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Application and analysis of innovative models in construction engineering management

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Abstract. With the continuous acceleration of China's industrialization process and urbanization construction, traditional engineering management models have gradually exposed various shortcomings and shortcomings, unable to adapt to the development of the new era. Therefore, exploring innovative models in engineering management has become particularly important. This article focuses on analyzing the characteristics and shortcomings of three traditional engineering management models that are widely used worldwide at present, and proposes corresponding analysis methods for them. Firstly, further improve the organizational system from the perspective of management system and establish a modern enterprise system and a responsible person system to fundamentally ensure the practicality of project management. Secondly, based on Building information modeling (BIM) technology, modeling and information collection are carried out for different management stages to achieve transparent and visual management, Further improve construction quality from a technical perspective, ensure construction progress, and improve management level. In summary, this article analyzes the problems of traditional models and analyzes the application of innovative models from two aspects. However, there are still issues that need to be addressed, such as different situations in different regions and insufficient information and data collection, in order to truly achieve the application of innovative models in engineering management.

Keywords: Engineering management, innovative models, BIM technology.

1. Introduction

There are currently issues with empiricism, formalism, and other aspects in engineering project management in China [1]. The traditional management mode, which is used most and widely, shows the characteristics of excessive construction personnel, complex engineering procedures, strong work dispersion, low technical level and insufficient management consciousness [2]. These factors greatly increase the difficulty of project management, but also cannot meet the needs of rapid development in the new era. With the continuous development of science and technology, the construction industry also presents a new development trend. In engineering project management, many new tools such as Building information modeling (BIM) have been widely used, and many new concepts have been gradually integrated. In order to continuously improve the level of project management, combined with the actual situation of the construction site, it is necessary to innovate the management mode, establish a more perfect management system, innovate the organizational system, and ensure the

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scientific management [3]. The introduction of Bim and other tools will technically improve the coordination between the construction unit and the management personnel, strengthen the management personnel's grasp of the project construction progress and the overall project planning, and further ensure the timeliness and practicability of the project management system [4].

2. Literature review

At present, there are many engineering management modes, and different policies in different regions also affect the use of management modes. The following lists three common patterns that are widely used and analyzes their current situation and problems [5].

2.1. Traditional project management mode

The traditional project management mode is design-bidding-build (DBB) mode. This management mode is the most commonly used in the world bank, Asian Development Bank (ADB) loan projects and projects based on the contract conditions of the International Federation of Consulting Engineers (FIDIC). The emphasis is to proceed in sequence, and only after completing one stage can enter the next stage [6]. Its advantages and disadvantages are also very obvious. The advantage is that the distribution of responsibilities and interests is clear. The construction party, the design party and the owner perform their respective duties and can exercise their rights while performing their obligations, avoiding the situation that the three parties do not want to take responsibility for each other. The disadvantages are as follows: first, it is difficult for all parties to coordinate. If the construction party and the design party do not belong to the same unit, it is difficult to quickly coordinate the two parties, which will damage the interests of the owner; Second, the sequence is rigid and the connection is not smooth, which is not conducive to the rapid completion of some projects with tight construction period and heavy tasks.

2.2. Construction management (CM) mode

This mode, also known as stage contracting mode, has been widely used in Europe and the United States in recent years. Different from the traditional project management mode, it does not need to wait for the completion of design before construction, but the close cooperation between design and construction, which greatly shortens the construction cycle of "design while construction". However, this mode requires a high level of project managers, and the form of phased bidding may increase the contracting fee [7].

2.3. Project management contracting (PMC)+partnering mode

In recent years, more and more countries and units choose the "PMC+partnering" model, which is one of the more innovative and efficient models in the world. This mode means that the project owner hires a company to manage the whole project process on behalf of the owner. The owner only needs to retain a small part of the infrastructure management force to make decisions on some key issues, and the vast majority of the project management work is undertaken by the project management contractor [8]. This mode is more suitable for projects with complex design technology and process, huge project investment and the owner does not have relevant management experience. This mode needs to maintain communication with the owner in the construction project to ensure the interests of the owner. At the same time, the project designers do not directly participate in the construction and do their own duties. In addition, the supervision unit will be independent for supervision, schedule decomposition and dynamic monitoring to ensure the safety of the construction process to the greatest extent. This mode also has corresponding measures to deal with emergencies, such as setting up a reserve fund to ensure that the project construction can keep up with the original progress. However, this mode also has its shortcomings and deficiencies. The technical level and management ability of the contracting company play a decisive role in the construction process, and there may be problems such as overlapping functions with the supervision unit in the process of project management [9]. The biggest problem is that the owner has no direct contractual relationship with the construction party, and cannot

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control the construction process, and then cannot control the project cost. Figure 1 shows the relationship between parties in PMC mode.

