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# The Development Status and Trends of Urban Lighting Masterplans in China - A Qualitative Study Using NVivo Software

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## Abstract:

In recent years, with the development of nighttime economy, the rising demand for characteristic city image, and the emergence of advanced and intelligent lighting technologies, the construction of urban night landscapes in China has entered a new period. Chinese municipal governments have started to introduce new urban lighting masterplans to meet the new demands of urban development. This paper takes the latest urban lighting masterplan texts released by 20 Chinese cities since 2017 as the research object, and uses NVivo software to conduct coding visual analysis, matrix analysis and cluster analysis on the masterplan texts to summarize the principles, objectives, construction contents, implementation and guarantee policies of these new urban lighting masterplans, and compare them with the previous lighting masterplans. Finally, extracting the focus of China's urban lighting construction and its future development direction, providing a basis for the formulation of urban night landscape policies and industry standard systems.

**Keywords:** Urban Lighting; Lighting Masterplan; Content Analysis; NVivo; Light landscape.

## 1. Introduction

Urban lighting masterplan is a guideline for the development of urban lighting programmatic documents, is the preparation of regional landscape lighting masterplan and implementation of landscape lighting construction and management of the fundamental basis. The history of China's urban lighting masterplan can be traced back to the 1989 Shanghai Bund architectural lighting and the Beijing city night lighting construction that began in 1997. The history of urban lighting masterplan in China can be divided into three stages (Hao et al., 2012). The first stage, from 1992 to 1999, is the enlightenment of China's urban lighting masterplan, the initial development stage. Although the awareness of urban lighting masterplan and design is very weak, the only lighting design is mostly limited to a single project or area, such as Beijing Tiananmen Square, the Bund, etc. The second stage, from 2000 to 2008, is the stage of China's urban lighting masterplan theory formation. Urban lighting masterplan in the content and mode gradually improved rich, the pursuit of brightness and landscape beautification is the main feature of this stage of urban lighting masterplan. The third stage, from 2005 to 2017, the green energy saving and light pollution problems in urban lighting became the focus of urban lighting masterplan in various provinces and cities. The theoretical study of China's urban lighting masterplan began to step into a phase focused on the coordinated development of people and the environment. China's urban lighting masterplan theory began to mature.

After 2017, with the advanced and intelligent lighting technology and the continuous development of nighttime economy, the relationship between lighting and the city at night has become more and more inseparable. Especially after the 19th National Congress of the Communist Party of China, the construction of an international, green, intelligent and humanistic modern metropolis has become the goal of the development of major cities. Various cities began to update their urban night lighting plans on the basis of the original plans. Urban lighting masterplan has entered a new fourth stage. In order to sort out the key construction content and development direction of the fourth stage of urban lighting masterplan, this paper uses NVivo software to conduct coding visualization analysis, matrix analysis and cluster analysis on the urban lighting masterplan texts introduced since 2017.

## 2. Indoor Space Conditions

### 2.1. Study Object

In order to obtain and sort out the policy texts issued by local governments nationwide on urban nighttime light landscape, multiple sources of policy texts were searched: firstly, policies and regulations were searched in local government portals with the keywords light landscape, urban lighting, and night lighting. Secondly, relevant policies were tested in the national laws and regulations database; finally, policy documents containing relevant keywords were searched in the well-known domestic policy literature database "Pkulaw", as a check and review reference. Finally, the policy documents with relevant keywords in the well-known domestic policy literature database "Pkulaw" were searched as reference for verification and review. After the above steps, this paper collects policy documents issued by various departments in 31 provinces and cities (except Hong Kong, Macao and Taiwan)

between January 2017 and January 2023. The range of selected policy texts includes official documents such as laws, regulations, rules, plans, and guidelines promulgated in the form of documents by national and local authorities or administrative organs at all levels. After screening and eliminating invalid documents such as forwarding, irrelevant content, and incomplete information, 20 valid samples were finally obtained (Table 1).

