Collaborative Whole-process Cost Control in Engineering under the EPC Turnkey Contract Mode

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Abstract: This article studies the project cost under EPC (engineering procurement construction) general contracting mode. Although EPC mode is widely used at present, there are some problems in project cost control, such as poor communication among participants and blocked information transmission, which leads to cost out of control. In order to maximize the economic and social benefits of the project, through the analysis of EPC general contracting mode and related theories of project cost, this article deeply analyzes the elements of cost coordination and control in each stage of decision-making, design, bidding, construction and completion, and finds that the influence of each stage on the cost is different and interrelated. Based on this, this article puts forward some strategies, such as constructing collaborative organizational structure and management process, establishing information sharing platform, strengthening contract management, and using technical and economic analysis methods, so as to reasonably determine and effectively control the project cost.

1. Introduction

With the continuous development and transformation of the construction industry, EPC general contracting mode has become the mainstream mode of engineering project construction by virtue of its integration advantages [1]. This model deeply integrates design, procurement, construction and other links, aiming at improving project construction efficiency, ensuring project quality and controlling project cost [2]. However, due to the numerous links and complicated participants in EPC general contracting mode, the effective control of project cost faces many challenges [3]. It is the key to ensure the economic and social benefits of EPC project to realize the coordinated management and control of all links in the whole process.

From an international perspective, developed countries have already widely applied EPC general contracting mode, and accumulated rich practical experience and mature management system [4]. In China, with the vigorous promotion of infrastructure construction, EPC general contracting mode has been applied more and more, but there are still some problems in project cost control [5]. For example, the lack of effective communication and coordination between the participants leads to poor information transmission, frequent engineering changes, and finally the cost is out of control [6]. Based on this reason, it is of great practical significance to study the collaborative control of the whole process of project cost under EPC general contracting mode for improving the project management level of construction industry and optimizing resource allocation.

This study focuses on the whole process of collaborative management and control of project cost under EPC general contracting mode, aiming at systematically analyzing the influencing factors and synergistic mechanism of cost in each stage and putting forward targeted management and control strategies. This will help to enrich and improve the theoretical system of project cost management, provide theoretical guidance and practical reference for the actual operation of EPC projects, promote the healthy development of EPC general contracting mode, and maximize the economic and social benefits of the project.

2. EPC general contracting mode and engineering cost theory

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EPC general contracting mode, that is, engineering procurement construction integration mode, means that the general contracting enterprise undertakes the design, procurement, construction and commissioning services of the project according to the contract, and is fully responsible for the quality, safety, construction period and cost of the contracted project. This model breaks the situation of separation of stages under the traditional model and has remarkable characteristics [7]. First, the responsibility subject is clear, and the owner only needs to dock with the general contractor, thus avoiding the complicated situation of multi-party coordination; Secondly, it has a high degree of integration, and the design, procurement and construction are closely linked, which can effectively shorten the construction period and reduce costs. For example, in the design stage, the feasibility of construction and the convenience of procurement can be fully considered, so as to reduce changes in construction and procurement delays.

The project cost consists of project cost, other costs of project construction and reserve funds. Its pricing principle is based on the decomposition and combination of engineering projects, and through the measurement and pricing of partial projects, the total cost is gradually summarized [8]. The whole process cost management theory emphasizes the cost control of the whole process of the project from investment decision to completion and delivery, and each stage has different degrees of influence on the cost. According to the theory of collaborative management, the overall efficiency and benefit can be improved by establishing a collaborative mechanism among the participants, integrating resources and sharing information. Under EPC general contracting mode, applying these theories to project cost management will help to realize the cooperative operation of all stages and participants and ensure the reasonable determination and effective control of project cost.

3. Elements of collaborative management and control in the whole process of project cost

In EPC general contracting mode, the whole process of collaborative management and control of project cost involves all key stages of the project from decision-making to completion [9]. The work in each stage is independent and closely linked, and the negligence of any link may have a significant impact on the final cost. For this reason, it is very important to deeply analyze the elements of collaborative management and control in each stage.

