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Research on Evaluation Index System of Low-carbon Existing Communities

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ABSTRACT

In recent years, China has carried out urban renewal in an orderly manner. Based on the new stage, to accelerate the construction of a low-carbon innovative society under the urban renewal, we should improve the low-carbon indicator system, deepen the transformation of existing urban communities, and enhance the urban low-carbon innovation capacity. Based on the review and reference of the evaluation system of low-carbon related pilot work, the practice of low-carbon community index system in foreign countries, and the existing research and practice of other Chinese scholars on the existing community low-carbon index system, this paper proposes the construction principles of low-carbon community evaluation index system. This paper summarizes the influencing factor framework of the construction of energy-saving buildings, low-carbon transportation and low-carbon living environment in the process of low-carbon existing communities, and selects the secondary and tertiary indicators according to the influencing factors. A set of low-carbon community index system is proposed to evaluate the existing community, and the operability of the evaluation index system is verified by questionnaire survey.

KEYWORDS

Existing community; Low-carbon development; Evaluation index.

1. INTRODUCTION

At present, urban renewal is an important part of the realization of low-carbon goals. It takes the form of re-planning, reconstruction and construction of old, crowded or unadaptable areas in the city, aiming at improving the function, image and living environment of the city and promoting sustainable urban development. In the process of urban renewal, the existing community is often the primary transformation object. Through the study and optimization of its low-carbon, existing resources can be utilized to the maximum extent, the demand for new facilities can be reduced, the overall carbon emission can be reduced, and the low-carbon transformation of other communities can be provided with reference and reference, and the overall low-carbon development of the city can be promoted.

2. RESEARCH ON COMMUNITY EVALUATION SYSTEM AT HOME AND ABROAD

2.1. Introduction to foreign evaluation system.

The low carbon community in foreign countries developed earlier and has formed a relatively perfect evaluation index system. Internationally influential green community evaluation systems include

LEED-ND evaluation system in the United States, BREEAM evaluation index system in Europe, CASBEE in Japan, etc. Under the three principles of "smart growth", "new urbanism" and "green building", the LEED-ND regional evaluation system has been launched[1]. ISO 37120 has a large number of indicators, all of which are quantitative indicators. Starting from the two aspects of urban service and quality of life, it can be basically classified into three categories: scale, structure and performance, which involve all aspects of urban sustainable development[2]. By setting different weights for each index, the British BREEAM Communities system integrates the regional characteristics and environmental characteristics of different regions into the index evaluation[3].

2.2. Introduction to domestic evaluation system

At present, a number of domestic scholars have conducted research on the decarbonization of existing communities: In terms of regional low-carbon evaluation in China, the relevant standards that can be referred to mainly include Technical Guidelines for Low-energy Green Building Demonstration Zones, Assessment indicators and Evaluation Criteria for Green Community, and Evaluation Indicators for the construction of Green and low-carbon Key small towns[4]. In their paper Research on Evaluation Methods and Index System of Low-carbon Community Planning, Guochao Zhao et al. proposed that the comprehensive evaluation system of low-carbon community planning is composed of five subsystems, and the evaluation index system of low-carbon community planning is formed after comprehensive summary of the low-carbon indicators involved in the sub-system[5]. In their paper "Research on Evaluation Index System of Low-carbon Community", Lin Fu et al put forward the construction principles of China's low-carbon community evaluation index system, that is, the index framework is determined before the selection of indicators[6]. In his paper "Research on Classification of Existing Communities for Low-Carbon Transformation", Shiyan Yu proposed to first identify the key elements of classification evaluation of low-carbon communities, and then build the corresponding type index system according to the framework of type-key-factor evaluation index[7].

2.3. Evaluation system analysis at home and abroad

Through the research and analysis of the community evaluation system at home and abroad, it is found that the above evaluation system is suitable for the existing community low-carbon evaluation system.

The existing low-carbon community evaluation system at home and abroad is generally elaborated by the framework of index category, primary index, secondary index and index item, which has clear classification and level. In terms of framework design, the most important aspect of the index system is the influence factors of low-carbon community, such as architecture, transportation, energy, resource utilization and operation management. Considering the index setting of the key points and technical guidelines of the whole life cycle construction of the community, it involves a wide range of areas and contains more comprehensive contents.

