Research on the Application of BIM Technology in the Cost Management of Construction Projects

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Abstract. Under the premise of ensuring safety, quality compliance, reasonable schedule, and lowest cost are the fundamental goals of construction project management. The realization of this goal, in the final analysis, will fall on the key point of cost management. With the advent of the "Internet +" era, the construction industry has developed rapidly, especially the application and promotion of BIM technology, which has gradually changed the traditional cost control mode. Based on BIM technology, taking construction project cost management as the research object, introducing the management method based on "BIM + earned value method", analyzing the application of BIM technology in construction project cost management, constructing a cost management practice model, proposing specific countermeasures, and guiding the project practice.

1.Introduction

Building Information Modeling (BIM for short) was first proposed by American scholar Chuck Eastman. It refers to the use of digital and informatization methods in the entire life cycle of construction projects. The functional characteristics and physical characteristics of the engineering project are described, and the total sum of the process and results of design, construction, and operation is carried out based on this. The information included must cover all majors, involving all the information of the whole process, all-round, and all-elements of design, construction, use and operation, etc., organically integrate them to form a building model. The key to the whole process management of construction projects is cost control; all participants attach great importance to cost management. How to deeply understand the essence of BIM technology and apply BIM technology for effective construction project cost management is one of the important issues in the engineering field at present and for some time to come.

2. The status quo of BIM-based cost management

2.1. Analyze from the various stages of the construction project

Compared with developed countries, the degree of informatization of current construction projects in my country is much lower than that of developed countries, and BIM technology urgently needs to be widely promoted. With the support of governments at all levels, the BIM operating mechanism led by the designer has developed to a certain extent. BIM technology has been applied to a certain extent in the design and construction, but compared with the operating mechanism led by the builder, its advantages Obviously it has not been used, and the resources have not been optimally used. In the decision-making stage, the main goal of the project owner is to select the best investment plan and grasp the initiative of cost management from the source. However, there is not much data on similar

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projects at this stage, which fails to provide a reference information platform for owners' decision-making services. In the design stage, the project construction party did not pay enough attention to the pre-design preparation work, investment decomposition and quota design implementation were not in place; the designer lacked the necessary cost control awareness, and unilaterally emphasized the legitimacy of the design and the operability of the technology. In the design stage, cost management was not fully paid attention to, and there was a disconnection between technology and economy. During the construction phase, various design changes occurred frequently, and some even data were inconsistent, and rework occurred from time to time. In the completion and acceptance stage, in order to maximize its own interests, the construction unit has serious over-calculation and fraudulent calculations in the settlement preparation process. The practice of high sets of quotas and high fees often occurs, which finally leads to distortion of the cost.

2.2. Analyze from the parties involved in the construction project

Effective cost management requires the collaboration of all parties involved in the construction project. The most important point is the collaborative sharing of project data and information throughout the entire process. In the practice of engineering project cost management, the participants in the whole process are too concerned about their own interests from their own perspectives, and information collaboration and data sharing are difficult. The main manifestations are: first, lack of overall awareness and limited data sharing. The project participants took the current stage and the main body as the starting point, emphasized local information and local interests, and failed to consider the overall situation. The second is information delay and low efficiency. Affected by the traditional management model, the transmission of information mainly relies on traditional drawings and documents, the degree of informatization is very limited, and the transmission and updating of information is slow. Project managers at all stages have delays in receiving information, communicating information, feeding back information, and processing information. The third is limited information communication and poor results. Construction projects have long duration, many participants, complex influencing factors, large amount of information on various project costs, and difficult communication. Objectively, all participants are required to actively cooperate. However, in actual work, due to the subjectivity of all participants, information errors and information transmission omissions are serious, which eventually leads to information deviations and affects the effectiveness of cost management.

3. Cost management method based on BIM+ earned value method

3.1. Principle analysis

The Earned Value Method, also known as Earned Value Management (Evm), is an advanced and applicable project management technology. It was first proposed by the US Department of Defense in the 1960s, and it is currently the majority of engineering project management in the world. An effective tool for the company to conduct cost management, expense analysis, and schedule control. The earned value method, based on a large amount of cost data, compares and analyzes the earned value of the project during a certain period with the planned value and actual value, and calculates the cost deviation value and the progress deviation value, so as to determine whether the progress is advanced or delayed. To conclude whether the cost is saved or overrun, comprehensively analyze the effect of cost management and provide information services for decision makers. The earned value method includes three parameters and four indicators, namely: BCWS (Budgeted Cost for Work Scheduled) for the completed project, BCWP (Budgeted Cost for Work Performed) for the completed project, and ACWP for the actual cost of the completed project (Actual Cost for Work Performed); Cost Variance (Cost Variance), Schedule Variance (SV), Cost Performance Index (CPI) and Schedule Performance Index (SPI). The four indicators influence and restrict each other to jointly achieve project cost management and schedule management goals. The relationship is shown in Figure 1.

