

Research on Project Cost Management Throughout the Entire Process of EPC Project Construction

Zhenwei Guo

Anhui Zhiyang Engineering Project Management Co., Ltd., Ma'anshan, Anhui, 243000, China

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Abstract: With the deepening of market-oriented reforms in China's engineering construction sector and the advancement of the "New Infrastructure" strategy, the EPC (Engineering, Procurement, and Construction) general contracting model has become a mainstream mode due to its ability to integrate resources and shorten construction periods. However, issues related to whole-process project cost management have become increasingly prominent. This paper takes the entire process of EPC project construction as its research object, aiming to analyze the key points of cost management at various stages, identify deficiencies in current management practices, and subsequently propose targeted implementation paths. Utilizing methods such as literature research and incorporating practical project experience, the study concludes that optimizing cost management requires efforts across multiple dimensions, including preliminary planning, process control, and technology integration. It provides references for enhancing the investment efficiency of EPC projects and promoting high-quality development within the industry.

1. Introduction

At present, China is in the key period of infrastructure construction transformation and upgrading. The "14th Five-Year Plan for New Infrastructure Construction" calls for "innovating engineering construction organization models, promoting EPC general contracting and other models, and improving project construction efficiency and quality." Increasing use of EPC model with its growing share for various projects covering a range of sectors like transportation, energy and municipal engineering. But EPC projects have links: design, procurement, and construction are various links of one thing: costs at each stage are intimately related to and affected by a simple complex of changes. Problems such as disjointed cost control and cost overruns of some projects not only affect the economic benefit of the project itself, but also seriously constrain the effective promotion of EPC mode. In this context, the research on project cost management in each stage of the EPC project construction process, combing through key management points, analyzing existing shortcomings and exploring scientific implementation paths is of great significance for regulating the order of engineering construction market, protecting the investment benefits of projects and promoting high-quality development of construction industry.

2. The Importance of Project Cost Management in the Entire Process of EPC Project Construction

The EPC model involves numerous project construction links with strong interconnections. Cost deviations in any single link can have a chain reaction on the overall project benefits. Therefore, whole-process project cost management plays an indispensable role throughout the project progression. Its importance can be analyzed from multiple dimensions.

2.1 Core Means of Guaranteeing Project Investment Benefits

However, due to investment scale of EPC projects themselves and long construction cycle, investment benefit is always the core concern for all project participants. The whole-process project cost management runs through the design, procurement and construction stages of the whole

process of projects. It uses professional approaches to accurately assess the cost of different stages, sets up dynamic monitoring systems based on these estimates, and appropriately identifies and regulates potential situations of excessive expenditure ^[1]. This thereby circumvents the investment overrun driven by price loss of control. This management model not only ensures that the project completion meets the originally set investment budget on time, but also ensures that the expected functions and benefits can be realized, greatly improving the return on investment of projects in this field and providing reliable economic returns to participants.

2.2 Key Pathway to Optimizing Project Resource Allocation

The EPC project construction process involves the consumption of human, material and financial resources. Resource allocation has a direct impact on the quality and progress of the project. The theory of whole-process project cost management can be tightly combined with the cost demand in each stage of a single cost center, which is conducive to scientific assessment and more rational allocation of various resources. The project requirements can be satisfied without wasting any good resources by allowing to do comparative cost analyses on multiple construction schemes and selecting the cheapest option. This cost management-targeted way of allocating resources directly impacts the efficient utilization of construction resources and can effectively realize that all construction resources can be used in their maximum capacity, thus improving the overall level of engineering construction.

2.3 Important Guarantee for Promoting Smooth Project Implementation

Due to long construction cycles and numerous parties involved in the execution of EPC projects, they are subject to different uncertainties. These elements can create price risks, which then affect how the project is carried out or not. Total Process Project Cost Management of whole-process project cost management have early warnings for risk. It is able to fully explore, model and anticipate potential cost risks at every stage (e.g. price fluctuations of materials or design changes) and generate actionable responses for such varied risk factors. In addition, during the construction process by dynamically tracking costs in real time to avoid engineering cost management problems. So it can solve various problems timely in project cost disputes avoiding project delays. This gives the project a strong assurance that things will go according to plan and on time. At the same time, it can also establish a stable communication bridge among all project participants and reduce disputes arising from cost issues, so as to further ensure the smooth implementation of the whole life cycle of projects.