3. ESTABLISHMENT OF LOW CARBON EVALUATION INDEX SYSTEM IN EXISTING COMMUNITIES

3.1. Construction principle

Based on the existing standards and norms at home and abroad, extensively collect and sort out domestic and foreign literatures and evaluation systems related to low-carbon concepts, community carbon emissions, and low-carbon community planning, classify and sort out the low-carbon community evaluation elements included, and focus on collecting monographs, journals, and national norms related to green communities, low-carbon communities, and zero-carbon communities. The

evaluation index system of low-carbon community is summarized by classifying, analyzing and comparing the cross-points of various literatures on low-carbon community evaluation.

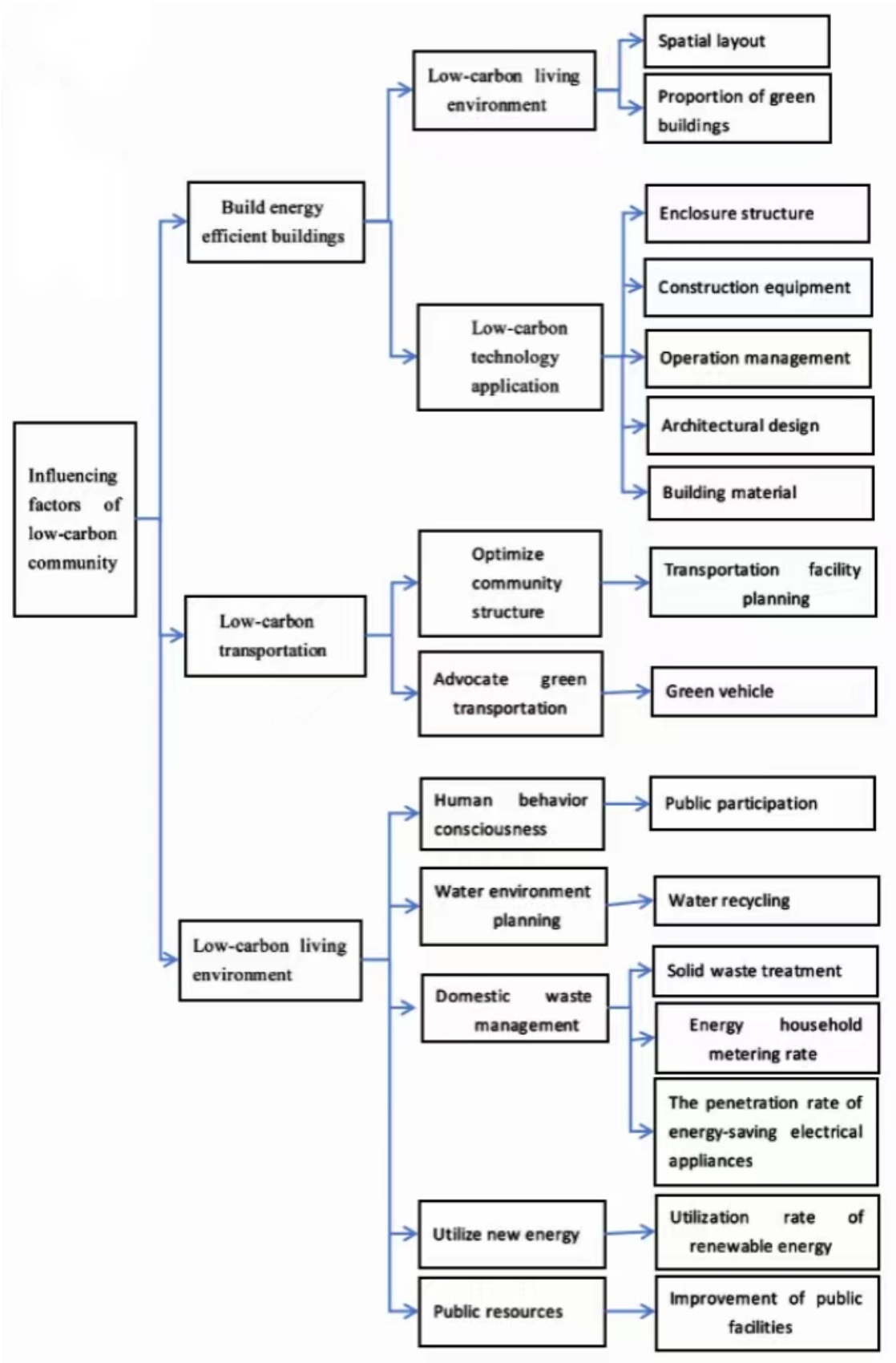

Figure 1. Influencing factors of low-carbon community

3.2. The construction of influencing factor frame

The construction of low-carbon community consists of three aspects: low-carbon building, low-carbon transportation and low-carbon living environment[8]. With the continuous updating of technology, the introduction of sustainable materials and renewable energy, the efficiency of existing buildings has been greatly improved, and the adverse impact on the environment has been greatly reduced. Therefore, the low-carbon existing communities should consider "building energy-saving buildings"; Through the use of energy-saving and environmentally friendly means of transportation, the exhaust emissions of motor vehicles can be reduced, thereby reducing the concentration of pollutants in the air, improving the air quality of the community and reducing energy waste and environmental pollution[9]. Therefore, "low-carbon transportation" should be considered in the low-carbon existing communities. In order to achieve green and low-carbon development, in the final analysis, it is necessary to solve the problems of economic and social development mode and lifestyle[10], so the low-carbon transformation of existing communities should consider "low-carbon living environment construction". According to the above research, the influencing factors of low-carbon communities are sorted out in Figure 1.

3.3. Construction of index score value

In order to build a comprehensive and effective low-carbon community evaluation index system, the relevant literature is examined and analyzed. By carefully sorting out and summarizing the evaluation indicators in the existing studies, the core factors affecting the construction of low-carbon communities are identified. These factors cover energy efficiency, building design and material selection, transportation modes, environmental greening and beautification, solid waste treatment, water resource management and utilization, and residents' lifestyles.

