features. It evokes the sensory, aesthetic and perceptual aspects felt by the recipient when looking at the facade as well as it functions as a vision element; as it evokes a set of sensory meanings that are considered as indicators and signs relating to time and place, being a historical monument that represents a civilization of a certain period of time.

The research consists of two aspects as follows. The first aspect is the theoretical aspect which outlines the importance of light in visual communication between the recipient and the historical facade. The research also studies the effect of lighting properties on highlighting historical monuments.

The second aspect is the practical aspect of the study which includes choosing models (case studies) from some historical buildings in Jordan to study the effect of Artificial lighting properties variables that were addressed by the research in the theoretical aspect, on the historical monument facade of these models and determining the effect of these variables on enriching the sensory and artistic aspects reflected by the structure of that historical monument.

The research problem was the absence of a study and application of the effect of Artificial light variables on the facades of some historical buildings in Jordan, which affects the visual communication between the historical monument and the recipient at night.

The research aims to figure out the effect of light variables on highlighting aesthetic values of architectural elements in the chosen historical building facades in Jordan.

Keywords: Historical Building Facade - Visual Perception - Artificial Light - Touristic buildings in Jordan
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1. INTRODUCTION

The historical monument facade is its external envelop that plays an essential role in the visual impact on the recipient. The various techniques of light also affect our visual perception of historical monuments at night using the different and advanced light technology, through light shows that make the recipient feel like a witness to the place and time and be contemporary with the civilization of that historical monument to reveal the secrets of this ancient history, the story of building the historical monument and glories of its civilization at that time.

The Artificial lighting concept should be in tune with architectural properties and features of historical monument facades. Thus, the light design can draw the attention of viewers to be able to create a relationship between the buildings and the urban context in which they exist. The light design can also help in reviving the historical place and improving the quality of historical monument scene. [1]

2. THEORETICAL BACKGROUND

2.1. Importance of Light in Visual Communication

Light plays an important role in being inspired and having a sense of the place, as it is considered as a design element that can visually reshape the facade configuration according to its different locations and properties. It shows the importance of architectural elements and masses in the facade, which provides visual inspiration explained by the recipient's mind based upon his previous knowledge of the place. [2]

The Artificial light activates the facade features without hiding the basic characteristics. The light properties (location, intensity, direction, color ... etc.) play an important role in changing the shape properties that create a different visual image. The light has two aspects: one of which is a practical aspect intending to achieve a clear vision when being distributed in a thoughtful way and the other is an aesthetic aspect intending to have a sense of temporal and spatial dimensions to create visual communication with the recipient and embody symbolic concepts of the place [2].

2.2. Variables of Light Properties

The variables of light properties (the light shape, its intensity and the method of distributing it on surfaces) have a dynamic effect on the facade surfaces due to the shape variation through:

- Focusing on the lighting of prominent architectural elements such as; the Frieze around the building edges, entrance mass, and some prominent facade elements [3].
- Highlighting a specific mass in the facade by lighting its outer edges [4].

The location and intensity of light emitted from lighting sources are changed through contrast according to the extent to which building materials reflect light. The light properties affect the shape of the formed shadow, which affects the recipient’s sensory impression.

The most important light properties affecting the shape of building facade includes; [2]
2.2.1. Type and Intensity of Light Source

**Point Sources:** They focus on lighting specific details in the facade. The traditional lighting is flashed using light projectors[^5] and is placed at a distance from the facade, so that the facade architectural elements appear as if they are in daylight.

The location of point source and the distance between it and the facade surface play an essential role in showing details, architectural decorations and the extent of shadow formation from those prominent parts exceeding the facade surface. In Figure 1-A, it is noticeable that if the source location is far from the facade, it will create small shadow bands on the facade, so no supplementary lighting will be required or added for the architectural details. On the contrary, if it is near, it will create large shadow bands. Hence, it is preferable to put small point sources directed on the decorative and sculptured parts of the facade to show its details, as in Figure 1-B[^6].

