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**Short Research Paper**

# Construction and Verification of Night-time Economy Development Evaluation Index System

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**Abstract:** Night-time economy is an important indicator to measure the level of regional economic development. Accurately measuring and evaluating the level of night-time economy is of great significance to promote consumption upgrading and economic growth. Under the background of digitalization, e-commerce and digital technology have greatly expanded the scene and market of night consumption. In this paper, on the basis of defining the connotation of night-time economy, the key elements of its development are determined. We construct and verify the night-time economy development evaluation index system from five dimensions: Environmental Basis, Convenience of Consumption, Vitality of Consumption, Quality Evaluation of Development and Network Attention. In the selection of index data, the method of multi-source data fusion analysis is adopted to integrate statistical data, night light data and data from the Internet platform to jointly measure and evaluate the development of night-time economy.

Keywords: night-time economy, multi-index evaluation system, life service e-commerce platform

## 1. INTRODUCTION

"Night-time economy" was first put forward by Britain in the 1970s to improve the phenomenon of empty nest at night in the urban center. In fact, Night-time economy is an economic form based on time division, which refers to the economic and cultural activities from 6 p.m. to 6 a.m. of the next day. It is dominated by tertiary industries such as catering, tourism and entertainment. The core of night-time economy is the extension of consumption chain of urban economy in time and scene.

According to the theory of leisure time and consumer behavior, night-time economy is the product of the enrichment of consumer leisure time when the economy of a city or region develops to a certain stage. Night-time economy has become a new driving force for economic growth. As an important part of urban economy, the prosperity of night-time economy is an important way to promote the adjustment of urban economic structure and enhance the comprehensive competitive strength. At present, more than 40 cities in the world have clearly issued policies on night-time economy. As of October 2020, China has issued nearly 200 policies that are highly relevant to night-time economy. Data from China's Ministry of Commerce shows that 60 percent of consumption in China takes place at night, and the market size of the night-time economy has reached 2,643,125 billion yuan in 2019.

At present, the study of night-time economy is mainly based on qualitative analysis, which expounds the function of night-time economy and how to develop it. By constructing a reasonable measurement framework, we can understand the development status of night-time economy in different time and different regions more clearly. That is to say, it can objectively reflect the development of night-time economy from the perspective of quantitative analysis, and provide theoretical basis for the practical development of it. Given the difficulty in

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obtaining data on the night-time economy, how to measure its level of development effectively remains a very innovative and challenging work.

The rapid development of digital technology is comprehensively restructuring the development model of various industries. The popularity of mobile Internet and e-commerce has greatly expanded the night consumption scene and promoted the digital transformation of the industry. Leading companies in the digital economy, such as Meituan, Alibaba and JD.com, are competing to enter the night-time consumer market to seek commercial value. E-commerce and social media platforms contain a large amount of data that can reflect users' online browsing, socializing and consumption behaviors at night, which provides a new data dimension to quantitatively analyze night-time economy.

In this paper, combined with the existing research basis, the measurement framework of night economic development level is constructed. We use the method of multi-source data fusion analysis to integrate statistical data, night light data and data from the Internet platform to jointly construct the evaluation index system of night-time economy development. On the basis of the index system, Analytic hierarchy process and Entropy weight method are used to comprehensively evaluate the night-time economy. Taking Beijing as an example, this paper verifies the evaluation index system and objectively evaluates its night-time economy development potential.

## 2. LITERATURE REVIEW

In fact, it was not until the 1990s that the night-time economy was formally incorporated into academic research <sup>[1]</sup>. Similar to the development course, the study of night-time economy has experienced three stages: preliminary exploration, gradual growth and rapid development. Most of the studies focus on the economic impact, social impact and development countermeasures of the night time economy <sup>[2]</sup>. In terms of economic impact, first of all, night-time economy can directly drive economic growth by extending the running time of economic activities <sup>[3]</sup>. The development of core industries in night-time economy will also drive the coordinated development of related industrial chains <sup>[4]</sup>. For example, the prosperity of night tourism will drive the development of catering, transportation, accommodation and retail. In addition, night-time economic agglomeration areas dominated by service industry will produce agglomeration effect and form economies of scale <sup>[5]</sup>. As for the social impact, the alcohol-centered night-time economy model in the past has led to a series of negative impacts threatening social security, such as urban management, crime and security at night <sup>[6]</sup>. With the improvement of living standard, the demand of high quality leisure and entertainment puts forward higher requirements for the development of night-time economy. Researchers began to propose a large number of policy development proposals for the high quality development of the night-time economy.