On this basis, the importance of these influencing factors is analyzed systematically. Through the combination of quantitative and qualitative methods, the weight and influence degree of each indicator in the construction of low-carbon communities are assessed. This not only serves to better understand the relationship and mechanism of each index, but also provides a scientific basis for the subsequent index score assignment.

Based on the relevant requirements and the local practice of the low-carbon community evaluation index system, the scientific and operability of the basic data of the index are comprehensively considered, and the index items are fine-adjusted, including the addition, deletion and merger of individual index items, and quantitative evaluation is made in the form of scores. The results have mathematical statistics characteristics.

Finally, according to the statistical results and analysis, we assigned a corresponding score value to each indicator. The total score of this low-carbon index system is 150 points, which consists of the construction of energy-saving buildings (70 points), low-carbon transportation (20 points), and the construction of low-carbon living environment (60 points). The specific index scores are shown in Table 1. These scores not only reflect the importance of each index in the construction of low-carbon communities, but also reflect its relative status in the overall index system. Through this assignment process, we construct a complete, scientific and operable low-carbon scale value to provide a scientific basis.

Table 1. Score of low-carbon community evaluation index

Primary index	Score	Secondary index	Score	Three-level index	Score
Build energy efficient buildings	70	Scientific low-carbon planning	20	Spatial layout	15
				Proportion of green buildings	5
		Low-carbon technology application	50	Enclosure structure	20
				Construction equipment	5
				Operation management	15
				Architectural design	20
				Construction material	5
Low-carbon transportation	20	Optimize community structure	10	Transportation facility planning	10
		Advocate green transportation	10	Green vehicle	10
Building low-carbon living environment	60	Human behavior consciousness	5	Public participation	5
		Utilize new energy	5	Water recycling	5
		Domestic waste management	15	Solid waste treatment	15
		Utilize new energy	30	Energy household dose rate	5
				The penetration rate of energy-saving electrical appliances	5
				Utilization rate of renewable energy	20
		Public resources	5	Improvement of public facilities	5

3.4. Evaluation level

According to the score value, the existing community evaluation is divided into four levels: smart low-carbon community, near low-carbon community, high energy community and ultra-high energy community to evaluate the low-carbon level of the existing community. The classification of low-carbon community evaluation levels is shown in Table 2.