**Table 1.** Urban lighting masterplans for 20 cities in China.

| <b>Publishing Department</b>  | <b>Masterplan</b>  |
|---|--|
| Beijing Municipal Commission of Urban Management                            | Beijing Urban Lighting Development Planning During the 14th Five-Year Plan |
| Shanghai Landscaping & City Appearance Administrative Bureau                | Shanghai Landscape Lighting Planning                                       |
| Guangzhou Municipal Housing and Urban-Rural Development Bureau              | Guangzhou City Lighting Subject Planning (2021-2035)                       |
| Shenzhen Urban Management and Comprehensive Law Enforcement Bureau          | Shenzhen City Lighting Subject Planning (2021-2035)                        |
| Shantou Urban Management and Comprehensive Law Enforcement Bureau           | Shantou City Landscape Lighting Planning (2018-2030)                       |
| Jinan Natural Resources and Planning Bureau                                 | Jinan City Lighting Masterplan (2018-2035)                                 |
| Chengdu Municipal Commission of Urban Management                            | Chengdu Central City Landscape Lighting Subject Planning (2017-2025)       |
| Nanjing Municipal Bureau of Planning and Natural Resources                  | Nanjing City Lighting Subject Planning (2020-2035)                         |
| Bureau of Natural Resources and Planning of Datong                          | Datong City Lighting Subject Planning (2017-2030)                          |
| Bureau of Natural Resources and Planning of Luoyang                         | Luoyang City Lighting Subject Planning                                     |
| Bureau of Natural Resources and Planning of Sanya                           | Sanya city night lighting Subject Planning                                 |
| Wenzhou Housing and Urban-Rural Development Bureau                          | Wenzhou City Lighting Subject Planning                                     |
| Nanning City Municipal and Landscape Management Bureau                      | Nanning City Lighting Subject Planning (2021-2035)                         |
| Kunming City Management Comprehensive Administrative Law Enforcement Bureau | Kunming City Center Urban Landscape Lighting Plan and Design               |
| Xi'an City Management and Comprehensive Law Enforcement Bureau              | Xi'an City Night Landscape Illumination Design Subject Planning            |
| Suzhou City Management Bureau   | Suzhou City Lighting Subject Planning (2035)                               |
| Bureau of Natural Resources and Planning of Zhuzhou                         | Zhuzhou City Lighting Subject Planning (2020-2035)                         |
| Zhangjiagang City Management Bureau   | Zhangjiagang City Urban Lighting Construction Subject Planning (2020-2035) |
| Quzhou Wisdom New City Management Committee                                 | Quzhou City Intelligent New City Night Lighting Subject Planning           |
| Baoding City Management Comprehensive Administrative Law Enforcement Bureau | Baoding City Lighting Subject Planning                                     |

## 2.2. Study Steps

The coding process of this paper is carried out based on the rooting theory research method. After collecting and importing the planning text into NVivo software, all plans are included in the coding according to the text order. In this study, the primary headings and secondary headings in the text are coded into parent and child nodes one by one against each other, and the same parent or child nodes are integrated, and finally categorized and integrated again according to the nature of the parent nodes. After all the texts were coded, the names and positions of the nodes were modified according to their corresponding textual contents, and then the utilization rate of each textual content was analyzed with the help of NVivo's coding coverage statistics. The coding coverage of the lighting masterplan texts of 20 cities was analyzed (see Fig.), with the highest coding coverage of 99.34%.

