

## Article

# Study on Evaluation of Night Lighting Design in Urban Green Space

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**Received:** May 14, 2023; **Revised:** Jun 1, 2023; **Accepted:** Jun 20, 2023; **Published:** Jun 30, 2023

**Abstract:** In a fast-paced life, people spend more time at night. Thus, the quality of lighting at night is required in urban green areas where people do a lot of activities. The design of night lighting demands functionality and environmental friendliness. Therefore, we surveyed and analyzed visitors' experience using a questionnaire survey for the landscape lighting design of the Xuzhou city's green space. The results showed that visitors were not satisfied with the lighting color and brightness. The current lighting design in the urban green space needs an improvement with new design ideas and concepts.

**Keywords:** Landscape lighting, Touring experience, Urban green space

## 1. Introduction

Highly intensive and fast-paced modern urban life puts people physically and mentally under great pressure. People are spending more leisure time at night so the urban green space is important to ease people's mental pressure and their relaxation [1,2]. Light plays an important role from medical and physiological points of view. The influence of light on physical strength is significant and lighting enables people's activities at night to be easier. Night lighting is an important part of the night landscape visualization with appropriate illumination. However, the majority of the urban green landscape lacks proper lighting and does not provide the expected effect of the night landscape [3]. Lighting affects the perception of the surrounding environment and the experience of visiting so it is necessary to analyze the relationship between the landscape and visual comfort of lighting in the urban green space and between people, lighting, and the environment. To meet people's aesthetic feelings and interests and the public's perception and preference for the lighting in the urban green space, we evaluated the lighting of the Xuzhou city's green space. The result provided a reference for the installment of new lighting system in the urban green space.

## 2. Case Studies

The International Commission on Illumination (CIE) and the Illuminating Engineering Society of North America (IESNA) are globally recognized authorities on lighting technology, and published documents for night lighting such as "Outdoor Ambient Lighting", "Projected Lighting Guide" and "North American Lighting Manual". Night lighting technology and the corresponding technical standards and specifications have played an important role in the development of landscape lighting. There has been research on the physical, functional, and ornamental aspects of lighting in humanistic design. Extensive research has been conducted on the effects of lighting on physical and mental health. The evaluation and prevention of ecological pollution and functional violations of light caused by inappropriate outdoor lighting also have been conducted. It was found that excessive lighting in the living environment affected human health [4], plant and animal physiology [5], and the entire ecological balance in the environment [6]. The landscape lighting of the Concorde Square in Paris reveals the psychological and physiological characteristics well using multiple lighting devices for each level of the square in a hierarchical and planned manner. The visual effect offers a clear spatial hierarchy and balanced lighting intensity. The landscape lighting of Rome's Piazza del Campidoglio is centered on human activity and visual experience, outstanding the rich historical atmosphere and cultural flavor of the building complex. It reveals the humanist spirit advocated by and continued from the Renaissance with a strong artistic impact. These lighting design provide high-value references for landscape lighting design.

### 3. Methods

Research has demonstrated that photos could be used to simulate real landscapes for evaluation. Photographs are also used for the assessment of the advantages of cost-effectiveness and efficiency [7]. Xuzhou boasts a wide array of green spaces, including prominent locations such as Yunlong Park, Yunlong Lake Scenic Area, and Pengzu Garden. To ensure the comprehensive nature of the sites and maintain their representativeness, 10 distinct types of urban green spaces were chosen and photographed including waterfront areas, urban street green spaces, and recreational squares. The photographs were taken in May 2022. To minimize the influence of moonlight, ideal weather conditions with optimal lighting and moonlight were selected, and the shooting time was scheduled between 19:00 and 21:00. Canon 30D cameras were used for the photography. 10 photographs were finally selected for research and evaluation. A survey of the urban green space visitors in Xuzhou City, Jiangsu Province was conducted online. The questionnaire comprised two parts: a survey for visitors' basic information such as gender and age and the evaluation and visitors' satisfaction with five lighting attributes in the night landscape of the urban green space in Xuzhou.

### 4. Results and Discussions

#### 4.1. Basic Information of Respondents

The number of female respondents accounted for 65.69% of the total number of respondents, while that of males accounted for 34.31%. Those who were under 18 years old accounted for 4.9%, while those between 19 and 50 years old and over 50 years old accounted for 85.3% and 9.8%. It was found that the youth and middle-aged people visited the urban green space at night more frequently, and so did more women than men (Figs. 1 and 2)..