![Figure 1 Effect of Point Source Location on Showing Architectural Details of Façade][6]

**Linear Sources:** They function in a sequence of small and highly efficient point sources emitting light, in the form of linear light fixtures to obtain a different view of specific surfaces in the facade.[^7]

**Mixed Sources:** They use both the point sources to highlight decorative details of a certain aesthetic value, and the linear sources to illuminate specific areas of the facade surfaces, point out to a mass in it and highlight it by lighting its outer edges.

2.2.2. Color of Light

The color of the light has a great visual impact on the recipient; as it affects the characteristics of the facade and it is a way to highlight the shape features. When the color is changed, the recipient's impression and visual perception change as well. Accordingly, the inspiring meanings differ by changing the color of the same shape[^5]. The colored lighting can be divided into:

- **Monochromatic Lighting**
  It is the use of light to form and add a new and different character to the facade design, in order to increase the emotional interaction of the recipient when looking at it, especially when being illuminated in neutral colors, as well as to emphasize the prominent architectural elements in the facade.[^1]

- **Multicolored Lighting**
  It is used to create color contrast between the elements constituting the facade, in order to divide them into a group of surfaces that differ in their importance through the color of the
light projected on them, to create harmony with a certain rhythm in the color of the light, or to highlight the shape or space between the elements' shapes. [1]

2.2.3. Direction of Light
The light rays fall at different angles on the surface. If they fall vertically, we get the highest level of even lighting intensity. On the other hand, if the inclination of the falling light ray direction increases, the lighting intensity level on it decreases, and it will be uneven on the same surface exposed to it, which reduces the lighting intensity level on it [5].

Changing the light angles will result in:

- Attracting attention to the details of a particular element in the facade because of its importance, as it represents one of the main features of the architecture of that monument, or because of its functional or historical importance, and giving it visual dominance in the composition.
- Hiding some details or angles that do not affect the composition of the facade [5].

2.2.4. Lighting Technology
The use of technology to illuminate the facade of buildings has paved the way to architecture as an informational tool, being a new tool that created a communication channel between the urban environment and the recipient. New technologies have been used as a result of the progress in the technology of light, image and video to provide 3D images with high quality due to the great advancement in computers and cameras such as Video Projection (It is the ability to highlight facade details and present a narrating view by illuminating the detail. It has the ability to produce colorful picture patterns and movements. Its importance lies in presenting and amplifying a historical event.), [3]

Lighting can be classified into two types:

- Communicative Lighting
- Dynamic Lighting

3. PRACTICAL STUDY
The research analyzes samples of the facades of important and distinctive historical buildings in Jordan with the aim to show the effect of light on the facade of the historical building at night. They include:

- The facade of Umayyad Palace located at the Citadel Hill;
- The facade of Jerash Gateway; and

The Photoshop program has been used to perform lighting experiments and highlight the new view of historical facades, with the aim of making them more attractive to tourists and visitors as much as possible.

3.1. Applied Procedures
The following light properties have been applied as variables affecting each of the facades of the historical buildings chosen as follows, see Table 1.

3.1.1. Type and Intensity of Light Source

<table>
<thead>
<tr>
<th>Source</th>
<th>Type and Intensity Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point Sources</td>
<td>a) High intensity/ giving double importance</td>
</tr>
<tr>
<td></td>
<td>b) Low intensity/ hiding elements to give another importance</td>
</tr>
<tr>
<td>Linear Sources</td>
<td>a) Even intensity/ horizontal and vertical linear extensions</td>
</tr>
<tr>
<td>Mixed Sources</td>
<td>a) High intensity/ creating harmony between facade elements</td>
</tr>
<tr>
<td></td>
<td>b) Low intensity/ creating harmony between the facade elements</td>
</tr>
</tbody>
</table>
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### 3.1.2. Direction of Light

Vertical (90 degrees) -
- a) Symmetry Giving a functional importance
- b) Rhythm Giving an aesthetic importance

Oblique (60 - 80 degrees) -
- a) Dynamic, giving a/an (functional, aesthetic) importance, dominance of architectural elements.