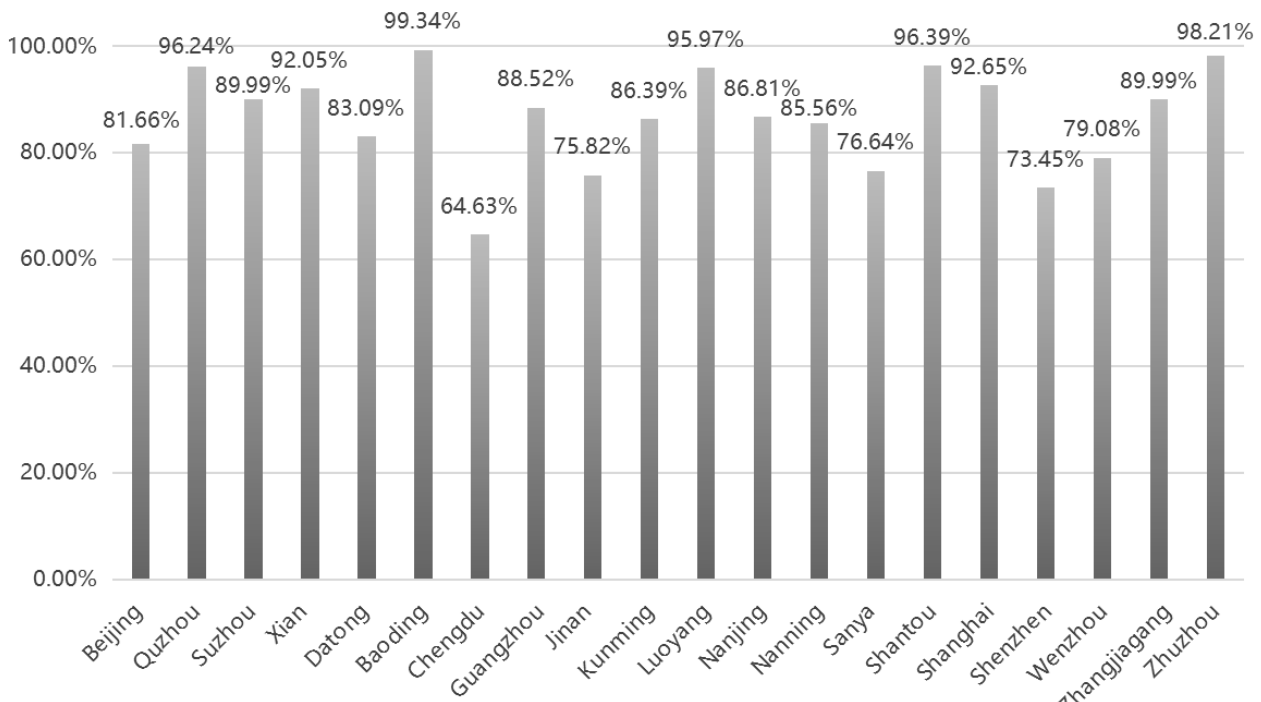


Figure 1. Coding coverage of 20 city lighting masterplan texts (Developed by Author).

**3. Results**

In the primary coding process of this study, 20 planning texts were read and analyzed word by word, resulting in 988 reference points. The second-level coding process summarized all reference points, which in turn resulted in 65 first-level sub-nodes and 20 second-level sub-nodes. The tertiary coding process pondered and analyzed the connection between each secondary sub-node, which was then summarized into 6 parent nodes of planning background, guiding ideology, planning principle, construction target, construction content, and implementation guarantee. These intrinsically linked tree nodes together interpret the lighting masterplan hierarchy and key contents of each city.

**3.1. General Framework of Urban Lighting Masterplan**

Through the overall word frequency analysis of urban lighting masterplan texts released by 20 cities, it was found that the high-frequency theme words of the planning texts include landscape, architecture, night view, control, area, design, road, etc. (Table 2). Combined with the analysis of the text content can be concluded that the relevant departments in the process of urban lighting masterplan, the main focus on the landscape, buildings, roads, parks and other carriers as the key planning objects, specifically from the control, design, function, brightness, culture, business, activities and other specific aspects, but also focus on the construction process required lamps, facilities and other elements.

Table 2. High-frequency words in the urban lighting masterplan texts of 20 cities.

| Subject word | Frequency | Subject word | Frequency | Subject word | Frequency |
|--------------|-----------|--------------|-----------|--------------|-----------|
| Lighting     | 7389      | Road         | 913       | Business     | 627       |
| City         | 3081      | Night        | 809       | Management   | 613       |
| Landscape    | 2302      | Function     | 782       | Area         | 584       |
| Plan         | 1972      | Space        | 778       | Important    | 578       |
| Architecture | 1603      | Brightness   | 774       | Center       | 567       |
| Nightscape   | 1268      | Economy      | 725       | Facilities   | 545       |
| Control      | 1118      | Environment  | 705       | Intelligent  | 542       |
| Region       | 1077      | Culture      | 691       | Dynamic      | 539       |
| Construction | 1066      | Park         | 668       | Requirement  | 537       |
| Design       | 987       | Lamp         | 667       | Activities   | 534       |

### 3.2. Analysis of Urban Lighting Masterplan Content

#### (a) Construction target

To further analyze the content of urban night lighting masterplan, this paper compares the lighting plans of 20 cities in which the father node is the construction goal (Table 3). It is found that promoting the development of night tourism and night economy, and promoting the construction of ecological civilization are the goals set by most of the city lighting plans. In addition, the construction goals of the plans include optimizing urban lighting resources, improving citizens' happiness index, and expanding the international influence of the cities. Nanning, Datong, Luoyang, Kunming and other cities also divide the planning goals into near-term and long-term goals. The near-term goals are achievable within a short period of time, from 2017 to 2025, and mainly include: improving functional lighting, creating a safe urban night environment, shaping the characteristic urban night landscape and other goals. Long-term goals are goals that can not be achieved in a short period of time, it runs through the entire process of urban lighting masterplan and construction, the need for staged short-term goals as a pavement, through the continuous superposition of short-term goals to achieve, its realization time is about 2026 to 2035, the main content contains the formation of a complete night landscape system, the formation of a characteristic night image, to enhance the vitality of the city, pulling business, tourism development The purpose is to achieve a balance of economic, social and environmental benefits and the sustainable development of urban lighting.

