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Analysis of Key Points in Engineering Project Management under the EPC Model

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Abstract: The construction process of engineering projects is complex, encompassing multiple critical stages such as engineering design, raw material procurement, and construction. Although the nature of work varies across these stages, they are highly interconnected. Any issues arising in one stage can impact the effectiveness of work in other stages. Under the EPC model, engineering project management can integrate the processes and resources of project construction, thereby enabling full-process control and thereby enhancing management efficiency while reducing risks. This article primarily analyzes the concept and characteristics of the EPC model and summarizes the key points of engineering project management under the EPC model at different stages, including decision-making, design, procurement, construction, and completion acceptance. Finally, it proposes optimization suggestions for engineering project management under the EPC model, providing a reference for the high-quality implementation of the EPC model in engineering management.

Keywords: EPC model; Key points of engineering project management; Cost control; Quality management; Safety management

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1. Introduction

In recent years, driven by urbanization, China's engineering construction industry has gained broader development space. The number and scale of construction projects have continuously expanded, while the requirements for construction quality have also increased. This has made it difficult for the traditional decentralized engineering management model to meet the current needs of construction project management. Traditional decentralized management divides engineering projects into different stages, with different contractors for each stage, leading to issues such as poor communication, inconsistent management objectives, and disjointed project management across stages, which severely impact the return on investment in engineering projects. The emergence of the EPC (Engineering, Procurement, and Construction) general contracting model has transformed decentralized engineering project construction management into an integrated management model, achieving the integration of project resources and tasks, which is of great

significance for improving construction efficiency and controlling construction costs.

2. Concept and characteristics of the EPC model

The EPC model is primarily applied in the field of construction engineering, emphasizing the integration of design, procurement, and construction into a unified general contracting model. The general contractor is required to strictly adhere to contractual provisions to ensure quality control across the design, procurement, and construction phases, and to assume risks related to quality, safety, cost, environmental protection, and other aspects that may arise during construction [1]. Compared to traditional decentralized engineering contracting methods, EPC general contracting model offers more significant advantages, which can be manifested in the following aspects:

2.1. Integrated engineering management and control

Under the EPC model, project management and control can coordinate the entire process of the project, effectively addressing issues such as poor communication and information barriers across different stages of traditional construction projects. The general contractor can start with an overall grasp of the construction process, effectively connecting various engineering stages, which facilitates the preparation of a unified overall project management and control plan.

2.2. Strong controllability over engineering management risks

In EPC contracting, the owner only needs to sign a contract with the general contractor, with subsequent quality control, progress control, and cost management being undertaken by the general contractor, thereby centralizing construction risks. This not only facilitates comprehensive risk management but also avoids issues of unclear division of responsibilities and rights in the later stages [2].

2.3. Demonstrates high efficiency in engineering cost control

In EPC project management, the general contractor is responsible for cost control at all stages of the project, aligning the contractor's cost control with its interests, thereby enhancing the effectiveness of cost control.

2.4. Achieves high construction efficiency

Under the EPC model, project management and control can integrate engineering design, procurement, and construction, making the connection between construction stages more convenient, reducing technical handover and communication time, thereby significantly shortening the construction period and improving project efficiency. To ensure a clearer comparison between the advantages of the EPC general contracting model and the traditional decentralized contracting model, their operational models are summarized in **Table** 1.

Table 1. Comparison between EPC general contracting model and traditional decentralized contracting model

Dimension	Traditional decentralized contracting mode	EPC general contracting mode
Management Entity	The owner needs to coordinate with contractors of each link separately	The owner interfaces with the EPC general contractor
Responsibility Allocation	Overlapping responsibilities, unclear division	EPC general contractor assumes full responsibility; no ambiguity in division of rights and responsibilities

Communication Efficiency	High communication difficulty, information barriers	Integrated control, collaborative communication
Change Management	High probability of changes, high risk	Enables coordinated management of design and construction, low probability of changes
Schedule Control	High difficulty in linking each phase, affecting project efficiency	Seamless connection between phases, shortening construction period
Risk Bearing	High risk for the owner	General contractor bears the risks

3. Key points of project management under the EPC model

3.1. Key management points in the project decision-making phase

In project management under the EPC model, the decision-making phase is a critical stage for studying decision-making content such as project feasibility demonstration, calculation of construction benefits, and preparation of project implementation plans. Decisions made during this phase are crucial for subsequent project control and corporate profitability. Therefore, it is essential to clarify the construction requirements of the project and select partners based on project objectives [3].

3.1.1. Comprehensive feasibility demonstration

Comprehensive feasibility demonstration of the project should be conducted. Before initiating the project, the owner should collaborate with a professional team specializing in construction project development to evaluate the project's comprehensive conditions, including investment, technology, and environment, thereby defining the overall project objectives [4].