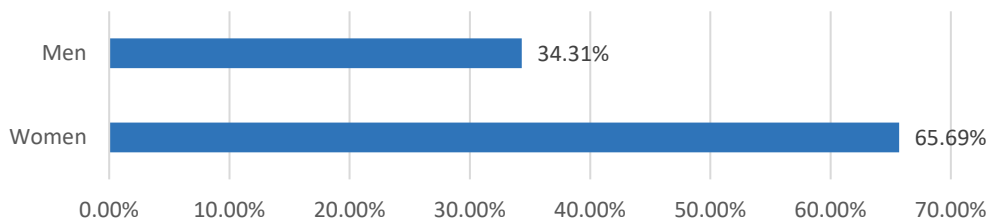


Fig. 1. Gender of visitors to urban green space in Xuzhou.

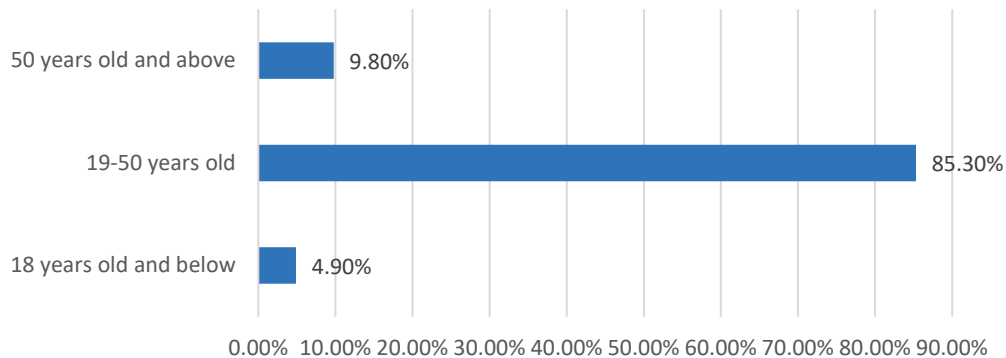


Fig. 2. Gender of visitors to urban green space in Xuzhou.

#### 4.2. Overall Satisfaction Rate

Fig. 3 shows that 39.22% of the visitors to the urban green space at night were satisfied with the space. 8.82% of the visitors were very satisfied, and 11.76% were relatively satisfied. 14.7% were not very satisfied, and 25.5% were relatively not satisfied. The evaluation of the urban green space was low (50.2%) with 38.68% unsatisfied with the space. This result indicated that the urban green space at night required improvement in general to satisfy the visitors.

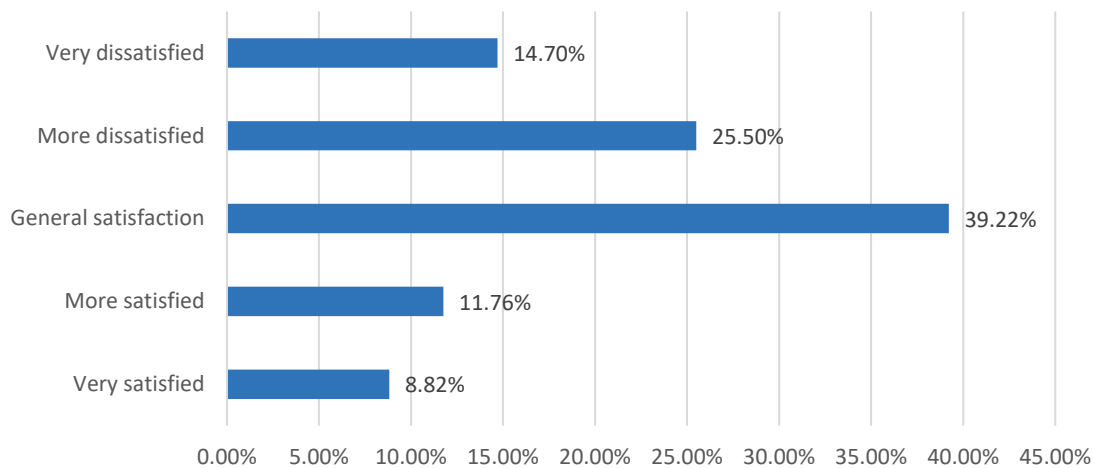


Fig. 3. Visitor's satisfaction rate of urban green space.

#### 4.3. Satisfaction Evaluation of Lighting Properties

As shown in Fig. 4, 41.18% and 20.61% of the visitors were not satisfied and not very satisfied with the colors of the lighting. 7.85% and 4.9% of the visitors were relatively not satisfied and not very satisfied with projection angles. For the quantity of the lighting, 77.45% were satisfied, while 81.36%, 59.81%, and 38.21% of the visitors were satisfied with the height, brightness, and color of the lighting in the urban green space. The result shows that colors need to be changed to improve the overall environment in the space and the satisfaction of visitors.