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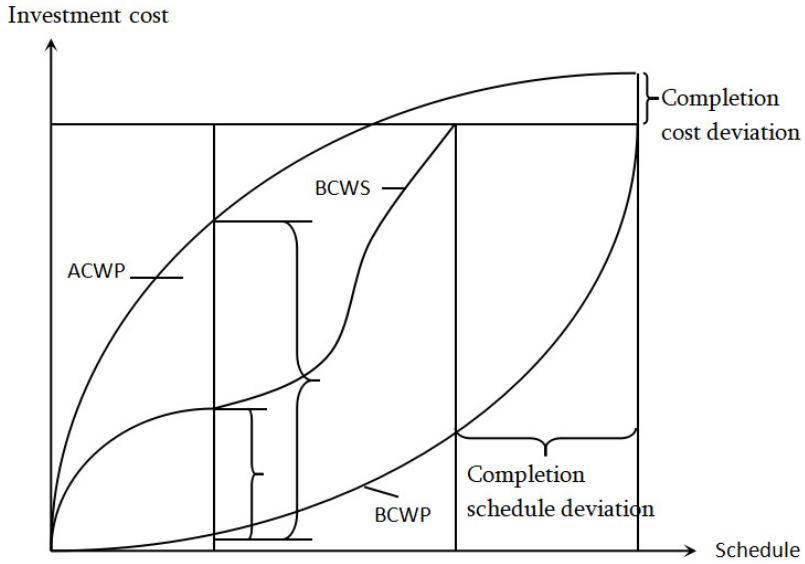

Figure 1. The relationship between the parameters and indicators of the earned value method

3.2. The integration of BIM technology and earned value

The cost management and schedule control of construction projects are carried out in stages and on schedule. The earned value method is a cost management method based on the project schedule and requires a large amount of project schedule data as support. In the process of project management, the acquisition of large amounts of data is achieved by creating WBS. WBS technology subdivides construction projects and single projects to obtain unit projects and sub-projects; while the application of BIM technology can accurately obtain each unit project. , Sub-projects, cost and progress data of each component, provide powerful data support for the application of earned value method.

Through BIM technology modeling, various engineering data can be obtained in time, and applied to the earned value method, to calculate various evaluation indicators, and analyze cost deviations and schedule deviations. The integration of BIM technology and earned value method dynamically grasps the cost and progress of each phase and component of the project, greatly improving the cost management effect.

4. The application of BIM technology in the cost management of construction projects

4.1. Investment decision stage

One is conducive to improving the accuracy of investment estimates. Accurate investment estimation is one of the main goals of cost management in the investment decision-making stage. To achieve this important goal, there must be a large number of similar project data databases and similar cost index systems. This is precisely the powerful function of BIM technology. BIM technology can quickly and accurately collect and summarize completed historical data, and provide scientific and comprehensive data information for the investment decision-making process. Using this information, and then comprehensively analyze and adjust according to the specific conditions and project characteristics of the proposed project, you can obtain information about the new project and get the investment estimate. This calculation mode greatly improves the accuracy of investment estimation and is beneficial to project cost control.

The second is conducive to improving the feasibility of the program. Visualization and simulation are the advantages of BIM technology. In the investment decision-making stage, BIM technology can

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be used to construct a three-dimensional architectural solid model to show the real situation of the entire project for decision makers and compare and select plans. Moreover, after the characteristics of the proposed project, project functions, and project model are constructed, data and functions can be separated, optimized and combined, and more and better solutions can be obtained. Through the construction, comparison and selection of different schemes, further optimization and improvement from different angles, to arrive at the best scheme, to provide investors with reference.

The third is conducive to improving the scientific nature of decision-making. The correct decision is the prerequisite for project cost management. According to the statistical analysis of project data, the impact of the decision-making stage on the project cost is 90%-95%, which objectively requires project managers to pay full attention to decision-making and scientific decision-making. Use BIM technology to obtain a large amount of engineering data information, fully carry out technical and economic analysis, integration, comparison and selection, comprehensive safety, quality, and construction period elements, find the best project cost management plan, improve the scientific nature of decision-making, and reduce investment risks.

4.2. Design phase

One is offline and thousands of investments are made", which is enough to illustrate the importance of investment control in the design stage. The application of BIM technology, combined with the completeness of the investment project information and the design depth, can greatly improve the rationality of the design and effectively carry out cost management. In the design stage, the application of BIM technology mainly includes construction simulation, design analysis and collaborative design, visual communication, collision check, construction drawing formation, and ultimately achieve the best cost management goals.

