

Research on the methods of Green Building in China

Yanbo Xue^{1,a}, Ning Qiu²

¹Beijing Jiao tong University, Beijing, China

²Beijing College of Politics and Law, Beijing, China

^ayanbo_xue@yeah.net

Abstract. On the basis of studying in depth of domestic and foreign existing green building evaluation technique and method, this paper seeks for comprehensive, scientific and effective method of evaluation for green building. The main contents includes researches of the existing green building evaluation method at home and abroad, discussion for theoretical framework of Green building evaluation system; According to the logic relation of the green building evaluation system, it established a comprehensive and scientific green building comprehensive evaluation index system with strong maneuverability; Then, based on the green building comprehensive evaluation features, multi-target, multi-factor and multi-level, we need to establish green building fuzzy comprehensive evaluation model which can effectively resolve the problems of green building evaluation.

Keywords: green building, assessment system, fuzzy comprehensive assessment model

1. Introduction

In 1950-60s, as "green movement" rose and was carried out among western countries, the "green" thought began to be accepted in the world. The "green" thought aims to protect the natural resources, adjust human behavior, meet the ecological virtuous cycle of nature, and ensure the safety of human existence. In economic terms, it advocates to abandon the present pure consuming economy, pursue the economic and ecological dual goal, and establish protective economy which can meet the material needs with no harm to the ecological balance under the guarantee of sustained economic development meanwhile. On the social side, it proposed to control the population, advocate family planning, coordinate people of different race, gender and age, create harmonious life, enjoy the happiness of the labor, and safeguard world peace. For the environment, it is thought that nature and human both belong to an integral field, where the interaction and balanced development of natural organization and human organization can cause the human itself to live on. As far as technical is concerned, it promotes to use the renewable technology of natural resources without any pollution of the environment or any damage of the ecological balance.

By the end of 1980s, "sustainable development" had become the worldwide program of action, and at the same time, ecology, sociology, and other subjects extended to the architecture domain, and then "green architecture" concept appeared naturally. "Green architecture" is an inevitable result of the architectural development and the specific reflect of sustainable development in architecture, and also it expounds the role and functions of building in ecosystem from the ecological viewpoint, and makes us re-know the building.

The introduction of the concept of green building makes new changes for understanding of building: first of all, the building cannot satisfy people's expanding desire. Architecture research should treat human and other creatures as a whole of interdependence, for a moderate use of natural resources, and emphasizes the unity of artificiality and nature. Second, the building should not only meet the contemporary needs, but pursue the sustainable development of human living environment. Third, architecture should not only meet the demand of physical environment quality and quantity, but also through the planning and design seek for the live environment with expression of human spirit world.

Based on the background that "sustainable development" becomes global strategy of human and natural coordinating development, and the green building becomes an inevitable trend in the development of construction, this paper carries on theoretical and practical researches for building heading to green and sustainable development.

2. Theoretical Framework of Green Building Evaluation System

Architecture green building system is a highly complex systems engineering, and to realize the project, not only the environmental engineers and architects need to use sustainable design method and means, also decision makers, management institutions, community organizations, owner and users should all keep environmental consciousness and participate in the whole process of the construction. The intervention of this multi-level cooperation relationship needs to establish a clear building environment evaluation result in the entire program, which should form the common view till the end. Therefore, the green building system urgently needs support from modern science, intelligent evaluation method as implementation operation technology. At present some relevant evaluation system has been used for reference, such as life cycle analysis, ecological database, ecological model and other information system, evaluation method, etc.

Green Building Evaluation Demarcation. The affects of artificial environmental construction to the natural environment can be divided into different levels from role for the global, regional and community to indoor environment. As well, the evaluation also involves the factors of some other important aspects, such as social economy, history and culture, the effects of physical environment (such as noise and climate), and ideological content (such as landscape, aesthetic) and so on, but it can be hard to determine the evaluation indexes or difficult to use a clear causality to express with these factors. Green building evaluation is modeling, systematic and quantification of the whole process specific for the complex system decision thought, planning and design, construction, and management and implementation, also a decision method of the quantitative analysis and the combination of quality and quantity for qualitative problems.

Green Building Evaluation System at Home and Abroad. In order to promote green building to develop healthily and rapidly and improve the scientificness and operability of the green building under the implementation of the life cycle, the countries all over the world have introduced their own green building evaluation system, which are summarized as follows:

British Buildings Environmental Evaluation Method, BREEM

The famous "British building research institute" launched "architectural environment evaluation method" (BREEM) for the first time in 1990. It is also the first set of green building evaluation method applied practically to the market and the administration.

