

# Selection and Practice of Engineering Management Mode for Large-scale Construction and Development Projects

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**Abstract:** Construction projects generally have the characteristics of large development scale, large investment, long development cycle and complex business structure. In order to reduce project investment risk and expand investment income, advanced and appropriate project management mode must be selected. However, there are still many problems in this aspect at present, mainly due to the difficulty in mode selection. This paper discusses three management modes suitable for engineering projects—DBB mode, EPC mode and PPP mode through multiple channels. The three modes are compared, analyzed and screened, and the most reliable project management mode is selected.

**Keywords:** project development and construction; management mode; contrast; practice

In the process of pursuing efficient implementation of engineering projects, an optimized management framework is very important to achieve the scheduled construction goals. With the scale of the project climbing, especially in the face of huge investment, complex structure and intensified technical challenges, the investor's credit guarantee ability often weakens the flexibility of this choice. Therefore, the management mode selection strategy for high-input projects is particularly critical. First of all, the following three main project management modes are analyzed.

## 1 Introduction of Three Management Modes of Large-scale Construction and Development Projects

### 1.1 DBB Mode

In the construction project management, a strategy adopted is the parallel contracting mode, that is, the owner decomposes the complex task of the project into three key links: design, construction and material supply, and entrusts them to independent design institutions,

construction contractors and suppliers respectively, and ensures the professional implementation of each link by signing separate contracts. Design teams maintain a parallel cooperation framework, construction teams also follow the principle of parallel work, while material suppliers maintain their own independent links, which promotes the efficient implementation of the project and the effective use of resources<sup>[1]</sup>. In the parallel contracting mode, the following factors need to be considered.

First, in the initial stage of project planning, the generation of contract is closely related to the engineering characteristics, including its specific type, scale definition and complexity of structural design. The duration of the project and its detailed schedule management strategy also play a key role in shaping the quantity and detailed content of the contract.

Second, considering the diversified characteristics of construction enterprises and the distribution characteristics of scale differences in local markets, the subcontracting

strategy of construction projects should be consistent with the diversity of market structure; Secondly, contract design needs to be attractive in the market. For example, the contract tasks and contents set for small and medium-sized enterprises can not only stimulate the enthusiasm of small and medium-sized contractors, but also not exclude the possibility of competition from large enterprises. In addition, the setting of contract terms should also follow the market's normal operating norms, geographical restrictions and relevant laws and regulations.

Third, when constructing the contract framework, for projects involving multiple loan participants, the key lies in taking into account the unique provisions that may be put forward by each lender. This includes, but is not limited to, the specific limitation of loan purposes and the differentiated standards of contractor qualification examination, which should be fully identified and integrated when designing the contract<sup>[2]</sup>.

## 1.2 EPC Mode

The general contracting mode refers to the overall control of the whole project life cycle by the general contractor, including design, material procurement, construction implementation, and even the integration of some design and construction tasks. In this mode, the general contractor not only takes full responsibility for the final quality, safety standards, schedule and cost-effectiveness of the project, but also aims to realize the smooth delivery of the project and optimize the benefits through efficient collaboration<sup>[3]</sup>.

### 1.2.1 EPC Integration Mode

It is composed of seamless connection of engineering design, material procurement and construction. As the core responsibility of the general contractor, EPC covers the whole process

management from conceptual design to completion acceptance, including ensuring project quality control, safety supervision, schedule arrangement and cost-effectiveness. Especially in the form of turnkey general contracting, this model further expands the service scope, with the goal of delivering a complete project with perfect functions and conditions for use, so as to meet the owner's expectation of meeting the use demand at one time.

### 1.2.2 EPCL Mode

As a form of general contracting, EPCM contract is usually based on the entrustment of the owner or public bidding. The contractor directly signs an agreement with the owner and is fully responsible for the whole project management, including design strategy, selection of materials and equipment and construction supervision. According to the owner's initial investment ideas and specific needs, EPCM contractors help to select and recommend the most suitable subcontractors to be responsible for the design, procurement and construction tasks respectively through the bidding mechanism<sup>[4]</sup>.

It is worth noting that subcontractors in the field of design and procurement report directly to EPCM contractors, while construction subcontractors are not directly contracted by EPCM, but they are managed by EPCM and maintain contractual relations with the owners. In this way, EPCM contractors can avoid directly bearing the construction contract and economic risks, especially when the payment method of one-time total quotation is adopted, this risk is effectively controlled, making the contractor's economic benefits more stable. Through this model, the economic burden of EPCM contractors is reasonably distributed, ensuring the stable income of the project.

### 1.2.3 D+B Mode

In D+B mode, as the core subject of the

contract, the general contractor is not only responsible for the whole design of the project, including conceptual design, detailed design and construction drawing design, but also covers the overall management of the construction stage. They are fully responsible for the quality, safety, progress and cost control of the project, aiming at improving the overall benefit of the project through integrated solutions.