On the facade line
Away from the facade

### 3.1.3. Color: Color Variations

Monochromatic Lighting –
- a) Repetition/ Rhythm
- b) Highlighting a (space, surface, decoration or element)

Multicolored Lighting –
- a) Dividing a surface/ dynamic
- b) Communication (conveying a specific message of an event, place or character).

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<table>
<thead>
<tr>
<th>Light Properties</th>
<th>Variables of Light Properties</th>
<th>Visual Inspiration of Facade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type and Intensity of Source (1)</td>
<td>Point (1.1)</td>
<td>High Intensity (a)</td>
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<td></td>
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<td>Low Intensity (b)</td>
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<td></td>
<td>Linear (1.2)</td>
<td>Even Intensity (a)</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Mixed (1.3)</td>
<td>High Intensity (a)</td>
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<tr>
<td></td>
<td></td>
<td>Low Intensity (b)</td>
</tr>
<tr>
<td>Direction of Light (2)</td>
<td>Vertical (2.1)</td>
<td>Symmetry (a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rhythm (b)</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Oblique (2.2)</td>
<td>Dynamic (a)</td>
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<td></td>
<td>On the facade line (2.3)</td>
<td>Volumetric effect (a)</td>
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<td>Away from the facade (2.4)</td>
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<tr>
<td>Color (3)</td>
<td>Monochromatic Lighting (3.1)</td>
<td>Repetition (a)</td>
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<td>Highlight (b)</td>
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<tr>
<td></td>
<td>Multicolored Lighting (3.2)</td>
<td>Dividing a surface (a)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communication to convey a message (b)</td>
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</table>
3.2. Analytical Procedures

The light variables presented in Table 1 were applied to the selected samples in Jordan (the facade of Umayyad Palace located at the Citadel Hill, the facade of Jerash Gateway) in order to determine their effect on highlighting the aesthetic values of the architectural elements in the facades of historical buildings and enriching the visual communication of the recipient, as shown in Table 2, 3.

Table 2 The Facade of Umayyad Palace located at the Citadel Hill [Author]

<table>
<thead>
<tr>
<th>Source Type</th>
<th>Direction</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Source Type: (1.1) a, Direction: (2.1) a/ (2.3) a, Color: (3.1) a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Used Light:** Point, high intensity, vertical, symmetrical, monochromatic, repeated and on the facade line.

**Visual Inspiration:** Giving double importance to the architectural elements in the facade and dominance over the composition of the facade, which creates a visual aesthetic value with a repeated rhythm.

| Source Type: (1.1) a, Direction: (2.1) a/ (2.2) a, (2.3) a, Color: (3.1) b |

**Used Light:** Point, high intensity, vertical, oblique, away from the facade and monochromatic.

**Visual Inspiration:** Giving double importance to the functional and aesthetic elements in the facade and establishing the dominance of the entrance in the facade.

| Source Type: (1.1) a, Direction: (2.1) a/ (2.2) a, (2.4) a, Color: (3.1) b |

**Used Light:** Point, high intensity, vertical, oblique, on the facade line and monochromatic.

**Visual Inspiration:** Giving double importance to the aesthetic elements in the facade, highlighting the features of the decoration shape, and emphasizing the entrance space.

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**Used Light:** Mixed, high intensity, vertical, oblique, on the facade line and multicolored.  
**Visual Inspiration:** Creating harmony between the facade elements, giving an aesthetic importance to the elements in the facade, and establishing the domination of the dome.

(5) **Source Type:** (1.3) a, **Direction:** (2.1) a/ (2.2) a, **Color:** (2.3) a

**Used Light:** Point, high intensity, vertical, oblique and multicolored.  
**Visual Inspiration:** Giving double importance, creating dynamism by dividing the surfaces between the facade elements, giving an aesthetic importance to the elements in the facade and establishing the domination of the dome and entrance.

