

Comprehensive Evaluation of Green Residential District in China from view of Social and Humanity Demand

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Abstract. Green building is becoming the main trend in current construction industry due to its main characteristics: energy saving, low carbon emission and environmental protection. Exist evaluation systems of green residential districts have little consideration on social and humanity demand. Based on the methods of social impact assessment and social life cycle assessment, and by considering the Chinese situation, an evaluation framework on the green residential districts from view of social and humanity demand was established. A series of indexes were included in this framework. An evaluation program was developed to make the evaluation more convenient. In the end, a case study was carried out to verify the effectiveness of the proposed framework and the developed program.

Introduction

Green building has become the main trend in current construction industry due to its main characteristics: energy saving, low carbon and environmental protection. At present, there are some evaluation systems, such as Building Research Establishment Environmental Assessment Method (BREEAM), Leadership in Energy and Environmental Design (LEED), The Key Points and Technical Guideline for Green Ecological Residential District Construction and The Manual for Technological Appraisals of Chinese Green Low-carbon Community focused on the green buildings worldwide. However, almost all the evaluation systems of green building have little consideration of the influence from social humanity to residents.

Social Impacts Assessment (SIA) and Social Life Cycle Assessment (S-LCA) are evaluation methods which concern social humanity. Some researchers have made their efforts on SIA to evaluate many public infrastructure industries such as water conservation, civil aviation and railway, etc. S-LCA is a method which takes objects' whole life into consideration and analyzes its social impacts from every stages of its life. At present, SIA and S-LCA focus mainly on industrial products or gigantic engineering project and little research has been done on green residential districts.

It is of great importance to establish evaluation systems for green residential district from the view of social and human demand. Green humane character and green humane planning should also be paid more attention on as well as green technology to re-recognize the performance and characteristic of green building on the side of humane needs is one of the essential aspects in sustainable development. Based on SIA and S-LCA, combining with the Chinese situation, an evaluation framework on green residential districts considering social and human demand was established. A program was developed to make the evaluation more convenient. Finally, a case

study was carried out to verify the effectiveness of the proposed framework and the developed program.

Evaluation Steps

First, information and data concerning with green residential districts were collected, and the system’s characteristics and all the factors which make up the system were analyzed comprehensively. Second, some of the indexes from “Guidelines for SIA” and “Guidelines for S-LCA” after the research on SIA and S-LCA were cited. Combining with the Chinese situation, every important factor of the system by category according to the analysis results was listed, and a primary index system was formed. Third, the indexes were put onto an investigation list and sent it to the residents who lived in green residential districts to make a social survey. After the analysis of the survey, the index system further considering importance degree of the indexes were filtered and modified. Forth, some experts were invited to make an assessment about the index system and give some suggestions on amendment. Fifth, all the indexes’ weight by AHP was figured out based on the relationship between green residential districts and social humane needs.

Comprehensive Evaluation Index System

The comprehensive evaluation indexes system consists of four parts: computing method, evaluation indexes, weight of the indexes and final grade.

Computing method. To illustrate the computing method of the index system clearly, the computing process has been simplified into a flow chart (Fig.1). The light part of the chart represents the process of the calculation and the dark part represents the results of the calculation.