Table 2. Classification of low-carbon evaluation index system

Lv.	Smart low-carbon community	Near low carbon community	High energy community	Ultra-high energy community
synthesis score	(120-150]	(90-120]	(50-90]	(0-50]

4. EMPIRICAL ANALYSIS

4.1. Empirical analysis

In order to verify the scientifically, rationality and operability of the constructed evaluation index system, the scoring table was compiled according to the existing community low-carbon evaluation index system, and a total of 21 communities such as Tangshan Caofeidian Shoutang Entrepreneur and Hebei Fengning Xinshun Homeland were effectively investigated and studied by combining online and offline approaches. In order to make the research results more representative and typical, the types of communities investigated include archaic communities with earlier construction years, traditional communities with widespread existence, and new passive communities.

Among the 21 valid questionnaires, the highest score was 117, and the lowest score was 22. In terms of score distribution, about 17 communities (accounting for 80.95%) scored above 50, and 21 communities scored (see Figure 2). From the point of view of sub-items, the community generally scored higher in the indicators of "public resources" and "energy household measurement"; The scores of "envelope structure" and "low-carbon management" are basically the same; The three fixed indicators with low score rates are "renewable energy utilization rate", "water recycling" and "green building proportion".

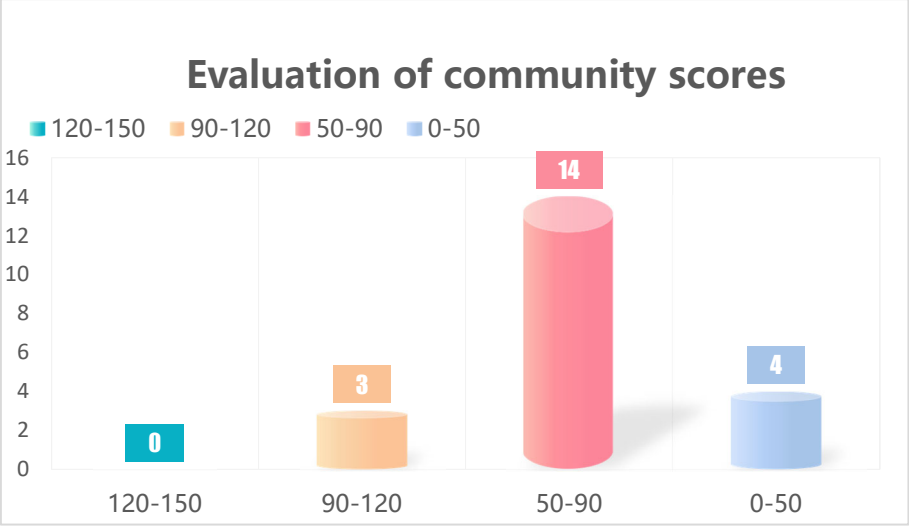

Figure 2. Statistical chart of scores of participating communities

4.2. Examples of evaluation rules

Relevant data were obtained through on-site investigation and interviews. According to the above evaluation process, scores were scored on various indicators and a multi-level comprehensive

evaluation model was introduced to obtain the scores of each criterion layer and the comprehensive scores of low-carbon communities. Taking Shoutang · Chuangjia ordinary residential community in Caofeidian District, Tangshan as an example, the survey results are as follows:

①Comprehensive floor area ratio:

Comprehensive plot ratio refers to the ratio of calculated plot ratio building area and residential land area. Among them, the construction area shall be calculated in accordance with GB/T 50353. The comprehensive floor area ratio scoring rules are shown in Table 3.

Table 3. Comprehensive plot ratio rating table

Composite floor area ratio	score
[2,3]	5
[1.5,2）	3
[1.0,1.5）	1

The community has a combined floor area ratio of 1.2 and a score of 1 according to the above rules.