Green Building Challenge 2000(GBC2000)

Green Building Challenge 2000 was launched and led by Natural Resource Canada. By October 2000, 19 countries had participated in establishing this kind of evaluation method to evaluate the environmental performance of buildings. Green building challenge's purpose is to develop a set of unified performance parameters and establish globalized green building performance evaluation standard and the authentication system, which makes useful building performance information exchanged between the countries, and finally makes the green architecture examples of different regions and countries comparable.

Leadership in Energy and Environmental Design (LEED)

The United States green building council (USGBC) in 1995 put forward a set of Leadership in Energy and Environmental Design (LEED), in March of 2000 updated and released its version 2.0. The United States green building council established a set of assessment standards to meet the construction market of green building in the requirement of evaluation, improve the environmental and economic characteristics.

Japanese Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)

This evaluation method classifies assessment ordinance at specific rating into two categories: "Q-building's environmental quality and performance" and "L: pay of energy, resources and environment load". The so-called green building is our pursuit of the minimum consumption from L during obtaining the biggest Q of the building.

China Green Olympics Building Evaluation System

In reference to Japan CASBEE China green Olympics building assessment system, according to the guiding ideology of the whole process of monitoring and staging assessment, establishes evaluation index system on plan stage, design stage, construction stage, acceptance and operation management.

Build the Framework of Green Building Evaluation System. Through the comparative studies above of the green building evaluation system at home and abroad, we can find the problems of the existing evaluation system, for example hierarchical structure is not clear, the life cycle of building green evaluation index system can't be achieved, lack of availability, representativeness and reinvention. The hierarchical structure of the evaluation system is the measurement of mutual subordinate relations between elements and importance. Based on the analysis of the system, form a perfect, organic the hierarchy structure sub systematically and stratified with evaluation index contained, so that the index order, position, weight procedures and quantitative index of all kinds can be clear at a glance. So, we should establish multi-dimension evaluation system with comprehensive consideration of the requirements for the green building development. Inspired by the system engineering methodology, we can build a three-dimensional structure system of green architecture evaluation similar to the Hall three dimensions structure system.

Green Building Evaluation Index Research. The general objective and the guiding ideology of green building evaluation is to realize accuracy, efficiency and comprehensive evaluation of the building greening, to provide strong scientific proof for the development of green building. The core of achieving this goal is to establish green building evaluation system, and there are two key points of establishing the green building evaluation system: hierarchical structure of the green building evaluation system and evaluation index system.

- a) The attention to build the green building evaluation index system
- b) Collection of index data
- c) Qualitative and quantitative evaluation
- d) Evaluation index quantification

Through the analysis of the key problem during the process of the green building evaluation system construction, we can draw the following conclusion that plays an important guiding role in establishing evaluation index system and improving the evaluation accuracy, operability and effectiveness.

There must be a clear goal of evaluation method for the behavior to use it and take it as the ultimate objective.

Distinguish between the early stage of making the auxiliary design tools and the late stage of making construction evaluation tool.

The setting of the evaluation methods must not demand too much, and we can't underestimate the time, energy and degree of difficulty in getting input data in the process of complete evaluation.

The clear boundaries must be set between the results of the evaluation and the secondary results.

If an evaluation method is to be developed, we must have enough suggestions and measures to cope with the changes of the factors in the structure.

During use, the two basic requirements must reflect: objectivity, and re-comment, for the same object different appraisers should produce similar evaluation results.

3. Green Building Evaluation System Research

"Green building" is architecture design developing trend under the guidance of sustainable development, focusing on resources and efficient interests of energy, harmless and economy of materials and construction method, high quality living environment, elastic variable space system and the respect of the local technology and the architectural history, expecting the realization of the protection and control of ecological system gradually from single building to town---the whole environment. Green building is a complicated multifactor and multilevel large "nature---society" artificial system, who has many design goals, involving in economy, society and ecological environment and many fields, with mutual connection, restrict each other.

Green building evaluation index system level. When we build the green building evaluation index system, first, we can determine comprehensive goals which can be divided into further several sub goals. Sub goals reflect the requirements of the general objective from different angles and different levels, and layer rule

layers are established below the sub goals. Standards should not only reflect the requirements of the comprehensive target for architecture, and also can be decomposed step by step. Rule layers can be divided into index layers that reflect the specific requirements green building meets relatively accurately. Green building evaluation index level is shown in figure 1 below.

