Research on the Influence of Modularization on the Performance of Old Building Area Improvement Project: A Longitudinal Analysis Based on Tianjin Data

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Abstract. In recent years, various areas have carried out different degrees of old building upgrading projects. However, due to the huge number of renovation projects in old building areas, the renovation needs of each building area vary, and the project objectives are characterized by scale supply, demand customization, strong timeliness, and limited investment. This poses a challenge for the government to improve the performance of such projects. How to respond quickly to the personalized needs of the masses while taking into account the efficiency of supply has become the primary problem to be solved by the government to ensure the project performance. On this basis, this paper takes Tianjin large-scale Old building area function promote renovation project as the research object, explore modularity theory in the process of such projects running "to do" and "how" problem, to explore the function module and structure module in the process of renovation project longitudinal launching state changes, as well as the comprehensive interface module standardization activities.

1. Introduction
In recent years, in order to improve the living environment of residents and improve the public satisfaction of the government, projects to improve the comprehensive functions of old residential buildings have been implemented in major cities across the country. Compared with the production process of the private sector, the public sector regards the public as the main beneficiary of customers and operations of the public sector [1], which is the core idea of the Chinese and western government reengineering movement of the new public management theory [2]. According to modularization recognized in the study of the type and process of exploratory case study method, this research adopts the ascend in Tianjin Old building area comprehensive renovation project as a case study object, on the basis of the longitudinal analysis, to change the task based on modular product perspective of deconstruction, in order to reveal the performance improvement of public project management efforts in the endogenous mechanism of modular, and make the following answer: through case longitudinal study in project management, there is a mention change products supply modular activities? How does product modularity affect project performance by affecting project decision flexibility? As the lean production based on big data is still in the concept and starting state, modularity will serve as a conscious management tool to guide the supply side to respond efficiently to changes in the demand side for a long time to come. The purpose of this study is to provide countermeasures to the similar supply-side problems in the development of old buildings under the new normal.
2. Literature review
The concept of modularity was first proposed in 1962 by Herbert Simon, who put forward the concept of "decomposability" of modules and illustrated the importance of modularity in dealing with complex system problems. Early studies on modularity tend to regard modules as generalized and standardized components [3]. The starting point of the modularization idea is to try to produce modules with independent and complete functions through simple design. Since each module has been determined with clear design rules and functions in advance, the control goal of reducing the cost of each link can be achieved through modules [4]. But the modularity theory gradually get the attention of academic circles, it was not until the 1980 s with the development of modular theory enriched and expanded application fields, modular approach is considered to be companies cope with economic globalization and information technology revolution brought about by the increasingly complex and changeful environment's new strategy [5, 6] to the essence of new industrial structure. Baldwin and Clark believe that modularity is a process in which each subsystem that can be independently designed and can play a certain role is built into a complex product or business [7]. Zhu Ruibo believes that modularity is a dynamic process of system decomposition and integration [8]. From this we can see that after the 1990s modularization was identified as the process of system decomposition and system integration. The connotation of modularization reflects the essential difference between modularized product architecture and traditional component product architecture: that is, modules are divided into independent modules through certain interface rules.

Figure 1. Benchmark theoretical model of modularization mechanism of old residential area renovation project.

3. Study design
Research question of this paper is to find the Old building area modular clues and regularity of the project supply, answer the "why" and "how to do", is in one direction but the conclusion is unknown, need to be based on the practical project of the specific situation and through systematic observation and thinking to find the modularization and the project performance to improve relations, thus for exploratory case method [9]. The selection of cases follows the principle of "theoretical sampling" [10]. The renovation of dilapidated houses in cities across the country has been going on for a long time. However, few large-scale comprehensive improvement projects have been completed and delivered. At the same time, considering the typicality of the selected objects and the convenience of in-depth data collection, this study selects the comprehensive function improvement project of the old buildings in the downtown area of Tianjin, and takes the project group of Nankai district as the main object of the case study.