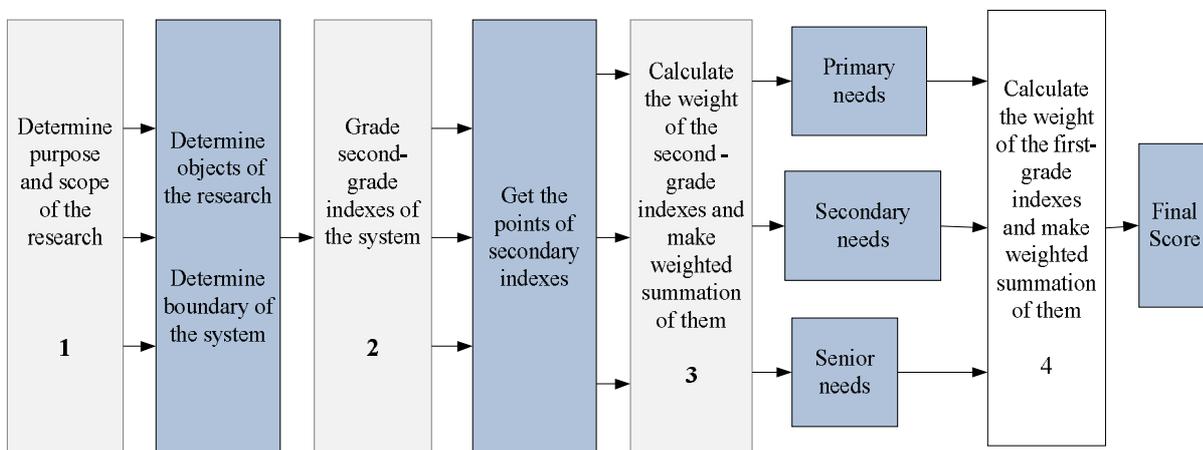


Fig.1 The flow chart of the comprehensive evaluation indexes system of green residential districts

Comprehensive evaluation index system. The evaluation indexes consist of three grades indexes (Fig.2). Higher grade indexes are summary and generalization of the lower ones while lower grade indexes are refinement and explanation of the higher ones. The first-grade indexes are used to evaluate green residential districts from the social and humanity demands perspective in three aspects: primary needs, secondary needs and senior needs.

To show different importance of all the indexes in the system objectively, expert investigation method and analytic hierarchy process (AHP) was adopted to analyze the weights. Stakeholders, including the representatives of the construction contractor, representatives of residents and representatives of government officials, are selected to be object of investigation.

The evaluation indexes and their weights are shown in Table 1.

First-grade Indexes U_i	Second-grade Indexes U_{ij}		Third-grade Indexes	
Primary Demands U_1 (Weight=0.4)	Education Culture U_{11}	0.15	Education facilities (school)	0.63
			Cultural facilities (library)	0.37
	Sports Amusement U_{12}	0.12	Places for exercise	0.68
			Places for amusement	0.32
	Medical Health U_{13}	0.11	Level of medical buildings	0.81
			Treatment of medical wastes	0.19
	Finance Commerce U_{14}	0.14	Commercial species richness	0.35
			Rank on the ease of doing business	0.33
			Banking institutions	0.32
	Public Infrastructure U_{15}	0.18	Heat supply	0.21
			Power supply	0.28
			Water supply	0.27
			Communication	0.24
	Safety U_{16}	0.15	Level of safety facilities	0.54
			Treatment of building death corner	0.21
			Amount of concealed lane	0.25
	Green Transport U_{17}	0.15	Public transport	0.43
Design of sidewalk			0.21	
Parking lot			0.36	
Secondary Demands U_2 (weight=0.25)	Adaptation to local conditions U_{21}	0.20	Adaptation to the climate of the community	0.56
			Adaptation to the landform of the community	0.44
	Construction Materials U_{22}	0.30	Usage of environmental materials and recyclable materials	0.53
			Proportion of the materials taken from location	0.47
	Building Layout U_{23}	0.30	Design of layout for shade	0.34
			Design of layout for ventilation	0.30
			Design of layout for going out	0.36
	Resource Conservation U_{24}	0.20	Utilization efficiency of resource	0.37
Utilization rate of regenerative resource			0.63	
Senior Demands U_3 (Weight=0.35)	Environmental Protection U_{31}	0.30	Adaptation to ecological diversity	0.72
			Comfort and health of activity places indoor and outdoor	0.28
	Resource Protection U_{32}	0.25	Protection on the original ecology of the land	0.31
			Protection on the original ecology of the water	0.42
			Protection on the original ecology of the material	0.27
	Spirit Culture U_{33}	0.25	Architectural art and aesthetic values	0.31
			Protection and development on local historic sites	0.38
			Protection and development on local culture	0.31
	Public Welfare U_{34}	0.20	Propaganda of social public service	0.36
			Humane care for special population in community	0.64

Table 1 The comprehensive evaluation indexes

Final grade. The comprehensive evaluation index system divides buildings into four grades according to their final scores, as shown in Table 2.