### 1.3 PPP Mode

PPP mode refers to the cooperation between the government and private organizations or enterprises based on franchise agreements, and their joint participation in urban infrastructure projects or provision of public services. In this model, both government and enterprises perform their rights and obligations under the constraints of contracts<sup>[5]</sup>.

## 2 Mode Selection Index System Establishment and Mode Comparison

### 2.1 Construction of Index System

The evaluation indexes of three kinds of project management modes include: project attribute characteristics, project implementation characteristics, project target requirements, contractor's technology and ability, owner's ability and preference, external policies and environment.

In order to ensure the comprehensiveness and effectiveness of the research, we first set up a diversified consulting team, including senior experts from government departments, owners, contractors, operating institutions and academia, all of whom have profound professional knowledge and focus on the research of construction investment and development projects. Guided by the principles of systematicness, operability, practical application, foresight and comprehensiveness, we customized a targeted questionnaire based on detailed literature

research, field investigation reports and successful case analysis, aiming at collecting experts' comments and opinions.

The questionnaire data were imported into the statistical software of Excel 2019 and SPSS 22.0 for in-depth analysis. The consensus index Cr of experts all exceeded 0.7, which indicated that experts' opinions were highly consistent, while the average coefficient of variation jV remained below 0.25, further confirming the stability and reliability of the results. The combination of these quantitative and qualitative feedbacks provides a solid foundation for our research conclusions.

Table 1 Comparison Table of Delphi's Expert Opinions

	first inning	Second round
Total number of indicators	35	25
Average degree of authority	0.7771	0.7931
Average coefficient of variation	0.2263	0.1349
kendall's coefficient of concordance	0.6589	0.6119

### 2.2 Mode Comparison

In DB mode, the contractor's division of responsibilities is clear, and the contractor undertakes the design and construction of the construction project. Therefore, compared with the traditional construction mode, it has strong continuity of design and construction. In this mode, the contractor must bear the design risk and construction risk in an all-round way.

CM mode means that the owner and the contractor sign a contract, define the rights and obligations of both parties in the terms of the contract, and clearly divide their respective risks. If some special problems occur in design and construction, they will be dealt with according to the terms of the contract.

Under the PMC mode, the PMC agent undertakes

the management and coordination of the project, and its role is similar to that of the general construction unit, and it must form a relationship of responsibility and rights with the designer, the contractor and even the material and equipment suppliers. When a risk event occurs in the process of engineering construction, PMC should not only respond in time, but also report to the owner in time. In this mode, the management level and ability of PMC agent is the key factor to determine whether the project can be implemented smoothly. Only through contract and system management, PMC agent can make the project management process clear and divide the responsibilities of all participants clearly, so that the project can be carried out smoothly.

DBB model is suitable for construction projects with clear responsibilities and repeatability, and can make good use of existing engineering practice to achieve the established project objectives. However, under special circumstances such as large-scale energy construction, the disadvantages of the traditional DBB model are increasingly prominent, and it is urgent to find other more suitable project transaction models and strengthen collaborative management among projects.

EPC mode has many advantages and is more favored by owners. In this mode, the project investors outsource all the work such as design, procurement and construction to the contractor, and limit their investment at the contract price. However, in EPC mode, large-scale engineering contractors can make full use of their own construction and management advantages, undertake greater risks, and thus obtain higher benefits<sup>[6]</sup>.

### 3 Innovative Practice of EPC Management Mode for Large-scale Construction and Development Projects

#### 3.1 EPC+ Smart Management Mode Construction

On the basis of the previous EPC model, EPC+ intelligent management mode is built by using technology empowerment, and advanced technologies such as 5G, BIM and blockchain are adopted to build an intelligent management platform, and social public participation mechanism, third-party service organizations and reputation management mechanism are organically combined, so that construction projects are subject to comprehensive and standardized supervision and management, and problems such as progress, cost and quality during construction of construction projects are solved to create greater benefits for construction projects<sup>[7]</sup>.

#### 3.2 Concrete Implementation of EPC+Smart Management Mode

##### (1) Pre-project Management

The pre-management of the project is led by the owner, who needs to invest more manpower and time to track and record the progress of the internal preparation of the project and the government's approval in real time, mainly including: investment plan management, project feasibility study and audit, land acquisition in the pre-project, environmental impact assessment and other transactional management, setting up the project team, completing the project outline and pre-cost management.

##### (2) Project Design Management

The owner chooses a professional design institute to complete the engineering design, or adopts the general contracting method, and the general contracting party completes the engineering design, so as to strengthen the whole process control of the design documents, improve the design quality and work efficiency of the engineering project, and ensure the smooth construction. It mainly includes: reviewing design progress plan, monitoring and tracking

design progress plan, reviewing design changes and related impacts, receiving design results, and reviewing design results.