3.1 the decision-making stage

The decision-making stage is the starting point of the project and plays a decisive role in the project cost. The key elements of this stage include the positioning and scale of the project. Project positioning determines the function and quality standard of the project, and then affects the construction cost. For example, the cost difference between high-end commercial buildings and ordinary houses is significant. The scale of the project, such as construction area and construction period, is also directly related to resource input and cost consumption. According to relevant research, the decision-making stage can affect the project cost by 80%-90%. At this stage, the owner, general contractor and relevant experts need to cooperate, fully investigate the market demand, analyze the technical feasibility and economic rationality, and formulate scientific and reasonable investment estimates, so as to lay the foundation for subsequent cost control.

3.2 Design stage

Design stage is the key link of project cost control. The design scheme directly affects the project cost. A well-designed scheme can not only meet the functional requirements of the project, but also reduce the cost by optimizing the layout and selecting materials reasonably. In the design of building structure, choosing suitable structural form can greatly save material cost on the premise of ensuring safety. Quota design is also an important means at this stage, that is, control the preliminary design according to the investment estimate, and then control the construction drawing design with the preliminary design estimate, so as to limit the project cost to a certain range. In addition, the coordination of design, procurement and construction can not be ignored. Designers should fully consider the feasibility of construction and the convenience of purchasing materials

and equipment, so as to avoid the cost increase caused by design changes. Table 1 lists the influence degree and coordination points of various factors on the cost in the design stage:

Table 1 Factors Influencing Project Cost During the Design Phase

Factor	Degree of Influence on Cost	Key Collaboration Points
Design Scheme	40%-60%	Clarify requirements with the owner; optimize solutions considering construction techniques and material supply
Structural Type Selection	20%-30%	Consider construction difficulty and material costs; finalize decisions jointly with the construction team
Material Selection	10%-20%	Collaborate with the procurement department to balance performance and cost
Design Changes	Likely to cause significant cost increases	Enhance communication at all stages to minimize changes

3.3 Bidding stage

The bidding stage is an important step in determining the project cost. The choice of bidding method directly affects the degree of competition and cost level. Public bidding can attract numerous potential bidders, form sufficient competition, and help reduce costs, but the process is complex and the cost is high. Invitation for bidding is more targeted and can improve bidding efficiency, but it may limit competition. The drafting of contract terms is also crucial, clarifying the rights and obligations of both parties, pricing methods, risk sharing, etc., which can effectively avoid cost changes caused by disputes in the later stage. For example, adopting a fixed price contract can enable the general contractor to fully consider risk factors and provide a reasonable quotation when bidding; If an adjustable price contract is adopted, it is needed to clarify the conditions and methods for price adjustment.

3.4 Construction phase

The construction phase is the specific implementation stage of project cost, and many factors can lead to cost changes. Engineering changes are common during the construction process and may be caused by design defects, changes in owner requirements, or changes in site conditions. Every change may involve an increase or decrease in the amount of work, material replacement, etc., thereby affecting the cost. The level of on-site management also has a significant impact on cost. Efficient construction organization and reasonable resource allocation can avoid phenomena such as idle work and waste, and reduce costs. In addition, construction quality control cannot be ignored. If there are quality problems leading to rework, it will significantly increase the cost.

3.5 Completion stage

The cost settlement work during the completion stage is the final confirmation of the project cost. Accurately calculating the engineering quantity and strictly implementing the contract pricing terms are the key to ensuring the accuracy of settlement. At the same time, the review of engineering changes, claims, and other expenses is also crucial. Only on the basis of collaborative control in each stage, ensuring the completeness and accuracy of data, can the completion settlement be successfully completed and the effective control of project cost be achieved.

4. Collaborative control strategy for the entire process of engineering cost

4.1 Building collaborative organizational structure and management process

In order to realize the effective control of project cost under EPC general contracting mode, it is needed to formulate cooperative control strategies from many aspects, which run through the whole process of the project [10]. Establishing a scientific and reasonable collaborative organization framework is the basis of realizing the collaborative management and control of the whole process of project cost. In EPC project, the responsibilities and division of labor of owners, general contractors, design units, construction units, suppliers, etc. should be defined, so as to form a well-organized organization system with smooth cooperation. For example, set up a project coordination committee, which is composed of the principal responsible persons of all parties, and hold regular meetings to solve major problems in the project and coordinate the work of all parties. At the same time, it is needed to formulate detailed management processes to standardize the work processes from project decision-making to completion settlement. Figure 1 shows the main work in each stage and the cooperation mode of participants:

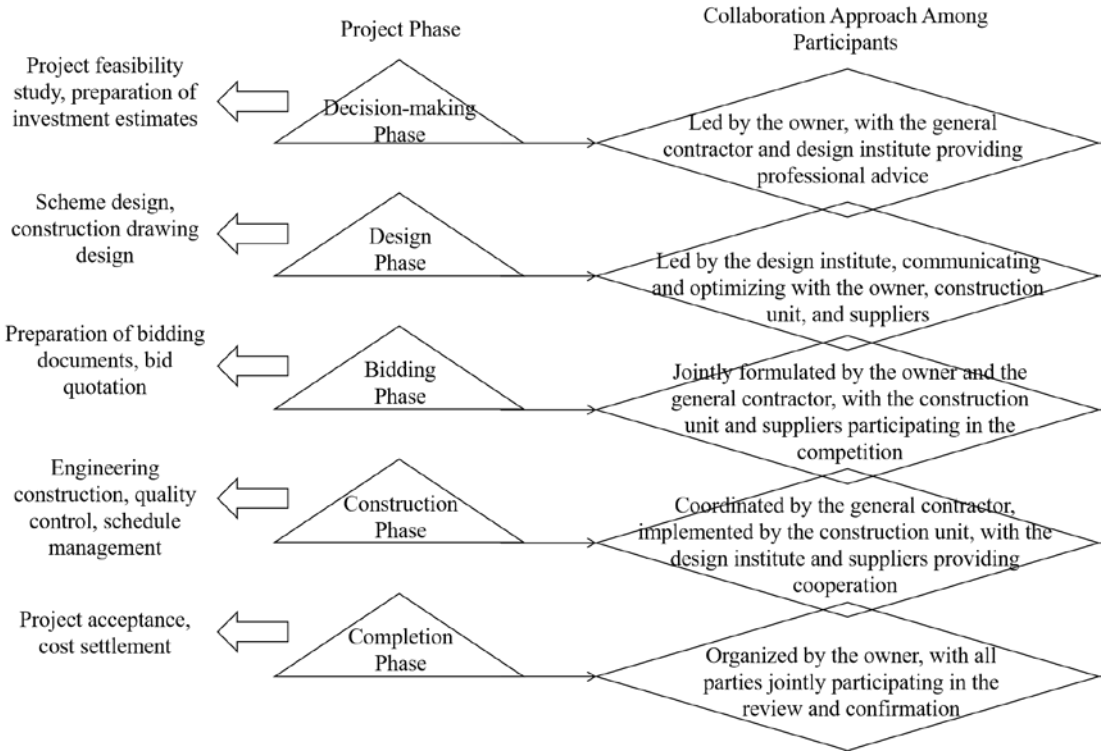

Figure 1 Collaborative Management Process of EPC Projects

4.2 Establish an Information Sharing Platform

Timely and accurate transmission and sharing of information is the key to collaborative management and control. With the help of modern information technology, the information sharing platform of EPC project is built to realize real-time information interaction among all parties. For example, design change information can be immediately communicated to construction units and suppliers, so as to adjust construction plans and procurement arrangements. Through this platform, all parties can share information such as project progress, quality and cost, find problems in time and solve them together. Figure 2 illustrates the interaction of various functional modules and related information of the platform:

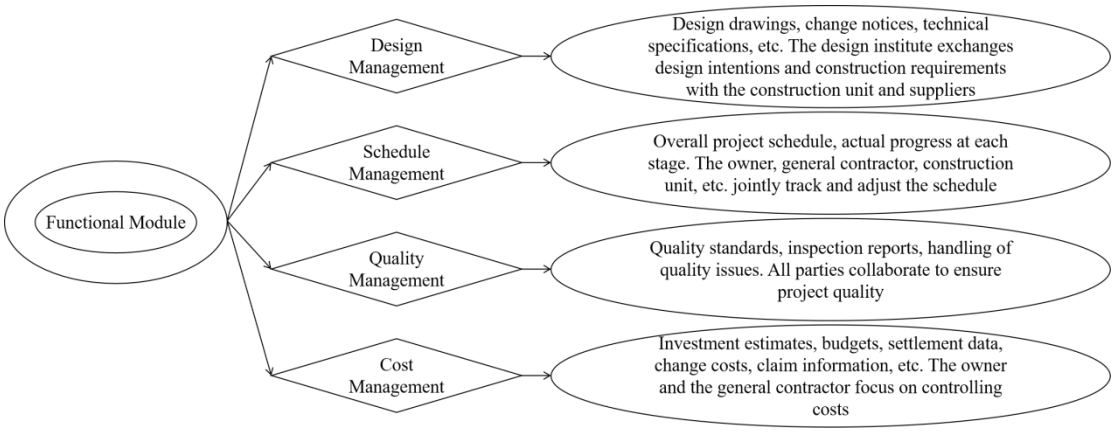

Figure 2 Functional Modules and Information Exchange Content

4.3 Strengthen contract management

Establishing an information sharing platform contract is an important basis for constraining the behavior of all parties and ensuring controllable project costs. Before signing the contract, the contract terms should be carefully reviewed to ensure that the pricing method, risk allocation, change claims, and other contents are clear and explicit. For example, for adjustable price contracts, it is needed to clarify the triggering conditions and calculation methods for price adjustments. During the execution of the contract, strictly fulfill obligations in accordance with the contract agreement and strengthen the management of contract changes and claims. It is needed to establish a contract execution supervision mechanism, track and inspect the contract execution of all parties, deal with the breach of contract in time, and avoid the increase in cost due to contract disputes.

4.4 Using technical and economic analysis methods

Using the technical and economic analysis method in each stage of the project can effectively optimize the scheme and reduce the cost. In the design stage, through the technical and economic comparison of different design schemes, the scheme that can meet the functional requirements and is economical and reasonable is selected. For example, in the selection of thermal insulation materials for building exterior walls, the thermal insulation performance, price and service life of different materials are compared to make the optimal decision. In the construction stage, the technical and economic analysis of construction technology and construction organization scheme is carried out to improve construction efficiency and reduce resource consumption. At the same time, it also pays attention to the application of new materials and technologies, and reasonably reduces the project cost on the premise of ensuring the project quality.

5. Conclusions

In this article, the collaborative management and control of the whole process of project cost under EPC general contracting mode is studied, and the following conclusions are drawn. In EPC general contracting mode, the project cost is influenced by multi-stage elements, and each stage is independent and closely connected with each other. The decision-making stage has a profound impact on cost, and the determination of project positioning and scale requires collaboration among all parties, thorough research and analysis, in order to develop a reasonable investment estimate. The design phase, as a key link in cost control, is significantly affected by factors such as design schemes, structural selection, material selection, and design changes. Therefore, optimization should be achieved through quota design and strengthening collaboration with procurement and construction. The bidding method and contract terms in the bidding stage are related to the degree of competition and cost risk, which should be treated with caution. Engineering changes, site management and quality control in the construction stage are easy to cause cost changes and need to be strictly controlled. Accurate cost settlement in the completion stage depends on the complete information and accurate data accumulated in each stage.

In view of the above factors, the collaborative management and control strategy proposed in this article has important practical significance. This strategy constructs the collaborative organizational structure and management process, clarifies the responsibilities of all parties, standardizes the workflow, and lays the foundation for collaborative management and control; It establishes an information sharing platform, breaks down information barriers, realizes real-time information interaction among all parties, and solves problems in time; This strategy strengthens contract management, clearly defines the rights and obligations of all parties, and effectively prevents and controls cost risks; It uses the technical and economic analysis method to optimize the scheme at each stage and reduce the cost.

Through the implementation of these collaborative management and control strategies, it is expected to achieve effective control of project cost under EPC general contracting mode, improve project management level, promote the healthy development of EPC general contracting mode in construction industry, and realize the unity of project economic and social benefits. However, the actual project situation is complex and changeable, and it is still needed to further study how to use these strategies flexibly according to the characteristics of different projects in the future to better cope with various challenges.

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