Final Scores	1.0—0.8	0.8—0.6	0.6—0.4	<0.4
Final Grade	A	B	C	D

Table 2 Grades of final scores of comprehensive evaluation method

Program Developments and Case Study

A residential area located in Beijing was taken as a case to verify the effectiveness of the proposed method.

Introduction of the Software. The comprehensive evaluation system software for social and humanity demands on green residential districts was designed based on java. Users can grade all indexes of the system by filling blank and choosing options in the software according to the community’s practical situation. Then the software collected the information from users and calculated the final points. The final grade of the community and the comprehensive analysis of the results will also be supplied. At the same time, the software also supplied the SIA and the S-LCA methods to evaluate the project so that users can compare three different results from three methods and make a more comprehensive conclusion.

The demonstration of evaluation process on the example

Project Profile. The project was built in 2014 and was the representative green residential districts in this area. The area of this community was about 26000m² and its building area was 60000m². The community’s green coverage area was 14000m² and its green coverage rate had reached more than 50%.

Evaluation Process.

Step 1, input basic information of the green residential districts.

Step 2, choose evaluation system. The author chose comprehensive evaluation index system to evaluate the example.

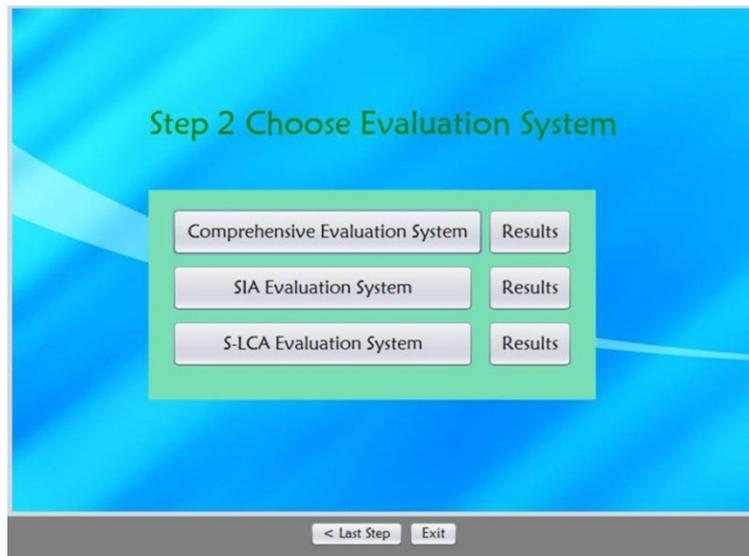


Fig.2.The interface for choosing evaluation system



Fig.3.The interface for grading indexes

Step 3, grade all the indexes on by one.

Step 4, check out the evaluation result. The result is demonstrated in three terms: the mark sheet, radar map and histogram.

The Evaluation Results					
Final Score	0.67				
First-grade Indexes	Weight	Score	Second-grade Indexes		
Primary Social Humane Needs	0.4	0.57	Education Culture	0.15	0.00
			Sports Amusement	0.12	0.75
			Medical Health	0.11	0.50
			Finance Commerce	0.14	0.33
			Public Infrastructure	0.18	1.00
			Safety	0.15	1.00
			Green Transport	0.15	0.33
			Adaptation to local conditions	0.20	1.00
Secondary Social Humane Needs	0.25	0.88	Construction Materials	0.30	0.75
			Building Layout	0.30	1.00
			Resource Conservation	0.20	0.75
			Environmental Protection	0.30	1.00
Junior Social Humane Needs	0.35	0.64	Resource Protection	0.25	0.83
			Spirit Culture	0.25	0.33
			Public Welfare	0.20	0.25
			Public Welfare	0.20	0.25