Quantitative analysis of night-time economy is still at a very slow start due to the lack of theory and the difficulty in obtaining data. Reasonable measurement of night-time economy is the primary task to carry out quantitative research on night-time economy. At present, a few scholars and research institutions have launched a preliminary exploration to the measurement of night-time economy. For example, the evaluation model for the development potential of night-time economy can be constructed from the aspects of city comprehensive strength, the ability of consumers, the business situation, the related industries, the government behavior, uncontrollable factors and so on <sup>[7]</sup>. However, the data are mainly from questionnaire survey, which lack the data to objectively reflect the night-time economic activity. With the development of remote sensing technology, night light data has been proved to be able to effectively reflect the economic development level of a region <sup>[8]</sup>. In addition, from the perspective of spatial geography, the comprehensive index of night economy can be constructed by combining

night light intensity data and POI data to analyze the level of night-time economy<sup>[9]</sup>.

In the past two years, some Internet enterprises and research institutions, such as Meituan, Alibaba and Jingdong, have released research reports on night-time economy. They use the platform's internal data to assess the vitality of the city's night-time economy from different perspectives. The "Digital Night-time Economy Development Report of Chinese Cities" constructs the digital night-time economy index from four dimensions: the development foundation of the tertiary industry, the infrastructure of night commerce, the circulation vitality of night consumption, and the initiative of the government to develop night-time economy. The "China Night-time Economy Development Quality Index 1.0" constructs the night-time economy development quality index from five dimensions: the richness of night business, the evaluation of night tour products, the activity of night consumption, the maturity of commercial facilities and the evaluation of green development. "Zhejiang Province Night-time Economy Activity Index 1.0" analyzes the difference of night-time economy in time and space from five dimensions: the richness of night business, the convenience of night consumption, the activity of night consumption, the evaluation of night consumption and the maturity of commercial facilities.

### 3. THEORETICAL FRAMEWORK OF NIGHT-TIME ECONOMY MEASUREMENT

Through the combing of these research reports, we can find that the environmental basis of development, the vitality of night consumption, the convenience of night consumption, the quality evaluation of development and the network attention are the key factors affecting the development level of night-time economy. Environmental basis reflects the macroscopic environment atmosphere of night-time economy development in a city or region, which is the important carrier of its development and the basic condition of night-time consumption. The convenience of consumption reflects the vitality of night-time economy from the perspective of supply side. The convenience of night consumption determines whether the supply of night-time economy can meet the needs of consumers. The core purpose of night-time economy development is to drive night consumption to expand domestic demand. Thus, the vitality of consumption is the most direct embodiment of the prosperity of night-time economy. The vitality of consumption measures the development of night-time economy from the perspective of quantity, while the quality evaluation measures its development from the perspective of quality. We evaluate the quality of night-time economy development from the two dimensions of supply and demand. The network attention of night-time economy, namely the popularity of "night-time economy" on social media, is an important factor to promote the development of night-time economy. Consumption is a kind of social behavior with strong demonstration effect. People imitate each other in their consumption. The publicity and promotion of night-time economy by social media in cyberspace can promote more people to participate in night consumption.

Drawing on the measurement experience of digital economy, this paper constructs a set of theoretical framework suitable for night-time economy measurement. First, refine and define the connotation of night-time economy. Secondly, the theoretical logic of night-time economy development is constructed. The development factors of night-time economy are subdivided into five parts: Environmental Basis, Convenience of Consumption, Vitality of Consumption, Quality Evaluation of Development and Network Attention. Thirdly, the core measurement indexes of night-time economy are screened and the evaluation index system is constructed. Next, the comprehensive evaluation method is determined. Finally, validate the evaluation development system, empirically analyze and objectively evaluate the potential of a region's night-time economy development. Figure 1 shows the theoretical framework of night-time economy measurement.

