Research on Dynamic Cost Management and Optimization Strategy of High-rise Building in Construction Stage

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Abstract: The construction stage of high-rise buildings is faced with challenges such as large investment scale, complex technology, high risk sensitivity and long construction period. The traditional static cost management model is difficult to cope with the dynamic changes in the construction process, resulting in high cost overruns. This paper analyzes the influencing factors of high-rise building construction cost, and constructs a dynamic cost management system based on real-time monitoring, rapid response and digital tool application. Aiming at the design, construction, material procurement and project management, the optimization strategies and implementation paths are put forward, including simplifying the structural scheme, rationally planning the building volume, applying prefabricated components, strengthening cooperation and communication, analyzing the cost performance of materials, purchasing in batches, optimizing transportation and storage, and linking schedule management with cost control. By implementing these strategies, the project cost can be effectively controlled, the investment benefit can be improved, and the healthy development of the construction industry can be promoted.

1. Introduction

High-rise building projects generally face the problems of "three highs and three lengths": high investment scale, high technical complexity, high risk sensitivity and long construction period, long decision-making chain and long cost fluctuation. The traditional cost management model is mainly based on static budget and after-the-fact accounting, which is difficult to cope with frequent design changes, material price fluctuations and unforeseen risks in the construction stage, resulting in high cost overruns. At the same time, the digital transformation of construction industry provides a new paradigm for cost management. The 5D application of BIM (Building Information Model) technology (3D model+time+cost) can realize real-time simulation of resource consumption, IOT equipment can accurately collect field data, and big data analysis can predict the price fluctuation trend.

2. Analysis of influencing factors of high-rise building construction cost

Construction stage is the key link of high-rise building cost management, and its cost is directly related to the economic benefits of the project and the competitiveness of enterprises [1]. Therefore, it is of great significance to deeply analyze the influencing factors of construction cost for effectively controlling and reducing the project cost and improving the investment benefit.

Design change refers to the behavior that the original design needs to be modified due to design errors, omissions or changes in site conditions during construction. Design changes often lead to the increase or decrease of engineering quantity, and then affect the cost [2]. Building materials are the main material basis of engineering entities, and their price fluctuations directly affect the project cost [3]. For example, the rising prices of bulk materials such as steel and cement will directly push up the project cost. Construction organization design is a comprehensive document to guide the whole construction process, and its scientificity and rationality have a direct impact on the project cost. Reasonable construction organization design can optimize resource allocation, improve construction efficiency, and thus reduce project cost. The choice of construction technology and technology has an important impact on the project cost. Advanced construction technology can

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improve construction efficiency, shorten construction period and reduce labor and mechanical costs; And backward construction technology may lead to rising costs. On-site management and control is an important part of cost management in construction stage. Effective site management can reduce waste and avoid rework, thus controlling the project cost. Contract management is the link between the owner and the contractor, and its rigor and rationality have a direct impact on the project cost. Whether the terms in the contract are clear and the responsibilities are clear will affect the control of the project cost. There are many factors affecting the cost of high-rise buildings in the construction stage, involving design, materials, construction, management and other aspects [4]. Only by comprehensively analyzing these factors and adopting effective optimization strategies can we realize scientific management and effective control of project cost and promote the healthy development of construction industry.

3. Construction of dynamic cost management system in construction stage

3.1Management framework design

Based on the total project budget, the cost target is decomposed step by step by process, time node and responsible subject to form a quantifiable control unit (as shown in Figure 1). For example, put the budget into every drawing, batch of materials or daily construction task, define the responsible person and the scope of fund use, and ensure that the whole process is controllable [5]; At the same time, combined with WBS model (work structure decomposition), a three-tier system is established, including project list, path planning and schedule planning, to realize the linkage management of cost and schedule [6].