**Table 3.** Construction targets in the urban lighting masterplan texts of 20 cities.

| Construction Target                     | Specific content   | Number of texts involved |
|---|--|--------------------------|
| Promoting Night Tourism                 | To enhance the attractiveness of the city's nighttime sightseeing tourism, and build a world-class night tourism destination.<br>To Promot the upgrading of urban night-time cultural tourism consumption.<br>To Provide a richer nightlife environment for citizens and tourists. | 12                       |
| Building Ecological Civilization        | To accelerate the construction of ecological civilization and create a green and livable night light environment.<br>To effectively control light pollution and protect the urban dark sky environment.<br>To achieve a balance of economic, social and environmental benefits.    | 12                       |
| Boosting Nighttime Economy              | To create a prosperous consumption environment at night, pull the city's comprehensive economic benefits, improve the economic structure of the situation, and adapt to the needs of the city's night-time economic development.   | 12                       |
| Achieving Green and Low-carbon Lighting | To reduce carbon emissions and promote the construction of low-carbon lighting   | 10                       |
| Upgrading Management                    | To form a perfect urban lighting management system.<br>To achieve intelligent, refined and efficient urban lighting management and help upgrade urban services.  | 10                       |
| Safeguarding Nighttime Safety           | To meet the basic safety needs of the public at night as the first, priority to solve the functional lighting problems, to protect the safety of night activities, to create a safe travel environment.  | 9                        |
| Showing Cultural Characteristics        | To enhance the cultural taste of landscape lighting, show the cultural heritage of the city, and promote the dissemination of urban night culture  | 9                        |
| Shaping City Image                      | To establish a characteristic night city image, improve the image and quality of urban lighting, highlighting the city's appearance  | 6                        |

#### (b) Construction content

After the targets are determined, actions become the key. In order to further analyze the focus of each city's night lighting masterplan and construction content, this paper compares and analyzes the lighting masterplan text of 20 cities in the section of the parent node "planning content". According to the "functional lighting masterplan" "landscape lighting masterplan" "green lighting masterplan" "low-carbon energy-saving lighting""Intelligent Lighting" "night economy and night tourism" six primary sub-nodes under the secondary sub-nodes of the number of reference points (Table 4), it can be seen that most cities still lighting the overall structure, functional lighting and landscape lighting as the main work of lighting masterplan It can be seen that most of the cities still consider the general lighting structure, functional lighting and landscape lighting as the main tasks of lighting masterplan.

**Table 4.** Distribution of reference points for construction contents

| Parent Node          | First-level Sub-node              | Second-level Sub-node   | Number of reference points |
|----------------------|-----------------------------------|---|----------------------------|
| Construction Content | Functional Lighting Planning      | General requirements, functional lighting zoning, road lighting, architectural lighting, residential lighting, village interior lighting, park lighting, square lighting, public parking lot lighting, urban greenway lighting, urban open space lighting, signage system lighting, advertising signage lighting, lighting issues pre-defined program | 106                        |
|                      | Landscape Lighting Planning       | General structure, management rules, lighting zoning, night landscape elements, landscape lighting control  | 91                         |
|                      | Green Lighting Planning           | Green lighting principles, green lighting indicators, harmful emissions control, the whole life cycle, light pollution prevention, dark sky protection, plant and animal protection, green lighting products and new technologies, intelligent IOT, control systems   | 61                         |
|                      | low-carbon energy-saving lighting | Light efficiency indicators, clean energy, functional density, energy-efficient lighting products, lighting start/close time and power supply, negative list, publicity and education, energy-efficient lighting methods  | 36                         |
|                      | Intelligent Lighting              | Intelligent lighting system, intelligent lighting fixtures  | 39                         |
|                      | Night Economy and Night Tourism   | Nighttime landmarks, night tourism routes, supporting nighttime services, commercial consumption-oriented activities, leisure and tourism-oriented activities, tourism and vacation-oriented activities, sports and fitness-oriented activities, festival and celebration-oriented activities, thematic event-oriented activities                     | 78                         |