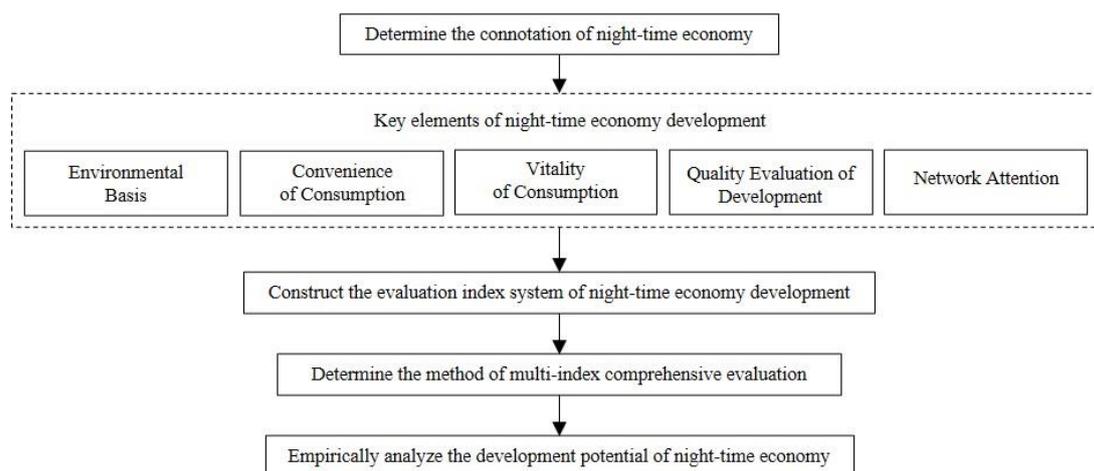


Figure 1. Theoretical framework of night-time economy measurement

#### 4. CONSTRUCTION OF DEVELOPMENT EVALUATION INDEX SYSTEM

There are many factors that affect the development of night-time economy. In the actual measurement of night-time economy, there are usually more qualitative indicators, less quantitative indicators. The development of Internet and digital technology makes it possible to measure night-time economy reasonably.

##### 4.1 Overall framework of the evaluation index system

On the basis of theoretical logic and research report, the evaluation index system of night-time economy development is preliminarily constructed. The index system covers the factors of night-time economy development in multiple dimensions and scenes. And it follows the principles of comprehensiveness, hierarchy and feasibility. Figure 2 shows the overall framework of the evaluation index system.

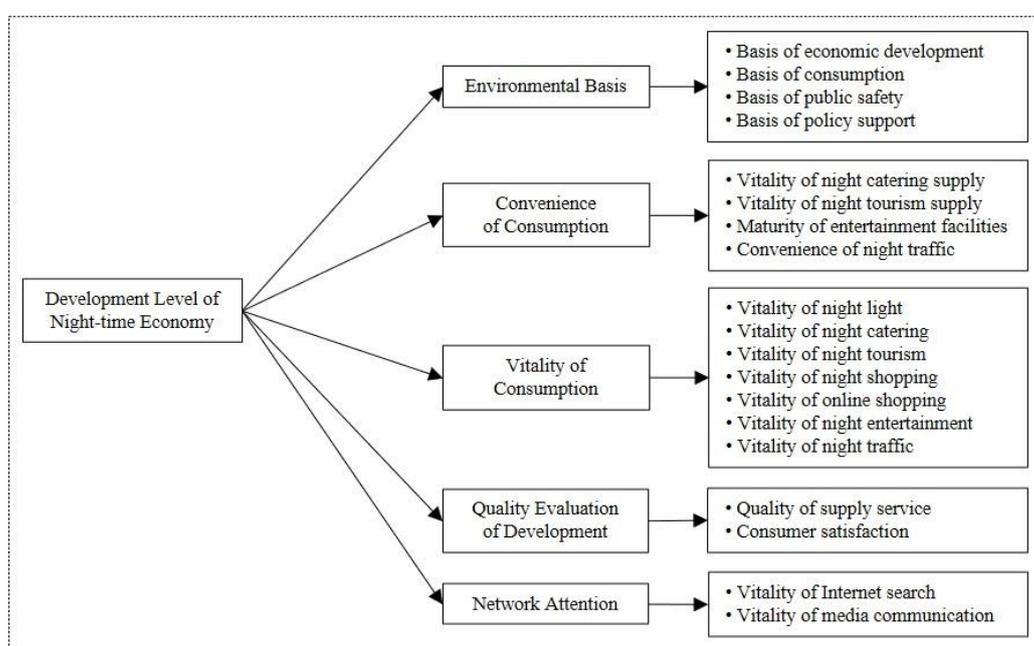


Figure 2. Overall framework of the evaluation index system

##### 4.2 Detailed evaluation index system and index description

Table 1 shows the detailed contents of the evaluation index system.