4. The results of the study
Figure 2 shows the resulting emergent constructs and their interrelationships. Functional module division, structural module division and module interface are the main considerations in general modular design. In this paper, we find that these three basic constructs not only exist in the case, but also have two dimensions, namely, residence dimension and management dimension. Decision flexibility refers to the supply capacity of functional plans for building products in response to the different transformation demands of each building area. Its flexibility is manifested in two dimensions: the feasible choice space of the plan (large quantity vs. small quantity), and the supply speed of the plan (fast vs. slow). Its essence is to realize the function module configuration ability or product custom design ability of building area each kind of difference transformation demand.
Influence of product modular design characteristics on decision flexibility

From the perspective of the adoption track of each mode in the municipal implementation plan, the first three years are the continuous development process of the functional module library with three types of modes, and the fourth year is the direct inheritance of the functional module library formed in the previous three years. The model of "safety and energy saving first + no property management" was adopted in the reform year, which formed the initial state of municipal functional module library. In 2014, in order to further improve residents' quality of life and ensure the "long-term stability" of the community, Tianjin adopted the mode of "comprehensive improvement and upgrading + property management". In 2014, the number of municipal functional modules continued to expand, entering a new state. When the improvement project was implemented in 2015, the module library ceased to be developed and the functional module division mode of "comprehensive improvement and upgrading + property management" was adopted. To sum up, proposition 1 is proposed as follows.

Proposition 1: the functional module division model of product improvement affects the decision-making flexibility of product improvement. When it is in the mode of safety and energy saving and no property use, there are few options for functional configuration and grade, and the program design is slow to respond to changes in demand. When the division is in a comprehensive upgrade and improvement, and there are property use rooms, there are many options for functional configuration grade, and the program design responds to the change of demand quickly.

In the scheme design of every district in the whole city, the final function configuration is characterized by: the compulsory standard and rigid option for unified implementation in the whole district. Therefore, both the required standard and optional items are low-grade configurations that can only meet the basic needs of people's livelihood. However, in 2013 and 2014, the structure module division was in the mode of "dynamic capacity expansion + self-creation on demand". In this mode, on the one hand, the number of prescribed modules in municipal libraries is expanding, from 24 in 2012 to 42 in 2013, and then to 46 in 2014. On the other hand, with the elimination of the given scope of the district optional module in the municipal implementation plan, self-created functional modules appear in the district library every year. To sum up, this paper puts forward the influence relationship of structural module division on decision-making flexibility, and puts forward proposition 2 as follows.

Proposition 2: the model of structural module division of product improvement affects the decision-making flexibility of product improvement. When the structure module partition mode is
static and unchanged and the optional item is constrained by the given optional range, the functional module library for people's livelihood needs is small, and the scheme design is slow to respond to the demand change.

4.2. Project decision-making flexibility and transformation project performance

Module reuse solves the problem that the design lags behind the transformation progress, shortens the design cycle of the transformation product, and improves the design response speed of the transformation product. The design decision-making efficiency of the product improvement is greatly improved, and the design experience can be transferred and integrated. While improving the design level, the decision-making is more adaptable to the dynamic changes in the project promotion process, which improves the government's adaptability to environmental uncertainty. It is beneficial to further improve the design level and enhance the decision-making flexibility. The flexible effect is as follows: in the case of fixed annual renovation time, the number of renovated building areas increased from 300 renovated building areas and 15.04 million square meters in 2012 to 560 residential areas and 26.01 million square meters in 2014. At the same time, not only the number of renovated building areas increased, but also the number of projects to be selected for the renovation increased from 24 in 2012 to 46 in 2014. Faced with such a heavy task of large-scale transformation, the acceptance rate still rose from 78% in 2012 to 90% in 2014 despite the gradual increase of acceptance items. Public satisfaction rose from 90 percent in 2012 to 92 percent in 2014.

5. Discussion and conclusion

Based on the longitudinal analysis of the case study, this paper constructs the relationship model of product modularization design → decision flexibility → project performance based on the proposition obtained from the case study. This model is a good example of how the functional positioning and design positioning of the project change with the vertical advancement of the project. It is an exploratory application of modularization theory in the field of public projects to extend the previous research focus of public projects from "how to perform" to "how to do". The research results are helpful to provide reference for the implementation and promotion of the old building improvement project under the new normal, and provide countermeasures for the similar supply-side problems of the improvement project.

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