From the text content, the number of secondary sub-node reference points for functional lighting and landscape lighting is the highest, with the number of 106 and 91. This indicates that functional lighting and landscape lighting are still the main work of the current urban night lighting construction. Functional lighting is the infrastructure of urban night lighting. Through the analysis of functional lighting secondary sub-nodes found that the current functional lighting masterplan of cities is mainly for different areas of road lighting for separate planning, such as city road lighting, village and town internal road lighting, tunnel lighting, bridge lighting, etc.. The main goal of functional lighting is to achieve "should be built as much as possible", to ensure the quality of lighting, construction of safe night activities environment. Through the analysis of landscape lighting secondary sub-nodes found that the planning of urban landscape lighting ideas are as follows: First, the important areas, axes, paths, landmarks, nodes, etc. in the urban area sorting sort, through the selection of landscape lighting carrier and comprehensive analysis, select the key landscape lighting areas, paths, nodes and landmarks, the formation of landscape lighting architecture. Second, according to the landscape lighting architecture, different lighting elements for targeted lighting strategy planning, general lighting elements are divided into: axes, areas, nodes, landmarks, boundaries, etc., planning content including lighting brightness, color temperature, color lighting control and dynamic lighting control; Finally, according to the upper planning requirements of the specific characteristics of the city's buildings to refine and establish lighting objectives, for the city's special architectural lighting. Finally, according to the upper planning requirements of the specific characteristics of the city's buildings to refine and set lighting objectives, to provide guidance for the city's special architectural lighting, including lighting techniques, luminaire type.

Through the text content analysis the author also found that the night economy and night tourism has become the focus of new lighting masterplan efforts. The number of reference points for their secondary sub-nodes is second only to functional lighting and landscape lighting, with a high number of 78. The planning content of the night economy is mainly for different types of nighttime public activities planning, including consumer business-type activities, leisure and tourism-type activities, tourism and vacation-type activities, sports and fitness-type activities, festival celebration-type activities, theme event-type activities, etc.; the main content of the night tourism planning focuses on various themes of the night tour route planning and lighting cultural tourism product planning.

#### **(c) Integrating degree between construction goal and construction content**

In the NVivo software "group query" function module, the code nodes were viewed, and the "construction target" code was found to be highly correlated with the "construction target" code, showing a The relationship of correspondence and support. On the one hand, it shows the tightness of the planning text and logical arrangement of each city lighting plan, on the other hand, it reflects the two-way interaction between "construction target" and "construction content". For example, the first-level sub-node "night economy and night tourism" contains 78 reference points such as "building night landmarks", "night tourism routes", "supporting night services" "These

planning contents reasonably depict the planning objectives of "boosting night economy" and "promoting night tourism development", and provide a concrete path to achieve the targets.

#### 4. Discussion

Through quantitative analysis of the content of the planning text, it is found that the light landscape becomes an independent object to be planned. Compared with the initial lighting masterplan, the new round of urban night lighting masterplan texts have added a lot of content to emerging light landscape forms such as light shows, light festivals, and immersive light tours. For example, the "Chengdu Central City Landscape Lighting Special Plan (2017-2025)" explicitly plans for the location of light shows; the "Guangzhou City Lighting Special Plan (2021-2035)" proposes to continue to expand the global influence of the Guangzhou International Light Festival brand to help Guangzhou become a world-class tourist destination; the "Xi'an City Night Landscape Lighting Design Special Planning" plans to use light shows and other forms as a festive celebration mode to distinguish between weekdays and festive periods in the city from building façade lighting. This shows that the city night landscape is no longer just stay on the roads, landscapes, buildings and other carriers of lighting, gradually by the media, information technology of the light has been rid of its subsidiary identity, light landscape has become an independent planning object.

In addition, many cities, such as Guangzhou, Shenzhen, Zhuzhou and Shantou, have incorporated the construction of smart light poles into their urban lighting plans. This is because, with the continuous development of China's information technology, the smart city will become a new generation of urban form development trend, which will certainly have a huge impact on urban planning methods. As a special urban planning, lighting masterplan has a close correlation with the construction of smart city hardware.

Finally, promoting the nighttime economy has become the most important purpose of urban lighting masterplan. Twelve of the 20 cities will promote the development of night tourism and boost the night economy as a planning goal. At present, night consumption has become the most fashionable way of life in commercial cities. The night economy, which consists of night tours, night drinks, night banquets, night singing, night shopping, night practice and other consumption contents, represents to a certain extent the prosperity level of local economy and culture, is the embodiment of city personality, and is a barometer of the quality of life of a city. In order to better promote the night tour economy, the planning of each city devotes a lot of space to developing night tour supporting facilities, planning night tour routes, and improving the night life environment, in order to achieve the ultimate purpose of boosting the night economy.

#### 5. Conclusions

In this paper, the texts of urban lighting plans of 20 cities were selected as the research objects, and the coding, word frequency analysis, and cluster analysis of NVivo software were used to analyze the development of urban lighting plans in each province. Due to the complexity and subjectivity of the preliminary coding work, there are some shortcomings in this study. However, this study combines data processing and analysis by NVivo software with rooting theory and content analysis method using urban lighting masterplan texts, which is a novel and useful attempt for urban night lighting research and provides a new direction for future related research.

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#### Conflict of Interests

The authors declare no conflict of interest.

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