(6) **Source Type:** (1.1) a, **Direction:** (2.1) a/ (2.3) a, **Color:** (3.2) a

**Used Light:** Mixed, high intensity, vertical, oblique and monochromatic.  
**Visual Inspiration:** Creating harmony between the facade elements and creating a dynamic direction to give an aesthetic importance and establish the dominance of the architectural elements.

(7) **Source Type:** (1.3) a, **Direction:** (2.1) a/ (2.2) a, **Color:** (3.1) b

**Used Light:** Mixed, high intensity, vertical, oblique and monochromatic.  
**Visual Inspiration:** Creating harmony between the facade elements, highlighting the ledge and the entrance arch, and making a rhythm in the ledge elements by repeating the point lighting.

(8) **Source Type:** (1.3) b, **Direction:** (2.1) b/ (2.2) a, **Color:** (3.1) a, (3.1) b

**Used Light:** Mixed, high intensity, vertical, oblique and multicolored to divide the surface and have communication.  
**Visual Inspiration:** Creating harmony between the facade elements, giving an aesthetic importance through symmetry, and creating a dynamic dome with the effect of the direction of the oblique light on it. Communicative lighting on both sides of the facade entrance to convey a tourist message about palaces in Jordan (Qasr al-Azraq).

(9) **Source Type:** (1.3) a, **Direction:** (2.1) b, **Color:** (3.2) b and a
**Used Light:** Mixed, high intensity, vertical, oblique and multicolored to divide the surface.

**Visual Inspiration:** Creating harmony between the facade elements, giving an aesthetic importance through symmetry, and creating a dynamic dome with the effect of the direction of the oblique light on it. Communicative lighting on both sides of the facade entrance to convey a tourist message about palaces in Jordan (Iraq al-Amir).

(10) Source Type: (1.3) a, Direction: (2.1) a/ (2.2) a, Color: (3.2) a, (3.2) b

**Used Light:** Mixed, high intensity, vertical, oblique and multicolored to divide the surface and have communication.

**Visual Inspiration:** Giving an aesthetic importance through symmetry and creating a dynamic color in the dome with the effect of the direction of light on it. Communicative lighting on both sides of the facade entrance to convey a tourist message about the palaces in Jordan. Creating a rhythmic repetition of the facade ledge with the color and type of point light.

(11) Source Type: (1.3) a, Direction: (2.1) a/ (2.4) a, Color: (3.1) b

**Used Light:** Mixed, low intensity, vertical and multicolored to divide the surface and have communication.

**Visual Inspiration:** The dominance of architectural elements through linear lighting, communicative lighting on both sides of the facade entrance to convey a tourist message about the palaces in Jordan (Qasr al-Harrana and Qasr al-Azraq).

(12) Source Type: (1.3) b, Direction: (2.1) b, Color: (3.2) b

**Table 3** The Facade of Jerash Gateway [Author]

**Used Light:** Point, high intensity, vertical, away from the facade and monochromatic.

**Visual Inspiration:** Doubling the dominance to highlight the (vertical) architectural elements in the composition of the facade (the entrance and the columns).

(1) Source Type: (1.1) a, Direction: (2.1) a/ (2.4) a, Color: (3.1) b
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**Used Light:** Point, high intensity, vertical, on the facade line and monochromatic.

**Visual Inspiration:** Doubling the dominance to highlight the surfaces and the (vertical) architectural elements in the composition of the facade by repetition. Volumetric effect of the facade.

(2) Source Type: (1.1) a, Direction: (2.1) a/ (2.3) a, Color: (3.1) a

**Used Light:** Point, high intensity, vertical, oblique and multicolored.

**Visual Inspiration:** Doubling the importance to highlight the dominance of the architectural and functional elements (the entrance) and creating dynamism through the multiple colors.