One is construction simulation. This stage includes construction process, construction method simulation, and construction plan simulation. Before the project is implemented, BIM technology is used to analyze, simulate, and improve the proposed project, find and solve problems in time, and obtain the best plan to guide the construction. The second is design analysis and collaborative design. In the preliminary design stage, each professional design department must carry out analysis work on its own professional design, which mainly includes structural analysis, safety analysis, energy-saving analysis, light analysis, etc. This plays an important role in ensuring the safety and reliability of construction projects, energy conservation and environmental protection, reasonable investment, and project operation feasibility. In the process of collaborative design, various professional design units cooperate to form a design team, build the same BIM model, share data resources, and build a collaborative work mechanism with the shared BIM model as the "junction". Through this mechanism, various professional design results can be reflected on the BIM model in time. At the same time, each professional designer can also obtain the latest results of other professional designers for the first time and share them in collaboration, which effectively avoids the design of each professional. Conflicts caused by poor communication between. The third is visual communication. In this link, BIM technology is used to construct a three-dimensional model to "tangibly" display the design intent, design concept, and design results to all project participants, including the construction unit, design unit, government management department, construction unit, and engineering consulting experts. Effective communication is carried out so that the construction intention of the construction unit can be fully demonstrated, and the government approval department can clearly know whether the project design approved by it meets the policy requirements. The fourth is collision checking. Through BIM technology, different professional design results can be collected in the same model, and the collision check function can be used to find the "collision points" between various disciplines, and feed them back to the corresponding professional designers in the first time, forming a "closed loop" design". The collision check function of BIM technology enables the design unit to obtain the possible problems in the construction process in advance in the design stage and correct them in time, which greatly reduces the design changes in the project implementation process. The fifth is the formation of construction drawings. The BIM model is a three-dimensional space model that completely and truly

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reflects the building components and building space. Derived from the only BIM model data, it can be said that any substantial modification to the project design will inevitably be reflected in the BIM model, and the BIM software can dynamically adjust the supporting two-dimensional construction drawings based on the latest data of the three-dimensional model. The automatic conversion and update function of BIM technology from "three-dimensional model" to "two-dimensional drawing" greatly saves the time for drawing modification and is beneficial to schedule control.

In the design stage, the space model constructed by BIM technology, on the one hand, truly reflects the data information of the building components and building space, and at the same time, it also presents the material functions and information used in the components in a timely manner. This information can be delivered to In the professional engineering measurement and pricing software system, corresponding engineering quantity indicators and cost information are obtained. This collaborative and integrated work model provides convenient conditions for quota design and value engineering project optimization, and is beneficial to project cost management.

4.3. Bidding stage

The bidding stage is also an important part of project cost management, and BIM technology plays an important role. First of all, it is conducive to the accurate calculation of engineering quantities and greatly improves the efficiency of cost management. In the traditional bidding stage, the cost practitioners are first familiar with the drawings and master the fixed amount of manual item calculation. The process workload is large and the accuracy rate is limited. Using BIM technology, the cost practitioners can quickly and accurately obtain the project by relying on the BIM model. This greatly improves work efficiency and accuracy, thus gaining the initiative for effective cost control. For the tendering party, each bidder will quickly obtain the same amount of work, saving the time for preparing bid documents, and is more conducive to the adoption of bidding strategies. At the same time, on the premise of the same amount of work, it also makes the bidding price more fair and just. Secondly, it helps to improve the efficiency and quality of bid evaluation and promote fair competition. In the traditional bid evaluation work, experts mostly rely on abstract drawings and text information, and their work efficiency and work quality are greatly restricted, which affects fair competition. Under the BIM model, each bid evaluation expert can use the visual model and the animation roaming function of BIM technology to intuitively and accurately review, control, and score the proposals of each bidder. At the same time, bidders can also show their plans to experts efficiently and quickly, and present their advantages. This will greatly improve the efficiency of bid evaluation, promote fair competition, and achieve effective cost management.

4.4. Construction phase

The construction stage is the formation stage of the construction project, which has the characteristics of long construction period, many participants, and complex influencing factors. Through BIM technology, it can intuitively and timely grasp the progress and resource consumption of each sub-project, and dynamically adjust cost; at the same time, it also has obvious advantages in the payment of progress payments and the handling of change claims, which is conducive to improving investment efficiency.

Firstly, the progress can be controlled and settlement can be made quickly. Project progress settlement is a very complicated task. Cost practitioners actually perform measurement and review at the settlement site based on the construction contract and the completed project volume submitted by the contracting unit. As the progress of the project progresses, cost practitioners, supervision units, etc. must carry out multi-stage, multi-level measurement and accounting. By using BIM technology, engineering quantities can be directly imported from the software, combined with actual site conditions, timely access to completed engineering information, and rapid settlement, which is conducive to schedule control and cost management. At the same time, the project management personnel can also directly export the relevant information of the unfinished project from the BIM model, so as to realize the progress management and cost control of the follow-up project.