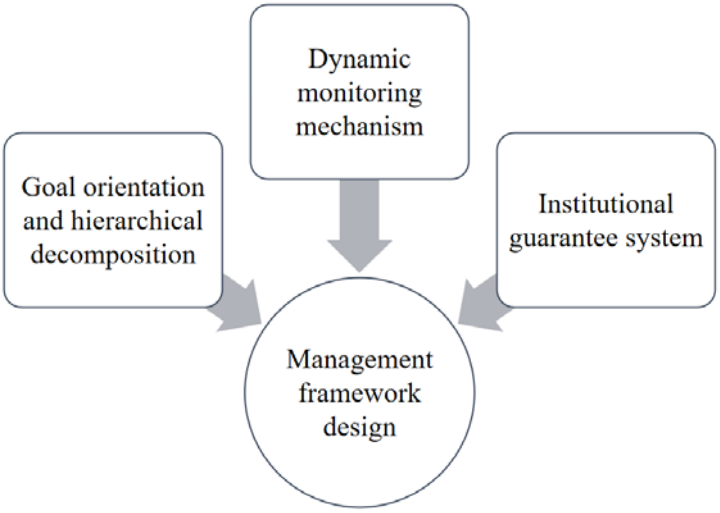

Figure 1 Management framework

Through real-time data collection and analysis, compare the difference between actual expenditure and planned value, timely warn the deviation and adjust the strategy. The mode of "real-time monitoring+quick response" is adopted, the capital flow is tracked based on the construction log and monthly cost report, and the matching degree between progress and cost is evaluated by the earned value method to ensure the scientific nature of dynamic rectification [7]. Formulate the quota acquisition system, change approval process and responsibility traceability mechanism. Conduct multi-party joint review of design changes and record their impact on the budget; Establish a reward and punishment system to motivate the team to implement the quota standard and strengthen the cost awareness of all staff [8].

3.2 Core management link

Optimize the procurement plan, carry out centralized bidding and long-term supplier cooperation to reduce the risk of unit price fluctuation; Implement dynamic inventory management to avoid extra expenses caused by backlog or shortage. The material demand cycle is simulated by BIM

model, and the purchasing opportunity is predicted in combination with the market price trend [9]; At the same time, the acceptance process is strict to ensure quality compliance and reduce rework losses [10]. Standardize the authenticity audit of engineering visas, and require all changes to be attached with the notice issued by the design unit and included in the dynamic cost accounting. Hold regular risk analysis meetings, predict potential cost overruns, reserve emergency reserves and formulate emergency plans; For extra-contract items, it is necessary to evaluate the economic rationality through multi-department cooperation before implementation. Transforming process standards into cost control nodes, such as reducing late repair rate through accurate positioning of embedded parts; The critical path method is used to optimize the construction sequence, shorten the construction period and reduce the cost of machinery leasing and manual idleness. In addition, strengthen the management of concealed engineering acceptance records to provide a basis for settlement and avoid controversial deduction.

3.3 Digital tool application

Construct a three-dimensional information model to integrate geometric data and cost information, and automatically generate a list of resource requirements in each stage. Support collision inspection to find design conflicts in advance and reduce the waste of on-site demolition and modification; And through visual disclosure, the operation efficiency is improved, and the cost simulation and optimization of the whole process from design to construction are realized [11]. Deploy a cloud-based cost platform to achieve multi-terminal data synchronization and break through the information barriers of design, procurement, finance and other modules. The system has a built-in historical database to assist rapid price assembly, and the AI algorithm predicts the price trend to guide decision-making; The mobile APP facilitates the on-site personnel to report the progress image data in real time, and enhances the transparency control ability. Based on the accumulated project data, the machine learning model is trained to identify the key factors that affect the cost. Using data mining technology to establish cost prediction curve, when the actual consumption deviates from the preset threshold, it automatically triggers an alarm and pushes optimization suggestions to the management mobile terminal.

4. Cost optimization strategy and implementation path

4.1 Design stage optimization

4.1.1 Simplification and standardization of structural scheme

The structural design of high-rise buildings accounts for a large proportion in the cost, so the structural form should be simplified and the frame-shear wall system should be adopted to reduce the amount of steel bars and concrete. At the same time, standardized design is also extremely important. Unifying the floor layout and floor height is beneficial to mass production of prefabricated components, reducing processing and transportation costs, and reducing on-site construction errors and rework rates.

4.1.2 Reasonable planning of building volume and functional layout

Building volume and functional layout have a far-reaching impact on the cost. For example, in the design of commercial complex, adjusting the size of atrium reasonably and optimizing the proportion of commercial and office space can make the building compact, which can reduce the structural burden and save costs. In addition, the functional layout should avoid complex cross pipelines, rationally plan the pipeline direction and equipment location, and reduce the cost of concealed works.

4.1.3 Attach importance to energy saving and environmental protection design

Although the initial investment of energy-saving and environmental protection design is high, in the long run, it can effectively reduce the construction operation cost. In addition, reasonable use of natural lighting and ventilation, reducing artificial lighting and air conditioning load, can also

reduce costs. The design team and the construction unit should cooperate closely to implement the energy-saving design concept throughout the project.