### (3)HSE Management

EPC+ intelligent management mode provides a standardized system for safety construction and employee health, and adopts PDCA cycle management mode to continuously improve management level; Constantly enrich the safety knowledge base, build the safety cornerstone, improve the safety awareness of all employees, and promote the construction of enterprise safety culture; Establish a preventive safety management mode in line with the direction of modern safety scientific management, adopt forecasting and early warning technologies and methods, form an early warning and prediction system for enterprise safety construction, and build an "active early warning" modern safety management mode.

### (4) Risk/Problem Management

With the help of EPC+ intelligent management mode, all kinds of risks and problems in the process of project implementation are managed in a unified way, which mainly includes: risk registration, risk assessment and response plan formulation, risk tracking, problem recording, problem coordination and solution formulation, and problem tracking.

### (5) Investment Control and Management

1) Establish the examination and approval system of the project cost control committee, which shall be the responsibility of the person in charge of all functions of the company (including finance, business, projects, etc.). Contract changes involve the investment and planning of the project, and can only be implemented after POG approval, so as to reduce unnecessary changes and ensure the investment control of the project.

2) Adopt the interim payment mode, which can be used for even a few projects and is divided into three stages, namely, prophase, production and commissioning. This method not only improves the working procedure, but also makes the payment more specific and clear, and reduces some financial expenses, thus realizing effective control of investment.

3) Use the milestone payment model linked to the main time target, which lists the materials that the contractor must provide to the owner to support his request for exemption from work.

4) Formulating relevant financing plans and signing long-term loan agreements with relevant banking institutions to ensure the smooth implementation of the project; In the process of construction, the timing of capital investment is determined through the expectation of exchange rate changes, thus effectively avoiding the exchange rate risk of investors; Broaden low-interest and low-interest financing channels and implement entrusted loans; Implement central quota settlement to save capital occupation expenses.

5) Enterprises can know the dynamic expenditure of the project through the intelligent management system, calculate the project cost on a weekly and monthly basis, compare the actual cost expenditure with the project budget, find out the risk of cost exceeding the budget in time, improve and optimize the cost scheme, and obtain the best economic benefits. The intelligent management system can be used to guide the owners to establish the target cost scheme, and then the project cost data can be dynamically updated in the system, and the monthly cash report and annual report of the project can be automatically generated by the system, so as to dynamically grasp the fund status

of the project and cooperate with corresponding adjustment and control measures to minimize the project over-budget risk<sup>[8]</sup>.

#### (6) Quality Control

In the construction contract, the investors make detailed stipulations on the responsibilities and obligations to guarantee the quality of project construction, procurement and bidding, so as to ensure that the construction management company will fulfill its duties and fulfill its obligations under the constraints of the contract, and supervise and inspect the construction quality of the project, so as to ensure the construction quality of the project.

In the design stage, the investment enterprise introduced the most advanced quality control system in the world and put its specific requirements into the construction contract. In the stage of bidding and procurement, we should communicate closely with the government and construction management units, formulate procurement strategies flexibly and adopt reasonable bidding methods.

#### (7) Schedule Management

Through the intelligent management system, the progress of the project can be viewed and tracked in real time, and at the same time, according to the data in the system, the risk of project delay can be analyzed, and the analysis results or suggestions for schedule adjustment can be transmitted to the owner in time to save the risk of project delay.

During the project construction, Navisworks manage software can be used to standardize the drawing of the project construction progress and list the project plan in detail. Then, the building model is built in the system based on BIM technology, and the simulated construction is

completed in advance. According to the simulated construction stage, it can be judged whether the project progress plan is reasonable and what needs to be improved, so that specific suggestions can be transmitted to the owner. In the construction stage, the project construction progress information will be entered into the system in real time, and the system will automatically generate a progress report, compare the progress report with the progress plan, fully understand the project construction progress, find out the problems such as delay in progress in time, and use the historical data tracing function of the system to deeply find out the reasons for the progress deviation, put forward specific adjustment strategies, and strengthen communication and cooperation with the project owner to jointly solve the progress deviation problem.

## 4 Conclusion

The fitness between the project management mode and the project affects the economic benefits of the project, so it is very important to choose and apply the management mode well. At present, three common engineering management modes are DBB mode, EPC mode and PPP mode. This paper makes a comparative analysis of these three modes, and points out that EPC management mode has higher applicability and is more favored by owners. On this basis, this paper innovatively puts forward the organic combination of EPC mode and intelligent management technology, which can better carry out design management, investment control, quality management and schedule management of engineering projects, reduce project investment risks and improve project economic benefits.

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