3. Current Deficiencies in Project Cost Management

Although whole-process project cost management is crucial for EPC projects, its current practical application, influenced by various factors, still exhibits significant shortcomings. These problems, to some extent, restrict the full play of project cost management's role and require in-depth analysis.

3.1 Insufficient Accuracy of Cost Estimation in the Preliminary Decision-Making Stage

As the first stage of EPC project construction, Cost analysis for preliminary decision-making plays an important role in maintaining cost control for the following stages of work. However, for some EPC projects that are still in the early stage of evaluation, major content such as project scale and technical scheme selection have not been demonstrated on other means at this stage yet, resulting in cost estimation work having no reliable foundation ^[2]. Since estimates are regularly based on historical data from similar projects or employee experience, the nature of the local market environment (such as local material supply, price levels) is often not accounted for sufficiently and policies or regulations that apply to all areas involved are rarely analyzed systematically. Without these factors included discrepancies between estimated and actual costs incurred at the time of construction are their result. This non-accuracy feature makes these estimates impossible to provide scientific instruction for the following cost-control and even leaves hidden troubles for the

later-stage practical cost management, in that it might lead to risk of loss of control on costs.

3.2 Disconnections in Cost Management Linkages Between Stages

EPC projects cover the design, procurement and construction stages which are inherently related processes in total cost management activities. Nevertheless, there are still some major disconnection problems with a few of the recent projects. At the stage of design, more often, the completion of work on a certain part is carried out only taking into account the technical result or innovation and functionality of a certain scheme or model without any regard for those factors that will affect its costs (the cost of materials in the procurement stage, construction difficulty and its costs at the stage of construction). As a result, this necessitates numerous redesigns during the subsequent procurement and construction stages, with each modification adding to project costs. Likewise, no effective communication channels exist between the procurement and construction phases. The procurement department may prepare its purchasing plans without considering the construction schedule, which causes materials to be purchased too early and, thus, increase inventory and waste; on the other hand, material supplies are delayed and delay progress in construction activities both of which impact cost control negatively. Finally, cost information at different stages is not well communicated and consequently, there are relatively independent information silos at each stage. This brings many difficulties to the establishment of a project cost control system covering the whole process, which restricts the overall effect of project cost management.

3.3 Information Technology Level of Cost Management Needs Improvement

In recent years, with the rapid development of information technology, informatization has become one of the important measures to enhance management efficiency and quality in various industries. However, the level of informatization is relatively low in many existing EPC projects for cost management. Most projects continue with old manual Accounting and Management strategies where staff spent time sorting through records, calculating data and other such things which not only is very inefficient but also makes human error a common scenario [3]. While some projects have developed cost management software, the functionality of such software is relatively monolithic and only meets the basic needs of cost calculation. They are unable to realize the whole-process cost data in real time, depth analysis of collected data, and shared information across organizations or stages. This is a combination of low informatization process, which can hardly support the dynamic and fine-grained development of cost management activities; in fact, it makes the efficiency of cost management activity into an internal system very low and directly affects the accuracy and reliability of its results. It severely restricts its modernization.

4. Implementation Path for Whole-Process Project Cost Management in EPC Project Construction

To solve current shortcomings in EPC project cost management, a scientific and operable implementation approach must be developed that takes into account both the needs of specific projects as well as industry development trends. The weaves of these paths must cover the whole project construction process, focus on key links, and use innovative management methods and technical means to implement a good scientific level of project cost management and effectively guarantee the quality benefit of Project Construction.

4.1 Strengthen Cost Control in the Preliminary Decision-Making Stage to Improve Estimation Accuracy

Accuracy of cost estimation at the early decision-making stage is crucial factor determining the quality of the foundation for further cost management. You need to develop a full-blown control system that includes team formation, data collection and method selection. At the beginning of a project, the initiator should also hire professional institutions such as design firms and cost consulting companies to strengthen and establish a cost management team with cross-disciplinary knowledge reserve. Members of the team should understand the market rules and policy orientation

in a project location ^[4]. In the data collection stage, the team should conduct detailed investigation on the fluctuation rules of local market price, sort out and analyze the impact clauses of new local policies and regulations on project cost, investigate the possible influence of site geological conditions; gather all these research into a dynamic big data. With respect to estimation techniques, experiential estimation should not be followed alone instead a joint approach with the BOQ pricing method and costing technique should be utilized. The preparation of a detailed bill of quantities based on the design scheme for the project should be done as one. Next, cost analysis is performed to decompose the cost composition of various links, find out the space for cost optimization and eventually produce transparent and accurate estimated results of resources.