**Table 1. Evaluation index system of night-time economy development**

First level indicators	Second level indicators	Description of indicators
Environmental Basis	Basis of economic development	Proportion of added value of tertiary industry
	Basis of consumption	Per capita income and consumption level
	Basis of public safety	Night public safety index
	Basis of policy support	Number of night economic policy releases
Convenience of Consumption	Vitality of night catering supply	Proportion of night catering businesses
	Vitality of night tourism supply	Proportion of night tourism businesses
	Maturity of entertainment facilities	Number of night entertainment facilities
	Convenience of night traffic	Proportion of night public transport
Vitality of Consumption	Vitality of night light	Global night light data
	Vitality of night catering	Proportion of catering consumption at night
	Vitality of night tourism	Proportion of tourism consumption at night
	Vitality of night shopping	Proportion of shopping consumption at night
	Vitality of night entertainment	Proportion of entertainment consumption at night
	Vitality of night traffic	Vitality index of public transport
Quality Evaluation of Development	Quality of supply service	Proportion of high quality night-time merchants
	Consumer satisfaction	Score for the quality of consumption
Network Attention	Vitality of Internet search	"Night-time economy" Internet search index
	Vitality of media communication	Number of information released by media platform

#### 4.2.1 Environmental basis

Environmental Basis is the key element to support night economic development. In this paper, we divide the Environmental Basis into four aspects: basis of economic development, basis of consumption, basis of public safety and basis of policy support. The development level of tertiary industry is the necessary condition for the development of night-time economy. Consumers are the key participants of night-time economic activities. Their consumption level determines their contribution to night-time economy. Good social security and traffic environment can ensure the smooth development of night-time economy. The issue of the policy reflects the government's emphasis on and support for the development of night-time economy.

#### 4.2.2 Convenience of consumption

"Convenience of Consumption" describes the vitality of the supply side at night. Supply of commercial infrastructure and transportation facilities is very important to the development of the night -time economy. Convenience of night traffic can provide the guarantee of traffic travel for night-time economic activities. We can describe the supply of commercial facilities in terms of the vitality of night catering, night tourism and the maturity of night entertainment facilities.

#### 4.2.3 Vitality of consumption

This partly reflects the vitality of consumers' participation in the night-time economy. In the past, night light data could reflect to some extent the intensity of night economic activity. With the development of digitization, we can capture data reflecting users' night consumption behavior from the Internet platform. The vitality of night consumption can be measured from different consumption forms such as night catering, night traveling, night shopping and night entertainment.

#### 4.2.4 Quality evaluation of development

This part evaluate the development of night-time economy from the perspective of quality. "Quality of supply

service" measures the development quality of night-time economy from the supply side, while "Consumer satisfaction" measures the development quality from the consumer side.

#### 4.2.5 Network attention

With the booming development of social networks, the development dynamics of night-time economy can be quickly spread through official and personal media. "Network Attention" reflects the popularity of the "night-time economy" on social media. "Vitality of Internet search" and "Vitality of media communication" related to night-time economy can reflect this online attention.

## 5. VALIDATION OF EVALUATION INDEX SYSTEM

### 5.1 Data Collection

The data in this paper mainly includes statistical data, night light data, and data from Internet platforms such as e-commerce and social media. Statistical data are mainly from the national and provincial statistics bureaus. All the statistical data of the study area have been obtained at present. Global Night-time Light Database is derived from raw image data from the National Oceanic and Atmospheric Administration (NOAA). So far, we have taken and corrected night light data in China from 2013 to 2019. About e-commerce platform data, we use Python to crawl relevant data on the life service e-commerce platforms such as Meituan, Dianping and so on. At present, the data of some cities and regions have been obtained. In terms of social media data, "night-time economy" is used as the key word to capture data from social media platforms such as Baidu and Weibo.