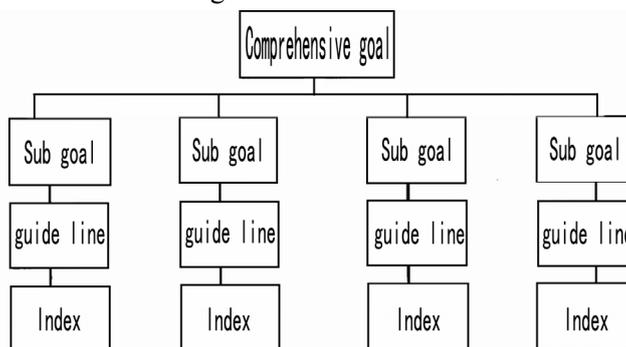


Figure-1 Green building evaluation index level

The Establishment of Green Building Evaluation Index System. On the basis of green building sub goals, we can further subdivide the green building evaluation index system’s rule layer, level 1 index layer, level 2 index layer, etc. It is to analyze the four sub goals specifically and respectively, and decompose rule layer and sub items of index layer, providing information for the establishment of a complete green building evaluation index system.

Environmental Protection. It mainly combines local geography, climate, original ecological environment and other objective conditions and the impact on the environment from the whole life cycle of building, proceeding with ecological environment system, atmospheric environment system, water environmental system, sound environment system, and solid waste treatment, and use appropriate technology to achieve the evaluation on the impact on environment from the building, such as ecology, atmosphere, water, noise, and solid waste, in order to protect and improve the ecological environment and realize the building greening.

Construction Product Greening. Construction product greening degree is with the foundation of the evaluation on green building materials, with the foundation and precondition that the composition’s construction products meet green building materials, considering the environmental impact produced by construction products under construction and use and its waste to make comments on the construction product greening degree.

Environment Quality of Building Space. Combined with local terrain, landform and the layout of regional climate and advanced design idea, we can realize reliable disaster prevention plan, organization and implementation, establish vegetation and greening system sharing symbiotic relationship with the regional ecological system, and interior space, physical and health conditions beneficial for the health of body and mind.

Economy. Architecture is a kind of products, and the investment of the products and energy consumption---economic index reflects not only one-time investment in the initial construction, more the life cycle cost, maintenance fee, energy consumption fee and scrap dismantle fee in the system. In addition, the green building land development and use should not be beyond the environmental bearing capacity.

Establishment of green building fuzzy comprehensive evaluation model. From the point view of system theory, green building evaluation system is a dimension system of time, logic, method, involving environment, resources, energy , economy, ecological ethics and many other factors, so we must build a multi-level obscure comprehensive evaluation system. It has set up green building evaluation index system, and multi-level index is the corresponding evaluation factors set of an obscure comprehensive evaluation model. To build the green building obscure comprehensive evaluation index system:

$$B = WR(w^1, w^2, w^3, w^4, w^5) \begin{bmatrix} B^1 \\ B^2 \\ B^3 \\ B^4 \\ B^5 \end{bmatrix} = (b_1, b_2, \dots, b_5)$$

Here w^i presents the corresponding weight of green evaluation index set factors; B presents the vector calculating green building obscure comprehensive evaluation; No.i evaluation factors will have a corresponding membership vector--- R_i .

4. Brief Summary

Through this paper's study of the method and evaluation technology of green building, we can draw some conclusions as follows: (1) the green building evaluation involves in environmental impact, building materials greening, construction product greening, human health and comfort, the economy of construction, the requirements for sustainable development and many other factors, so the green building evaluation is a multi-goal, multi-factor and multi-level complex system engineering. This paper, from the principle and the viewpoint of the Hall three dimensions structure system engineering methodology, studies the problems of the green building evaluation and establishes the green building evaluation system theory frame. (2) How to establish a complete, scientific and effective green building evaluation index system is the key point of green architecture evaluation. This paper surveyed and studied the green building evaluation system both home and abroad. On that foundation, the green building materials, the components of green building and the evaluation index system of the green building's three levels was established, and carried on massive researches on problems of the aspects, such as avoiding the repetition, one-sidedness and thinness of the evaluation index, the reflection of green building life cycle requirement in the view of evaluation index, and then received a good effect.

5. Reference

- [1] Brenda, V, Vale R. Green Architecture: Design for Sustainable Future. London: UKRIBA, 1991
- [2] Braya C F, Naney D O. Environmental Economies. Mc Graw—Hill Ryerson Lintier, 1995
- [3] Daming Zhu: New Vision of Contemporary Architecture Comments [J] 1.New Building. 3rd in 2000.
- [4] Yang Hu: First Explosion of Green Building [J]. Yangzhou Vocational College Journals. 4th in 2000.
- [5] Xiaoyun Ma: Sustainable Development of Green Building Material and Green Architecture [J].Shanxi Building. 14th in 2000.
- [6] Guowei Li: Discussion of Green Building Materials [J]. Journals of Wuhan City Construction. 12th in 1997.
- [7] Zongbin Guo:2121 Century Architecture and Sustainable Development [j].Jiangxi Building Materials. 2nd in 2003.
- [8] Chengren Sun: Sustainable Design: From Concept to implementation [J].New Building. 1st in 2002