②Passenger-vehicle diversion:

Take people-vehicle diversion measures, and the walking and bicycle traffic system has sufficient lighting, the total score of the evaluation value is 5 points, the scoring details are as follows：Take human-vehicle diversion measures, 3 points；Adequate lighting for walking and cycling systems, 2 points.

The example community has a human-vehicle split mode with sufficient lighting and scores 5 points.

③Green coverage rate:

Green coverage rate refers to the percentage of the total land occupied by the sum of the green space and the converted green space in the community.The green area includes the horizontal projection area of the planting and covering soil of the green area, and the horizontal projection area of some hard landscapes and water views that meet the specified requirements within the green area. Among them, green space includes ground green space and roof green space. In a green space with a width of not less than 8 m and a green space area of not less than 400, a pedestrian path with a width of less than 2.5m can be regarded as a green space, and its horizontal projected area can be included in the green space. The converted green space shall be calculated according to the Rules of Shenzhen Architectural Design.

Table 4. Green coverage rate rating table

Green coverage rate	score
≥40%	5
[35%,40%)	3
[30%,35%)	1

The green coverage rate of the community can reach 50%, which is a perfect score.

⑤500 meters coverage of public transport stations:

Refers to the service area of public transport stations in the community built-up area (a circle with the public transport station as the center and a radius of 500 meters; Intersecting parts shall not be counted twice) as a percentage of the built-up area. Public transport stations include bus stations and rail transit stations, and the location of rail transit stations is calculated according to the location of exit and entry stations. The scoring rules of 500-meter coverage of public transport stations are shown in Table 5.

Table 5. Rating table for 500-metre coverage of public transport stations

500 meters coverage of public transport stations	Score
100%	5
[90%，100%）	3
[85%，90%）	1

The 500-meter coverage of the community reached 92%, scoring 3 points.

⑤Community new energy vehicles:

Table 6. Rating table for the proportion of new energy vehicles

Community new energy vehicles	Score
≥70%	5
（50%,70%]	3
（30%,50%]	1

In this example community, the proportion of new energy vehicles can reach 43%, scoring 1 point.

⑥Classification and collection rate of domestic garbage:

The garbage sorting collection rate refers to the percentage of households in the community that implement garbage sorting collection in the total number of residents.

Table 7. Classification and collection rate of domestic garbage

Classification and collection rate of domestic garbage	Score
＞90%	5
（80%，90]	3
（0，80%]	1

The classification rate of domestic waste is 100%, full marks.

The evaluation rules of the 30 indicators are evaluated and scored according to the above examples, and the final score of the community is shown in Table 8:

Table 8. Comprehensive scores of existing communities

index	Build energy efficient buildings	Low-carbon transportation	Low carbon living environment The construction of
Score	59	5	30

Judging from the evaluation results, the total score of Shoutang · entrepreneur is 94 points, reaching the development level of low carbon community.Through comparison and combination with the established low-carbon evaluation system, the following conclusions can be drawn: compared with most communities, this community has a higher degree of low carbon, and has excellent performance in the planning and layout of human-vehicle separation, the proportion of green buildings ≥50%, the envelope structure meets the requirements, low-carbon operation and management, and the green rate ≥40%. However, it has not yet reached the standard of low-carbon community, and there are still problems such as unreasonable spatial layout and design, low carbon transportation, shallow awareness of carbon reduction, and low utilization rate of new energy, which provide reference for relevant departments to carry out transformation.

5. SUMMARY

In this paper, the existing community low-carbon evaluation index system is constructed, the specific evaluation level is established, the score of each index is determined, and the empirical research is conducted. This evaluation index system has an orderly hierarchy, clear objectives, can reflect the development characteristics of existing urban communities, is convenient to operate, simple and practical, can play a role in evaluating the low-carbon construction of communities, construction analysis of existing community planning in urban renewal, and has certain positive significance for quantitative assessment and index management of communities. Promote the scientific and standardized construction of low-carbon communities. At the same time, this index system can also be adjusted and optimized according to the actual application situation to meet the needs of low-carbon community construction in different regions and different development stages.

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