### 5.2 Selection of research scope

As the key city of night-time economy, Beijing is suitable as the object of study in the first stage. Beijing has so far identified the first batch of four landmarks, nine business circles and nine living circles for night-time economy development. Beijing Municipal Bureau of Commerce and Meituan jointly issued the "Consumption Guide for Night City 2020".

### 5.3 Method of multi-index comprehensive evaluation

Multi-index comprehensive evaluation method is widely used. According to the evaluation indexes, it can be seen that some indexes are suitable for using the hierarchical structure model to abstract the problem, and some evaluation indexes meet the calculation conditions of objective weighting. Therefore, the combination weighting method is adopted to weight the evaluation indicators. The calculation formula of linear weighted combination method is as follows.

$$\theta_j = \sum_{i=1}^k b_i w_{ij} \quad (1)$$

$\theta_j$  is the combination ownership of the j-th index,  $b_i$  is the weight coefficient of the i-th method,  $w_{ij}$  is the ownership of the j-th index obtained by the i-th method.

Specifically, Analytic hierarchy process and Entropy weight method are used to comprehensively evaluate the development level of night-time economy.

#### 5.3.1 Analytic hierarchy process

Analytic Hierarchy Process is a comprehensive evaluation method established by American operations researcher T.L.Saaty in the 1970s. It is mainly divided into the following four steps:

- Establish the hierarchical structure model and form hierarchical organization chart.
- Construct a judgment matrix and compare each element in the same hierarchy pairwise. The values of the judgment matrix reflect the relative importance of the various indicators.
- Hierarchical single sort: The weight value of each index in this level relative to an index in the upper level is calculated. The consistency test is carried out on the judgment matrix.
- Hierarchical total sort: Determine the composite weight of all indicators against the overall target for

overall sorting. The consistency test is carried out on the judgment matrix.

### 5.3.2 Entropy weight method

Entropy weight method is to determine the weight of each index according to the amount of information contained in it. It is mainly divided into the following steps:

- The original data of each index is normalized.
- Calculate the information entropy value of each index.
- Convert the entropy value of each index to its weight.

### 5.4 Rationality analysis of evaluation results

This paper constructed the evaluation index system on the basis of the existing night-time economy research report. In terms of the selection of evaluation indexes, it refers to the indexes in the existing research. We will verify the accuracy of the evaluation index system by comparing the comprehensive evaluation results with the analytical data of business reports and socio-economic statistics. If the evaluation results are highly correlated with the validation data, it would indicate that the indicator systems in this paper and other reports can achieve consistent results when assessing the level of night-time economy development in specific areas.

## 6. CONCLUSIONS

In this digital and intelligent era, big data, cloud computing, artificial intelligence and other digital technologies are deeply integrated with the night-time economy. The digital transformation of night-time economy related industries provides a data basis to quantitatively analyze the development of night-time economy and enriches the dimension of night-time economy quantitative research.

In this paper, we draw on the experience of economic scale measurement such as digital economy to construct the theoretical framework of night-time economy measurement under the digital background. On the basis of analyzing literatures, research reports and policies, the key elements of night-time economy development are identified. Using the method of multi-source data fusion analysis, this paper constructs and verifies the evaluation index system of night economic development. In the selection of evaluation methods, the combination of Analytic hierarchy process and Entropy weight method is used to comprehensively evaluate the development level of night-time economy.

Due to the limitation of time, we have only preliminarily constructed the framework of night-time economy measurement and the evaluation index system, which still needs to be improved with the enrichment of theories and data. At the same time, due to the heavy workload of Internet data collection, this paper does not give the results of night-time economy measurement of Beijing. In the future research, we will first complete the measurement of Beijing's night-time economy. Next, incorporate more research areas into the empirical analysis to optimize the evaluation index system and evaluation methods. And the evaluation result will be compared with the results of more research reports on night-time economy to verify the accuracy of the evaluation results. The measurement of night-time economy is the first step of its quantitative analysis. With the development of theory and practice, the driving mechanism of night-time economy to economic growth and the policy effectiveness analysis will also be included in the research scope.

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