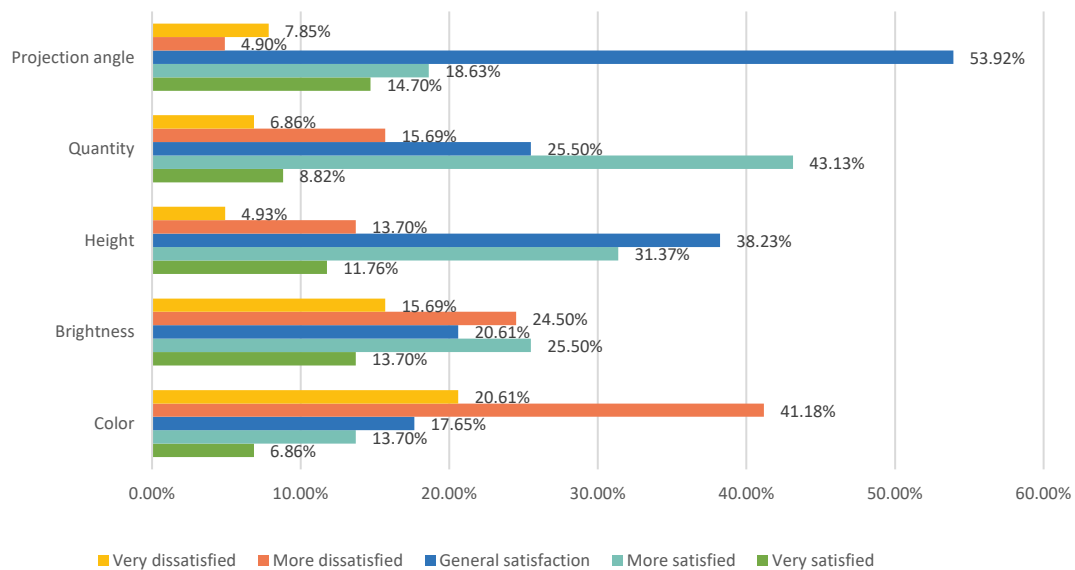


Fig. 4. Satisfaction evaluation of five lighting attributes.

### 5. Discussions and Conclusions

As the main landscape space of the city, urban green spaces provide outdoor spaces for urban residents to conduct recreational activities, communicate with others, and relax. Since most people are busy during the day, they need a comfortable and relaxing space to release their physical and mental stress at night. The urban green space at night allows for people's comfort and activities. Therefore, the design of the lighting in the night landscape is important for people because of the absence of natural light at night which enhances people's viewing experience. The visitors to the urban green space were not satisfied with the current lighting design of the urban green space. For five lighting attributes, visitors showed the lowest satisfaction rates for colors and brightness which were correlated and most directly perceived by visitors. Thus, the visitors' sense of security and aesthetics were lowered.

Based on the above result, the following suggestions were made in this study. Future lighting design of the urban green space at night needs to ensure the safety of the lighting and provide the visual perception of visitors. In the urban green space landscape, various design elements are integrated including planting, vignettes, structures, road networks, and other elements. For different landscapes, the appropriate brightness and color must be chosen according to the characteristics, size, and location of the sites. The light projection angle, brightness, and colors also need to be adjusted to avoid improper projection angles or high brightness which cause dazzling, light pollution, and other problems. In the night of the urban green space, besides these landscape elements, human health, surrounding ecology (e.g., birds, fish, insects, and other organisms) and other elements also must be considered in lighting design. Artificial lighting at night may be related to breast and prostate cancers, depression, obesity, and sleep disorders with the effects of environment and urbanization [8]. Birds cannot detect direction for flying at night due to the effects of light and reflections from building surfaces, insects are also disrupted and die or prolong their lifespans. Insects also increase the information exchange and reproduction rates, which adversely affects plants. Therefore, these environmental factors must be taken into account in the night lighting design of the urban green space. For the site evaluation, there may be deviations in the result caused by odor, visitor density, and body temperature. As the photos did not restore the real scenes, respondents might lack an immersive experience. Such uncontrollable factors may affect the visitors' judgment and evaluation. As we photographed only ten sites, they do not represent all elements of the urban green space. Therefore, more scenes are required for further research to provide design ideas and concepts for lighting design of the urban green space at night.

**Author Contributions:** Conceptualization, Q. Liu; methodology, Q. Liu; software, Q. Liu; validation, Q. Liu; formal analysis, Q. Liu; investigation, Q. Liu and X. Li; data curation, Q. Liu; writing—original draft preparation, Q. Liu; writing—review and editing, Q. Liu; visualization, Q. Liu and X. Li; supervision, Q. Liu and X. Li.

**Funding:** This research was funded by “The Graduate Innovation Program of China University of Mining and Technology”, Grant No. 2023WLJCRZL330.

**Acknowledgments:** We would like to thank anonymous reviewers for their valuable comments and suggestions for improving this paper.

**Conflicts of Interest:** The authors declare no conflict of interest.

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