4.2 Optimization of construction stage

4.2.1 Scientifically arrange the construction scheme

Reasonable arrangement of working procedures can avoid idle workers, mechanical waiting and long-term stacking of materials, thus reducing the loss. For example, using the "jacking method" to construct the elevator can reduce the number of disassembly and assembly, saving time and labor costs; Reasonable arrangement of concrete pouring time and sequence can avoid repeated construction and reduce the cost of secondary construction.

4.2.2 Prefabricated components are widely used

Prefabricated components have the advantages of stable quality, fast construction speed and less on-site processing, which can greatly reduce the use time of construction personnel and machinery. However, the design and transportation of prefabricated components need to be coordinated in advance to ensure accurate dimensions and safe transportation, and to prevent rework and damage from increasing costs.

4.2.3 Rational use of construction machinery and technology

Choosing the right construction machinery according to the actual situation of the project can improve efficiency and reduce costs. If the tower crane is arranged and used reasonably, the hoisting efficiency can be improved and repeated hoisting and mechanical idleness can be avoided; Reasonable selection and arrangement of concrete pump truck can affect the pouring speed, quality and construction period. At the same time, the use of information technology for construction management, such as progress tracking, material procurement and on-site safety monitoring, can reduce human error and save management costs.

Strengthen cooperation between the construction unit and the construction unit. The designer, the constructor and the owner should maintain efficient communication and adjust the scheme in time to avoid rework caused by information lag. In the high-rise office building project, it is helpful to establish a monthly joint coordination meeting system, review the progress and cost changes in real time, and adjust the procurement plan and construction plan in time to reduce material waste and unnecessary expenses.

4.3 Material procurement and supply chain management optimization

4.3.1 Cost-effective analysis of material selection

Material selection should give consideration to performance and cost, and avoid blindly pursuing high-end brands. Through detailed performance testing and market research, select materials with high cost performance.

4.3.2 Establish the relationship between batch purchase and cooperation

Bulk purchasing can reduce the unit price of materials, establish a long-term and stable cooperative relationship with suppliers, not only get preferential prices, but also ensure timely supply and stable quality. In large-scale residential projects, signing a long-term supply agreement with steel suppliers to obtain price discounts and priority supply rights can effectively avoid the risk of market price fluctuations.

4.3.3 Optimize material transportation and storage management

Reasonable planning of transportation and storage of high-rise building materials can reduce loss and waste. If the warehouse layout is adjusted and strict warehousing and warehousing procedures are formulated, material loss can be reduced; Scientifically arrange transportation, coordinate suppliers and construction site time nodes, ensure materials arrive on demand, and reduce site accumulation and space occupation.

Strict material acceptance and quality control. Strict material acceptance process and third-party testing can ensure that materials meet the design and specification requirements and prevent rework and maintenance costs from rising in the later period. Finding and returning substandard steel in time can avoid potential structural safety hazards and huge maintenance costs.

4.4 Deepening of project management

4.4.1 Two-way linkage between schedule management and cost control

In high-rise building projects, schedule delay will directly lead to cost increase. Scientific progress plan should be made, construction nodes should be arranged reasonably, and construction trends should be grasped in time to avoid quality problems and overtime expenses caused by rushing to work. Carrying out the daily progress report system can find and adjust problems in time and avoid construction bottlenecks.

4.4.2 Establish risk early warning and emergency measures

The construction of high-rise buildings is complicated and there are many risk factors. Establishing a perfect risk early warning mechanism, identifying potential problems in advance and making emergency plans can effectively prevent small problems from turning into big losses. Prepare in advance for risks such as bad weather and large fluctuations in material prices.

5. Conclusion

There are many complicated factors in the construction stage of high-rise buildings, including design changes, material price fluctuations, construction organization design, construction technology and process selection, site management and control, and contract management, which have a significant impact on the project cost. The dynamic cost management and optimization strategy in the construction stage of high-rise buildings put forward in this study not only helps to solve the shortcomings of the traditional cost management model, but also promotes the healthy development of the construction industry, providing valuable reference and guidance for similar projects. In the future, with the further development of digital technology, tools such as BIM, Internet of Things, big data analysis and AI will be more widely used, which is expected to further improve the efficiency and accuracy of cost management and make it possible to achieve higher-level cost control and optimal allocation of resources.

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