3.1.2. Functional positioning of the project

The project's functional positioning should be determined, and the rights and responsibilities of all parties involved should be clarified to avoid issues such as passing the buck in case of project problems.

3.1.3. General contraction selection

The EPC general contractor should be selected reasonably. During the bidding process for the general contractor, comprehensive indicators such as the contractor's business capabilities, construction experience, industry reputation, and corporate financial status should be considered. Priority should be given to cooperating with enterprises that have a high reputation and strong risk resistance capabilities [5].

3.2. Key management points in the project design phase

The design phase of an EPC project involves overall planning for project construction, and the construction plan developed during this phase is crucial for subsequent project control quality. In EPC projects, the design is the responsibility of the general contractor, but the owner needs to review the design content to ensure it meets the owner's requirements.

3.2.1. Identification of the owner's requirements

Project design should be based on the owner's requirements for construction, clarifying technical and functional standards. The general contractor should further survey the construction site based on geological survey data provided by the owner and design the project plan based on the survey results. Moreover, BIM

technology should be used to create a three-dimensional digital model of the design plan, which should be shared via an online platform with participants such as the construction party, supervision party, and owner. Each party should provide feedback on the design plan from their respective professional perspectives to ensure its rationality and reduce the likelihood of subsequent design changes [6].

3.2.2. Through review of the design plan

The design plan should be thoroughly reviewed. The review of the engineering design plan should also primarily take place on an online platform, where all parties involved use the BIM model to conduct a joint review of the final design plan, focusing on comprehensive considerations such as the completeness of the design drawings, the feasibility of the engineering design, and the controllability of costs.

3.2.3. Procurement lead and construction development

Design should lead procurement and construction to develop synergistically. Under the EPC model, the general contractor is responsible for design, procurement, and construction. Therefore, designers should not only fully consider the ease of procurement of design materials and cost control but also consider construction site conditions and the difficulty of implementing processes to ensure that the design meets the owner's requirements and facilitates subsequent procurement and construction [7].

3.2.4. Strengthening control of design changes

Control over design changes should be strengthened. Design changes during construction pose severe challenges to project cost control and schedule management. Therefore, it is essential to combine the review of two-dimensional drawings with BIM three-dimensional models during design to predict potential risks and minimize subsequent changes. If changes are unavoidable due to unforeseen circumstances or special reasons, a thorough change assessment should be conducted to minimize change risks and costs.

3.3. Key management points in the project procurement phase

The primary tasks in the project procurement phase involve the procurement of project materials and equipment. The formulation of procurement plans and control over material quality can significantly impact construction progress, quality, and safety management. Therefore, procurement planning should be conducted before procurement.

3.3.1. Formulation of procurement plan

A reasonable procurement plan should be formulated [8]. Given the long construction period of engineering projects, to avoid excessive accumulation of materials at the construction site and reasonably control procurement costs, the general contractor should develop a batch procurement plan. The plan should specify material names, specifications, quantities, and transportation times to provide a sufficient basis for procurement work.

3.3.2. Establishment of supplier selection system

A supplier selection system should be established. The current construction materials market is mixed, and to ensure the quality of raw materials, the procurement department should conduct a meticulous screening of suppliers. During the supplier screening process, the procurement department can establish a supplier

cooperation resource library, input supplier names into the library, and the system can comprehensively rank suppliers based on their reputation, quotations, and corporate operational status. Procurement personnel should include the top-ranked suppliers in the cooperation resource library and select the most suitable partners from them. This screening method facilitates establishing long-term cooperative relationships with suppliers and quickly finding alternative partners after terminating cooperation with one company, avoiding passivity in procurement work. Additionally, after determining cooperation intentions, procurement personnel should visit the supplier's factory to inspect their supply capabilities and avoid subsequent supply disruptions that could affect construction progress.

3.3.3. Strengthening of the procurement process

Control over the procurement process should be strengthened. After procurement and before materials enter the site, they should be monitored throughout to ensure their quality meets industry standards and construction requirements. Materials can only enter the site after passing the "three inspections" [9]. If materials do not comply with contract specifications, they are not allowed to enter the site under any circumstances.

3.3.4. Attention to cost risk management in procurement

Attention should be paid to cost risk management in procurement. The prices in the construction materials market fluctuate significantly, and batch procurement can easily lead to increased procurement costs due to subsequent material price increases. Therefore, price fluctuation agreements can be used to control prices within a reasonable range and reduce procurement risks.

3.4. Key management points in the project construction phase

The construction phase is a critical stage for the physical realization of the project, involving comprehensive and detailed management tasks that require simultaneous attention to quality, safety, progress, and cost control. Therefore, fine management is essential.