(3) Source Type: (1.1) a, Direction: (2.1) a/ (2.2) a, Color: (3.2) a

**Used Light:** Mixed, low intensity, vertical, oblique and monochromatic.

**Visual Inspiration:** Creating harmony between the facade elements, establishing the dominance of the architectural elements, giving a functional importance (the entrance) and highlighting elements and decorations.

(4) Source Type: (1.3) b, Direction: (2.1) a/ (2.2) a, Color: (3.1) b

**Used Light:** Mixed, low intensity, vertical, (linear) horizontal extensions and monochromatic.

**Visual Inspiration:** Creating harmony between the facade elements to give a functional and aesthetic importance in order to highlight the vertical elements and the ledge.

(5) Source Type: (1.3) b, Direction: (2.1) a, Color: (3.1) b
Used Light: Mixed, low intensity, vertical, oblique, horizontal extensions and multicolored.
Visual Inspiration: Creating harmony between the facade elements to give a functional and aesthetic importance in order to highlight the vertical elements and the ledge, and emphasize the entrance space.

(6) Source Type: (1.3) a, Direction: (2.1) a/ (2.2) a, Color: (3.2) a

Used Light: Mixed, low intensity, vertical, symmetrical and monochromatic.
Visual Inspiration: Creating harmony between the elements and giving a functional and aesthetic importance in order to highlight the entrance, columns and ledge.

(7) Source Type: (1.3) b, Direction: (2.1) a, Color: (3.1) b

Used Light: Mixed, low intensity, vertical and on the facade line, along with emphasizing the linear extensions.
Visual Inspiration: Creating harmony and giving an aesthetic importance in order to highlight the features of the facade shape.

(8) Source Type: (1.3) b, Direction: (2.1) a/ (2.3) a, Color: (3.2) a

4. FINDINGS AND RESULT
Based on the analytical study of the selected models (samples) and the application of light properties variables on the facade of historical buildings in Jordan, the following can be concluded:

4.1. Type and Source of Light
The use of the mixed type (point and linear) creates harmony between the facade elements, together with being able to add an aesthetic importance to certain architectural elements in the facade. It also helps in establishing the dominance of a specific functional element in the facade, in addition to giving a dynamic direction. Thus, the mixed source type is ideal for
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influencing the recipient and for visual communication of the recipient, as in the figures of the Umayyad Palace (5, 7, 8, 9 and 12), the Jerash Gateway (4, 5, 6, 7 and 8).

4.2. Direction of Light
Diversity in the use of (vertical, horizontal and oblique directions) with different angles creates visual continuity and draws the attention of the recipient towards specific morphological features in the facade. Thus, the use of diverse directions enriches the facade and creates visual pleasure and suspense for the recipient, as in the figures of the Umayyad Palace (2, 3, 4, 6, 7, 9, 10 and 11), the Jerash Gateway (3, 4 and 6).

4.3. Color
• Using one color to give additional emphasis to certain elements for the purpose of highlighting them and establishing their dominance, as in the figures of the Umayyad Palace (2, 3, 4 and 7), the Jerash Gateway (1, 2, 4 and 5).
• Using multiple colors to emphasize the hierarchy of the importance of the architectural elements in the composition of the facade, as in the figures of the Umayyad Palace (5 and 6), the Jerash Gateway (3, 6 and 8).
• Communicative Lighting: it is used as indicating elements to convey a specific message and generate a new image in the recipient’s mind to become an informational message for a (place/ event/ character), as in the figures of the Umayyad Palace (10, 11, 12 and 9).

5. CONCLUSION
The research problem was the absence of a study and application of the effect of Artificial light variables on the facades of some historical buildings in Jordan, which affects the visual communication between the historical monument and the recipient at night. The research aims to figure out the effect of light variables on highlighting aesthetic values of architectural elements in the chosen historical building facades in Jordan. Based on the analytical study of the selected models (samples - Type and Source of Light, Direction of Light and Color) and the application of light properties variables on the facade of historical buildings in Jordan are concluded

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