Research on the environmental evaluation model of pre-engineered town house system based on whole life cycle theory

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Abstract. In recent years, with the rapid development of economy, china's natural and ecological environment has been damaged to varying degrees. Environmental pollution has become more serious with a great negative impact on people's health. The environmental evaluation of house system can improve people's ability to identify the surrounding environment and enable them to take relevant measures according to changes in the surrounding environment so as to ensure that their living environment can develop in a healthy direction, which is of great significance in protecting their physical health. Therefore, this paper designs an environmental evaluation model of pre-engineered town house system mainly based on the whole life cycle theory, aiming to provide a reference for residents for rational house purchasing and for developers for residential communities planning and building.

1. Introduction

The whole life cycle management theory originated in the 1960s and was proposed by the U.S. military for high-tech weapons management. In the 1970s, the theory expanded from military management to key areas such as transportation, aerospace, national defense construction and energy engineering. Its central idea is to take long-term benefits as the core and use various new technologies and methods to make overall plans for the construction, production, operation and decommissioning of various equipment, so as to ensure the rational planning, safe production and reliable operation. In the Ninth Five-Year Plan period in China, the whole life cycle management theory was studied in depth, in combination with the National 863 Program. Several universities, such as Tsinghua University, Shanghai Jiaotong University, Zhejiang University and Huazhong University of Science and Technology, studied the concurrent optimization and concurrent engineering technology of whole life cycle management theory and achieved remarkable results in 1991. Since then, the whole life cycle management theory has penetrated into many areas in China and played an important role in promoting the sustainable development of various industries.

The whole life cycle management theory is a characteristic of macro-prediction and overall control. It focuses on long-term benefits and effectively avoids short-term cost behaviors. It is used to the system to carry out management over the entire process of planning, designing and end-of-life recycling and thus break the boundaries among departments. At the same time, it strengthens the cost management of different stages of planning, infrastructure and operation, providing companies with more effective solutions. It penetrates into all aspects of management. Through the integrated management of assets,
time, cost, human resources, risk, quality, procurement and communication, it transforms the focus of management model from project life to operational period. The whole life cycle management model has a leap-frog improvement over traditional management models. The theory is of the following characteristics: Integrity comes first. The whole life cycle of a project is considered at the beginning of decision-making phase, and thus management and supervision can be carried out from the overall perspective; integration comes second, including the integration of information and the integration of management processes; coordination comes third, reflecting the coordination and communication among the management in different stages; concurrency comes last. Management processes are carried out concurrently to reduce the feedback of changes to the project proposal phase in the actual implementation phase [1-3].

2. Overview of whole life cycle management theory

2.1. Definition of whole life cycle management theory

The theory originated from the U.S. military, and the U.S. Department of Defense defines whole life cycle cost as all the expenses consumed by the government and the military in order to obtain and manage the processes of system remanufacturing, use, scrapping and recycling. The whole life cycle management theory is a new management method based on modern management theory, system theory, cybernetics, information theory and other theories, in combination and integration with engineering projects. In general, it is mainly used in engineering and finance. In engineering, it is mainly used for equipment reliability management, life analysis of equipment and engineering projects, equipment failure statistics, equipment update and impact of maintenance on equipment life. It requires that people, from the long run, make cost optimization designs for engineering projects, considering not only the initial investment to projects but also the maintenance cost required to maintain the operation of projects and relevant cost needed after the completion of such projects. In engineering projects, it runs through the whole process and plays an important pivotal role in the management of all stages. See Figure 1 for more details [4-5]:

![Fig.1 The embodiment of the life cycle management theory in engineering projects](image)

In general, the formula for environmental evaluation of house system based on the whole life cycle theory is as follows:

$$\sum_{i=1}^{n} \sum_{j=1}^{n} |b_{ij}w_j - w_i| = 0$$

Wherein, deduct absolute values from the results obtained; i and j represent the environmental impact factors of house system, and $w_i, w_j$ represent the two judgment matrixes of environmental impact factors. The weight values of judgment matrixes are as follows:
\[ \sum_{i=1}^{n} \sum_{j=1}^{n} |b_{ij}w_j - w_i| = 0 \]  

(2)

2.2. Characteristics of whole life cycle management theory

The theory is of the following characteristics:

Firstly, the theory is a systematic project. Only with a systematic and scientific management mode, can it achieve its goals in all stages of life cycle management and the ultimate goals eventually, that is, expected maximum economic, social and environmental benefits of investment [6].

Secondly, whole life cycle management runs through the whole process in construction projects and plays different roles in different stages. At the operation and maintenance stage, whole life cycle management is mainly used to maintain the use function of projects and control the operation costs of such projects. At the decision-making stage, it is mainly used to select appropriate construction projects and determine the corresponding investment objectives. At the design stage, it is mainly used to implement the investment objectives and formulate reasonable design plans. At the construction stage, it is mainly used to ensure the achievement of projects’ goals of safety, quality, schedule and cost. At the scrap recovery stage, it is mainly used to convert waste into recycled products and renewable resources so as to reduce resource consumption and reduce the impact on society and the environment [7-8].