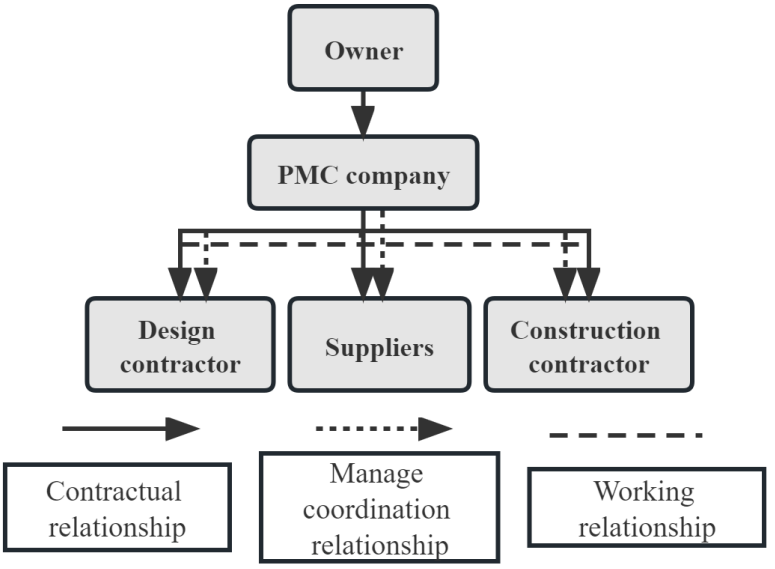

Figure 1. Relationship between parties of PMC mode [8].

3. Application and analysis of organizational mechanism innovation

3.1. Organizational innovation

In the general project construction management, the project department is born with the signing of the contract and ends with the completion of the contract. The project department represents the construction enterprise, but it is not a perfect enterprise and cannot undertake this clearly defined responsibility. The project department often only considers its own local interests in engineering construction, and cannot link the operation of the project department with the development of the enterprise, leaving potential hidden dangers to the enterprise. At the same time, the project manager has the power of property disposal, construction command and decision-making. However, it lacks effective constraints. Construction enterprises generally carry out engineering construction of several projects at the same time, and it is difficult to coordinate the interests between enterprises and projects, projects and employees. Therefore, it is necessary to innovate the organizational structure of the project department: first, extend the content of construction management in space, grasp the overall interests of the whole project, and subdivide the functions of the project manager from multiple angles; Secondly, the responsibilities of the project department should be improved from the whole process of market tracking, bidding competition, contract signing, performance, and obtaining social and economic benefits, and all possible situations should be analyzed. Through the effective management of the whole process of the project, the organization of the project department is established and perfected, that is, the project department is positioned and established as a branch of the enterprise.

3.2. System innovation

After the organizational innovation of project construction management, the system of this institution must be innovated. The project cycle is still the contract performance period, but the project department is no longer just the agency of the enterprise, but turns the project department into a branch company and establishes a modern enterprise system.

First of all, it is necessary to establish the responsibility subject system and implement the asset management responsibility system. The enterprise, as the investment subject of the project, retreats to the position of the holding company, exercises its responsibilities in the way of shareholders, and

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assumes part of the responsibilities. It is necessary to establish a new property right relationship according to law, and clarify the boundary responsibility between the investment enterprise and the project department.'

The second is to establish the property system of the enterprise responsible person. Make the project department own a piece of property with clear boundaries, and use the property of the responsible person with clear boundaries to bear the legal liability. The independent status of the project department should be determined according to the clear boundary of the legal person property. In this way, the project department can truly go to the market, operate independently, assume its own profits and losses, and independently assume its responsibilities.

The third is to form a scientific governance structure and form incentives and constraints from the company or construction unit, because some of the project companies are funded by enterprises, which must fully reflect the will of the enterprise holding company. The will of the holding company is to pursue the highest profit on the one hand and avoid risks as much as possible on the other. The pursuit of maximum profit is an incentive for the holding company, which urges some project companies to seriously implement the contract, effectively control the quality, duration and cost, and avoid the risks caused by contract defects and poor management, so as to form necessary constraints for some project companies.

4. New technical charter and management system based on BIM Technology

As a new modeling technology, BIM technology can integrate various information such as 3D geometry, physical properties and structural details in digital models. In the field of building construction, the information of building design and construction acceptance can be coordinated and integrated, so as to improve the efficiency and quality of engineering construction, and evaluate complex environmental structures to reduce project costs. The following are the different innovative applications of BIM Technology in different management stages [10].

4.1. Planning and design stage

In the construction project management, BIM Technology has a very significant role and significance for planning and design. First, through digital modeling, the visualization and flattening of project planning and design can be easily realized, and the project department and managers can more intuitively understand the overall planning of the project. Figure 2 is a partial model of the planned display curtain wall in the eastern New Area of Chengdu. The application of BIM Technology in modeling can clarify the design scheme, project planning layout, key and difficult points in the construction process, and then formulate a more standardized scheme and make targeted decisions. Secondly, BIM Technology has a complete dynamic database, which is helpful for the whole process management of the project. Managers and construction units can use BIM Technology to simulate, more intuitively and clearly understand the design and planning intention, and can give corresponding feedback to scientifically evaluate the feasibility of the scheme from the perspective of the field. Finally, BIM Technology can also be used for multi-dimensional modeling of mechanical, electrical, water supply and drainage systems. Construction personnel can analyze the influencing factors of construction safety and engineering quality from multiple perspectives, so as to further improve the efficiency of engineering construction [11].