4.2 Establish a Collaborative Management Mechanism Across Stages to Achieve Seamless Cost Management Linkages

Collective management mechanism information sharing and clear responsibilities, breaking down the barriers between stages of cost management in EPC projects. The digital collaborative management platform should be established jointly by project participants. These platforms have specialized modules for design, procurement, construction etc. with data interfaces held aside in each module to enable cost information to flow almost instantaneously. Value Engineering Analysis Tool needs to be embedded in the design module. In fact, when designing development schemes Designers-level access procurement module material price data and construction module process cost data are required so that the designer simultaneously obtains accurate information to optimize operational details from a cost perspective and reduce later changes. Once the scheme is finished, a process to solicit opinions through the platform from procurement and construction departments should be initiated, and the scheme should be modified on the basis of feedback to enhance implementability ^[5]. This has led to batch material procurement plans being formulated in the platform by the procurement department based on the construction schedule. For example, during procurement, data including relevant market information (material prices and quality standards) needs to be uploaded in real time for verification by design and construction departments. Linkage meeting via the platform should be driven to jointly determine products with alternative materials or timing of purchase when abnormal movements on price are met. In the construction department, comparing actual cost data with budget data in the platform needs to happen in real-time during construction. When deviations are found, the traceability of the source should be completed on the platform, and adjustment plans should be jointly formulated with relevant departments to ensure that cost management is closed-looped between upstream supply and downstream sales links.

4.3 Advance the Informatization Construction of Cost Management to Improve Efficiency and Quality

In order to promote the cost management model upgrading based on the latest technology, we need to gradually advance informatization construction from three aspects: System development, Technology integration and Personnel training. For a cost management information system, the project entity should invest on creating it by itself This system should have multi functional components for information gathering, analysis, sharing and warning. The data collection module shall interact with the business systems used by all stakeholders in the project and allow automatic capturing of information such as design drawings, material procurement and construction progress. The analysis module should use big data algorithms to perform multi-dimensional analysis on the collected data, generate cost trend reports and cost composition analysis charts. The early warning module which will be used to define the level of cost deviations and automatically generate alerts if actual costs approach these thresholds ^[6]. Artificial intelligence (AI) technology is integrated into the system in the technology, and intelligent quantity takeoff functions matching with the manual tedious calculation can be developed to avoid human error. It should also add Building Information Modeling (BIM) technology to build a 3D model of the project with cost data associated with nearly every element of that projection, allowing for visual cost management and direct identification of abnormal cost areas. On the training of personnel, define systematic training plans. Personnel engaged in cost management should also regularly take part in the information technology training

of system operation, data analysis method and new technology application. It should be carried out through case-based teaching, where the excellent project cases with typical results achieved from framework of informatization management are selected as cases to illustrate important application points and lessons learned. Establish the assessment mechanism, incorporate the informatization tool into the employee performance assessment, so that employees take dynamic actions to improve their own IT literacy through the incentives of becoming better information leaders and promoting cost management comprehensive intelligence refinement.

5. Conclusion

In EPC project construction, project cost management is a systematic and complex task that runs through the entire process of a project. The quality of which directly relates to the investment benefit of the project and its smooth implementation. At present, the main progress paid in China's EPC project cost management is that some common problems such as preliminary estimation and inter-stage connectivity have been solved to a certain extent, but defects still exist and restricts its full benefits of the EPC model from being incorporated. Through the implementation of paths such as strengthening practical planning, collaborating entity construction mechanisms and promoting information construction, it will effectively improve the level of whole-process project cost management of EPC projects and protect project investment benefits to promote high-quality development in the construction industry. However, in the future, as the reform of engineering construction continues to deepen and technology innovation continues to improve, EPC project cost management also needs to be further optimized and improved based on the new development requirements of the industry.

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