Thirdly, characteristic of continuity, whole life cycle management is both phased and integrated, and is of continuity among phases.

Fourthly, there are many participants in whole life cycle management. However, there are both close links and mutual constraints among participants [9].

Fifthly, whole life cycle management has a high degree of complexity, and its complexity is mainly determined by the systematic, phased and multi-participant characteristics.

3. Methods of environmental evaluation of pre-engineered town house system

3.1. Basic principles for environmental evaluation of pre-engineered town house system

The basic principles for environmental evaluation of pre-engineered town house system are as follows: Firstly, adhere to the principle of people-centeredness to protect the basic rights and interests of residents; secondly, adhere to the principle of comprehensiveness. The evaluation must involve all aspects of house system; thirdly, adhere to the principle of scientificity. The evaluation results need to have a scientific reference value; fourthly, adhere to the principle of stability and dynamics; fifthly, adhere to the principle of hierarchy; sixthly, adhere to the principle of operability [10].

3.2. Emphasizing the evaluation of humanistic ecology and community cultural construction

Humanized environment based on materialized environment has a direct impact on the evaluation of people’s living environment. The pre-engineered house system should be equipped with relatively complete public service facilities and infrastructure and provided with a good ecological environment so as to provide a more orderly, convenient and comfortable living environment and high quality enjoyment for residents. To improve the deeper connotation of the pre-engineered town house system, it is necessary to build a good community cultural environment and help residents build a harmonious and friendly neighborhood relationship. In the process of urbanization, community has become the main area where people live for a long time. The new community neighborhood relationship is mainly maintained with community culture. Meanwhile, culture is the cornerstone for the existence and development of cities and also an important value. The cultural construction for the pre-engineered town house system should highly value humanistic ecology. It is necessary to coordinate the relationship between men and nature and between men and men, and better handle the relationship between men and culture. In the pre-engineered town house system, various types of community cultural activities can be organized regularly to provide convenient conditions for the exchange and communication among residents, so that community members, in pursuit of their own lifestyles, can also build a relationship of family affection in the neighborhood. Therefore, the level of humanistic ecological and cultural
construction of the pre-engineered town house system has also become an important index for the environmental evaluation of house system [11-12].

3.3. Building environmental suitability model for the pre-engineered town house system
The habitat suitability of the pre-engineered town house system refers to the closeness of the actual ecology where people live in the system to the best living ecology. It intuitively reflects the level of residential living comfort. In order to provide residents with a better living environment, it is imperative, in the development and construction of buildings, to take the residential quality of life as a starting point, use ecological principles as a guide to improve the residential environment and strive to create a green living environment. In addition, in order to enhance the overall environment and construction level of a city, the pre-engineered town house system must not only consider the ecological balance, energy saving and environmental protection for individual housing units, but also take the entire pre-engineered town house system as an integrity based on the surrounding environment to design and optimize the living environment. This can help not only ensure the high quality of such system, but also enable the integration of the house system with the surrounding environment to build a friendly living environment and give residents a sense of belonging to the system and improve the habitat suitability of the system [13].

3.4. Analysis on the fitness of peripheral public facilities to residents' needs
Nowadays, public facilities around most of China's residential communities cannot meet the basic needs of residents. Even in communities where public service facilities and infrastructure are relatively complete, public facilities are still not adequate enough. The main reason is that, in addition to limited land area, there are also large differences in the living needs of residents of all ages, especially the elderly. Compared with other age groups, the elderly concern more about living conditions, transportation vehicles, cultural and sports facilities and medical facilities, etc., while young and middle-aged people concern more about parking facilities, leisure plazas, schools and kindergartens. Developers often gave no comprehensive consideration to this area. Therefore, whether the supporting public facilities can meet the diversified needs of residents or are fit to residents' needs has also become an important part of the quantitative evaluation index system for the environmental quality of the pre-engineered town house system [14-15].

4. Conclusion
The whole life cycle management theory is a management method used to analyze the whole process of construction, operation and processing of construction projects or equipment, so as to effectively reduce unnecessary production costs and improve the level of construction or utilization. It is widely applied in many fields. The application of the theory in the environmental evaluation of the pre-engineered town house system needs to emphasize the evaluation of humanistic ecological and community culture construction and build environmental suitability models for the system to analyze the fitness of peripheral public facilities to residents' needs so as to achieve the purpose of evaluating the environmental quality of such system.

Acknowledgement
Foundation item: Henan Province Soft Science Research Plan Projects (182400410355).

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