Scientific and reasonable project planning is of great significance for improving the scientificity and accuracy of construction project management. With the help of BIM technology, information technology can be integrated into engineering management, establishing a comprehensive database, and helping to improve the stability and systematization of later construction and acceptance. By leveraging advantages such as visualization and controllability, utilizing BIM technology in project planning can improve the quality of information retrieval. Planning and management departments can showcase the value of data from multiple perspectives, and integrate GIS technology into BIM database systems to ensure the rigor of early planning for construction projects [12].

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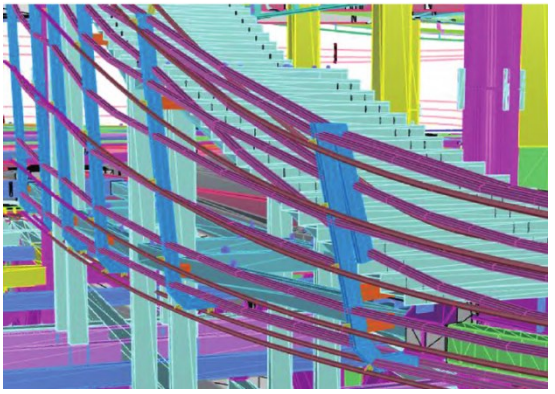

Figure 2. partial model of curtain wall of Chengdu Eastern New Area Planning Exhibition Center [13].

4.2. Construction stage

4.2.1. Construction site management. BIM technology has a dynamic and complete database that can quickly collect all data from design, construction, operation and management stages, providing a complete scientific basis for construction units and management personnel to coordinate construction and project planning.

Firstly, in the pre construction stage, managers or construction units can use BIM Technology to build virtual scenes and simulate front-end design, so as to clarify the specific requirements of construction progress, construction quality, construction process, etc., plan construction tasks more efficiently and comprehensively, reduce construction risks, and improve construction quality and efficiency. Secondly, BIM Technology is applied to collect the construction position. According to the construction period, building scale and other data, the management personnel and construction units can optimize and adjust the construction scheme, reasonably use and redistribute the remaining resources, reduce the waste of materials and manpower, and further improve the construction efficiency. Finally, relying on the real-time and dynamic nature of BIM Technology, real-time supervision and dynamic monitoring can be carried out on the construction site. The site construction personnel and management personnel upload data uniformly to achieve data sharing, analysis and exchange, so as to ensure that the dynamic changes of the construction site are mastered and ensure the smooth progress of engineering construction.

4.2.2. Construction quality management. First, with the help of BIM Technology, strengthen the quality inspection of construction engineering construction. BIM Technology can help quality management personnel timely find out the quality problems existing in construction, identify and judge human factors, material factors or environmental factors, and clarify the key points of project quality control. Secondly, BIM Technology is used to adjust and optimize the quality objectives of construction projects. Through the construction of the model, the information such as the number of components required for the project, specification level, manufacturer price, etc. are summarized in detail, and the scientific and reasonable general and sub objectives of construction quality control are formulated. The sub objectives of quality are constructed in combination with the actual situation, so as to improve the construction efficiency and overall construction level of construction engineering.

4.3. Acceptance stage

The BIM Technology is used to integrate all data of the project, effectively integrate the construction information and control information, and analyze whether the construction project is consistent with the early analysis data when it is completed. Through the real-time generation of digital model, it is convenient for managers to compare and analyze the building information model and construction

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drawings before acceptance to determine whether the construction situation meets the expected effect. Managers can bring great help to the actual work of acceptance and improve the efficiency of completion acceptance by comparing and analyzing the data and confirming the data target. BIM Technology is applied to the completion acceptance. Managers can evaluate and accept the completion of the project in an all-round way according to the analysis of dynamic data and indicators. They can monitor and manage each project node in real time and comprehensively evaluate the reliability, safety and durability of the project. In this way, it can avoid the single acceptance method with the completion degree of construction indicators as the evaluation standard [14].

5. Conclusion

This paper mainly studies the application and analysis of innovation mode in engineering management, and draws the following main conclusions:

(1) The advantages and disadvantages of the traditional project management mode are obvious. The common points are mainly the imperfect management system, the backward technology of construction management personnel and the lack of management consciousness and experience.

(2) At this stage, the project management system is not perfect, the responsibility system is not clear, and the responsibilities of the project department are miscellaneous and the supervision is not in place. After the innovation of the organization system, the project management organization system has been improved, the modern enterprise system and the clear responsible person system have been established, and the rights and obligations of the project department and other units have been clarified, effectively ensuring the construction quality and construction process.

(3) As a new modeling technology, BIM Technology has gradually become an important tool in construction engineering management. The management personnel of the project department should rely on BIM Technology to continuously strengthen the mastery of relevant technologies and modeling methods, further improve the project management level, ensure the construction quality and progress, continuously improve and optimize the construction management process, and promote the digital management and sustainable development of the construction industry.

(4) Due to incomplete information collection, regional differences, different levels of technology popularization in different regions, empirical formalism and other issues, it is still difficult to promote the innovation mode. It needs further research and exploration to truly apply the innovative mode in the actual project management.

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