Fig.4.The details for evaluation results

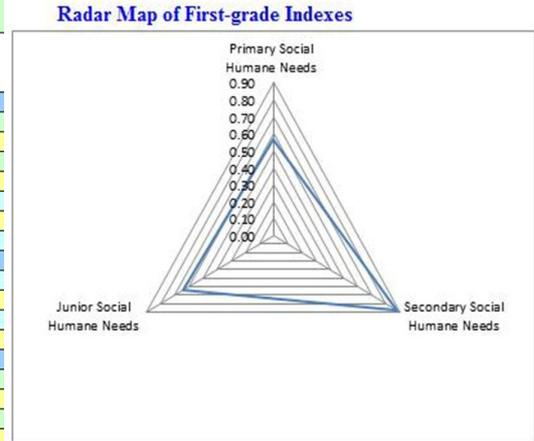


Fig.5.The radar map of first-grade indexes

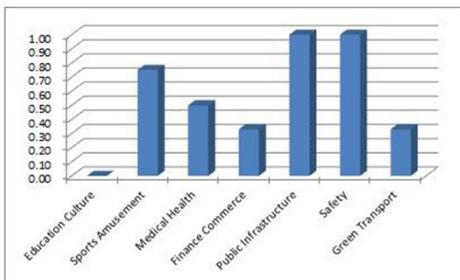


Fig.6.The histogram of primary social and humanity demands

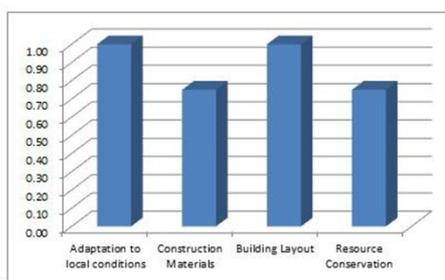


Fig.7.The histogram of secondary social and humanity demands

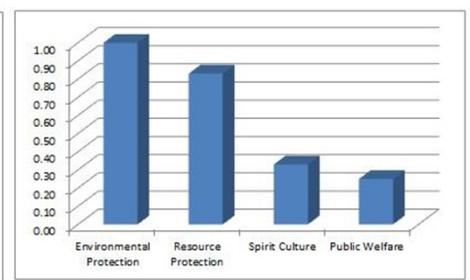


Fig.8.The histogram of senior social and humanity demands

Analysis on the results of the evaluation. The case project's final score is 0.63 and grade B according to Table.2. In the three first-grade indexes which directly constitutes final scores, secondary demands indexes got the highest score while the other two, primary demands indexes and senior demands indexes, got about the same scores.

The evaluation result shows that the Public infrastructure index and the Safety index of the community got higher scores than others. This is consistent with the community's reliable public and safety infrastructure. However, indexes, including Education& culture, Medical Health, and Finance commerce got lower scores, because that this community is situated in the suburb where is not well-developed and there is few schools, libraries, community hospitals or major commercial streets nearby. The good scores of "Sports & Amusement" index has a lot to do with the newly-built large green park which applies a compatible place for residents to exercise and play. The result in Fig.7 shows that the community's secondary social and humanity demands indexes generally did well which is consistent with the perfect integrated planning , the proper architectural layout and the fully use of green building materials during the construction of the community. It can be seen clearly from fig.8 that the community got high scores on environmental protection and resource protection indexes. It should be another outcome of the perfect planning during the construction. The lack of buildings and attractions with historic and cultural characters as well as the incomplete development of the public welfare organizations is responsible for the low scores of spirit culture and public welfare indexes.

Above all, the comprehensive evaluation results show that: the advantages of the community mainly consist in the perfect integrated planning, environmental construction and reliable public infrastructure while its disadvantages reflect in the lack of humane facilities nearby. So advices on the development of the community based on the evaluation results are that government should promote the development of the humane environment around the community and the construction of some necessary buildings such as public welfare communities, the elderly's home, schools and

libraries. The humane needs of residents in the community will finally be fulfilled step by step when the evaluation scores become higher and higher.

Conclusions

Social and humanity demands were introduced into green residential districts evaluation system in this study. The proposed evaluation framework considered some aspects of the humane environment. An evaluation software based on the proposed system was developed and used to evaluate an actual project to illustrate the application of the software. It can be found from the example that the analysis on the results from the software is consistent with the real situation and is instructively beneficial to the construction of the community. The research of the article is meaningful to the improvement of the evaluation system of Chinese green residential districts. It has also emphasized the humanity demands' role in the construction of green buildings and is of great importance for promoting the development of Chinese green building and improving people's humane sense.

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