3.4.1. Optimization of construction organization design

The construction organization design should be optimized. Before construction begins, the general contractor should optimize the construction organization design based on engineering design, site survey results, and construction standards to provide an effective basis for subsequent construction management. Special management plans should be designed for special construction processes (such as deep excavations and high-formwork) to improve construction quality and ensure project safety.

3.4.2. Strengthening of construction quality management

Construction quality management should be strengthened. Before construction, the project manager should organize construction teams for construction training and technical disclosures to ensure that construction personnel are familiar with construction processes and procedures, thereby effectively reducing quality and safety accidents caused by human errors. For critical processes, a "sample" approach should be adopted to test construction processes and ensure their feasibility before full implementation.

3.4.3. Attention to construction safety management

Attention should be paid to construction safety management. Safety management has always been the core

of project control. In safety management, AI image recognition technology can be used to identify on-site violations and help avoid safety issues caused by inadequate safety control [10]. Construction personnel safety training should be strengthened, and AI-immersive safety accident scenarios can be used to enhance safety awareness. Additionally, a construction safety management ledger should be established to provide a reference for improving subsequent safety management standards.

3.4.4. Strengthening of construction progress control

Construction progress control should be strengthened. To ensure the efficiency of progress control, BIM technology can be used to construct a construction progress control model and compare the designed progress model with the actual project progress model to understand progress control situations. This facilitates managers in promptly identifying progress deviations and adjusting progress plans.

3.4.5. Strict control of construction costs

Construction costs should be strictly controlled. A dynamic engineering cost control model should be constructed to more accurately track the application of engineering materials and equipment, facilitating the regulation of construction materials, equipment, and personnel and avoiding resource waste, thereby improving construction cost control effectiveness.

3.5. Key management points in the project completion acceptance and operation and maintenance phase

Project completion acceptance and operation and maintenance represent the continuous service phase after project construction and serve as the final checkpoint for project quality control.

3.5.1. Project completion preparation

Project completion preparations should be made. After construction is completed, the general contractor should organize all parties involved in construction to conduct a self-inspection of the project's main body to ensure compliance with contract specifications.

3.5.2. Initiation of completion acceptance process

The completion acceptance process should be initiated. The primary party responsible for completion acceptance is the owner, who needs to conduct a comprehensive inspection of the project's quality, duration, and functionality according to contract specifications and handle acceptance procedures after confirmation of compliance. Subsequently, specialized acceptance should be conducted by departments such as fire protection and environmental protection to ensure compliance with regulations.

3.5.3. Implementation of operation and maintenance phase control

Operation and maintenance phase control should be implemented. The operation and maintenance control period is relatively long, and during the warranty period for various services of the building, the general contractor should dispatch professionals to regularly inspect the project's operational status and explain building maintenance methods to the property management company or owner to improve building maintenance efficiency. After the building operation and maintenance period expires, operation and maintenance authority transfer procedures should be handled in writing.

4. Optimization suggestions for project management under the EPC model

The application of EPC project management effectively eliminates the drawbacks of traditional decentralized construction contracting models, forming a collaborative and unified management model that significantly improves management efficiency. However, current EPC project management is not yet perfect and requires further optimization based on existing issues.

4.1. Leveraging of collaborative role of EPC projects

The collaborative role of EPC projects should be fully leveraged by establishing a collaborative control mechanism in project management to provide a more favorable platform for communication among departments. Data standardization among departments should be promoted to improve data sharing efficiency.

4.2. Strengthening of risk control in EPC project management

Risk control in EPC project management should be strengthened. Artificial intelligence and big data technologies should be used to enhance risk identification capabilities and construct a full-process risk control mechanism to achieve precise control over various stages of project implementation.

4.3. Introduction of modern technological means

Modern technological means should be actively introduced to transform traditional manual control models into digital control models, ensuring the fine development of management work.

4.4. Strengthening of industry supervision

Industry supervision should be strengthened. The EPC model differs significantly from traditional decentralized contracting methods, and traditional industry standards and regulations are not applicable to EPC projects. Therefore, the improvement of the industry supervision system is necessary to lay the foundation for the long-term development of the EPC model.

5. Conclusion

In summary, the EPC model can integrate the various management stages of construction engineering projects into a unified management mechanism, facilitating control over project quality, safety, progress, and costs, thereby improving project economic benefits and reducing risks. However, the EPC model is not yet fully mature and still has certain deficiencies. Future research should expand in areas such as the characteristics of modern construction and the application of digital technologies to promote continuous innovation in the EPC model, thereby laying the foundation for the high-quality development of the construction industry.

Disclosure statement

The authors declare no conflict of interest.

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