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Secondly, it can reduce changes and accurately handle claims. The visual characteristics of BIM technology enable various consumption and engineering adjustments in the construction process to be intuitively reflected, and various changes can be warned to reduce changes. Of course, it is impossible to completely eliminate changes during the implementation of construction projects. After the change occurs, project managers such as construction units and construction units can adjust relevant information and improve relevant data on the BIM model, and conduct accurate project cost information verification and comparison. The BIM technology model can not only scientifically and accurately allocate each sub-project and cost plan at each stage, but also predict various consumption during the project implementation process and carry out effective cost control.

4.5. Completion acceptance and use stage

In the traditional engineering project completion acceptance stage, project management personnel need to conduct on-site review and measurement based on the completed engineering quantity and construction drawings, collect comprehensive and effective technical and economic data, and pass the initial inspection, formal acceptance and other links. This mode of operation is extremely complicated, requiring a lot of manpower, material resources, and financial resources, and a large amount of manual data collection is prone to work errors that affect the acceptance results. Using BIM technology, the entire process management and formation of the project can be visually presented. Various changes and adjustments during the construction process have been improved in the model, including various structural information, production factor prices, and sub-item engineering quantities, etc. All are the final actual data, which will greatly increase the speed of completion acceptance. At the same time, in the operation process, especially in the data collection link, the use of various software and models reduces the complicated manual links and avoids manual operation errors, which will surely save investment costs and improve management efficiency.

In the use, operation and maintenance stage, based on the previous BIM model, accurate and complete storage of data and information in decision-making, design, bidding, construction, and completion acceptance. Operations and maintenance personnel can clearly obtain the structure and equipment at any time Parameter information, performance indicators, accurate operation and maintenance management, reducing various consumption and saving costs.

5.the countermeasures of BIM technology in the cost management of construction projects

5.1. Strengthen guidance and increase government support

In 2003, my country's construction industry began to introduce BIM technology. At present, the use of BIM technology is mainly based on large design institutes, and various training institutions and consulting companies are gradually using it. Industry associations and relevant government departments are also paying more and more attention to its value and significance. The introduction of BIM technology into engineering project cost management can achieve the optimal plan, improve the efficiency of the enterprise, and at the same time, it is also conducive to the sustainability of project cost management. As a new technology, the competent government department should increase investment, and should provide strong support in terms of policies and taxation to achieve its sound development.

5.2. Improve standards and formulate BIM technical laws and regulations

At present, a considerable number of companies do not fully understand BIM technology, and its application in engineering practice is even more uneven, resulting in the poor effect of applying BIM technology to control costs in the process of engineering project cost management, and some Recognize the misunderstanding. At the same time, there are also employees and construction companies in the process of use, the rights and interests cannot be guaranteed, and the interests of the enterprise cannot be realized. To a large extent, this is caused by the lack of relevant laws and irregular

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system standards. Therefore, it is very urgent and necessary to realize the effective promotion of BIM technology, improve standards, and formulate supporting regulations.

5.3. Encourage innovation and build a BIM-based cost database

Timely and accurate engineering project data is the basis for building BIM models. In the process of engineering project cost management, management personnel enter relevant information such as labor, materials, mechanical shifts, quotas, and cost indicators in a timely manner, and adjust and improve them along with the progress of the project, which is conducive to decision makers to accurately grasp the actual situation of the project. Thereby scientific decision-making. Data collection involves many subjects and a long process, which is an extremely complex task. Innovations should be encouraged and new technologies and methods should be adopted to achieve efficient and accurate data collection, transmission, and use processes to serve project cost management.

At present, China has become the region with the largest infrastructure investment and the most active construction activities in the world. A large number of complex civil engineering projects with large quotas and high-rise buildings continue to emerge, and their cost management will become increasingly complex and important. This objectively requires relevant practitioners to study hard, continue to innovate, and continuously tap the potential value of BIM technology to realize the cost of engineering projects. Sustainable development of management. The study of BIM technology is an important topic for project management personnel at present and for a period of time to come.

6.conclusion

The "Internet +" technology is changing with each passing day, which promotes the rapid development of the construction industry; the application and promotion of BIM technology has gradually changed the traditional cost control mode of engineering projects. At present, China has become the region with the largest infrastructure investment and the most active construction activities in the world. A large number of complex civil engineering projects with large quotas and high-rise buildings continue to emerge, and their cost management will become increasingly complex and important. This objectively requires relevant practitioners to study hard, keep innovating, and constantly tap the potential value of BIM technology to realize the cost of engineering projects. Sustainable development of management. The study of BIM technology is an important topic for project management personnel at present and for a period of time to come.

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