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Original Empirical Research

Research on Budget Control Issues and Strategies in EPC Projects Implemented in People's Republic of China

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Abstract

Introduction. The global practice of implementing investment projects distinguishes EPC and EPCM contracts as the most promising strategies for implementing complex infrastructure and industrial projects. In Russia, the EPC contracting scheme is the most common one in the oil and gas industry, largely in implementing foreign projects in the Russian Federation. In other industries, the development of the EPC market in the Russian Federation is in its infancy.

The article looks into the problems during implementing investment and construction projects in People's Republic of China and which should be considered in the Russian Federation. The aim of the study is to identify the existing problems of the EPC contract and set forth some ways of addressing them.

Materials and Methods. A comparative analysis of the construction project management methodology based on signing an EPC contract has been performed.

Research Results. Based on the analysis of the problems of controlling the budget of the EPC contract in China, a methodological guide for working with the budget of the EPC contract has been developed.

Discussion and Conclusion. Enterprises that have signed an EPC contract need, most importantly, to standardize the project's budgeting management system, to improve project change management, to optimize supply chain management of material resources, to develop an algorithm of addressing the problem of exceeding the budget limit and to improve the budget assessment mechanism accounting for the current actual situation. It is assumed that owing to the above measures, the effectiveness of budget control of general contracting enterprises of EPC contracts will be enhanced.

Keywords: EPC contract, investment and construction project management, budget control, design errors, construction cost, construction deadlines

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Оригинальное эмпирическое исследование

Исследование проблем бюджетного контроля и стратегий в проектах EPC, реализуемых в Китайской народной республике

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Аннотация

Введение. Мировая практика реализации инвестиционных проектов выделяет EPC- и EPCM-контракты как наиболее перспективные стратегии реализации сложных инфраструктурных и промышленных проектов. В Рос-

сии в настоящее время схема EPC-контрактования наиболее распространена в сфере нефтегазовой промышленности, в основном при реализации зарубежных проектов на территории РФ. В остальных отраслях развитие рынка по схемам EPC в РФ находится в зачаточном состоянии.

В статье рассматриваются проблемы, которые возникают при реализации инвестиционно-строительных проектов в КНР и которые следует учитывать в РФ.

Цель исследования — выявить существующие проблемы EPC-контракта и предложить пути их решения.

Материалы и методы. Проведен сравнительный анализ методологии управления строительным проектом на основе заключения EPC-контракта.

***Результаты исследования*.** По итогам анализа проблем контроля бюджета EPC-контракта в КНР разработано методическое руководство по работе с бюджетом EPC-контракта.

Обсуждение и заключение. Предприятиям, заключившим EPC-контракт, необходимо прежде всего осуществить стандартизацию системы управления бюджетированием проекта, улучшить управление изменениями в проекте, оптимизировать управление цепями поставок материальных ресурсов, разработать алгоритм решения проблемы превышения лимита бюджета и улучшения механизма оценки бюджета с учетом сложившейся фактической ситуации. Предполагается, что благодаря этим мерам эффективность бюджетного контроля генподрядных предприятий EPC-контрактов будет повышена.

Ключевые слова: EPC-контракт, управление инвестиционно-строительным проектом, бюджетный контроль, ошибки проектирования, стоимость строительства, сроки строительства

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Introduction. Since the 1980s, the State Council of the People's Republic of China, various ministries and commissions in the field of construction have prepared and issued documents pertaining to the general contract, and a new trend has emerged in the engineering contracting market, i.e., customers have increasingly been making use of the general contract construction regime in investment projects.

Back then, the government issued regulatory documents regulating the implementation of the EPC methodology. The implementation of the methodology and the implementation of pilot EPC projects in China started in 1984. In September 1984, testing of a general contracting regime got underway at chemical industry facilities. In November 1997, the "Construction Law" came into effect in China showing direct support of the introduction of a general contracting regime, and in August 1999, the Ministry of Construction issued a document "On Guiding Decisions on Promoting Large Design Units for Creating International Engineering Companies." In this document, it was assumed that integrating a number of survey and design departments into international engineering companies with possible signing of a general contract for design, procurement and construction would take about five years. In early 2014, the relevant ministries and commissions of China issued a general directive for further expansion of the application of the EPC contract concept. The directive was aimed at correcting and improving the existing investment and construction project management system, increasing responsibilities of an EPC contractor and management personnel, training a talent pool of the youth, etc. As a result of the activities, an EPC contractor regime started developing rapidly in China.

Design, Procurement and Construction include a general contract, according to which a general contractor takes on full responsibility for implementing a general contract model: design, procurement, construction and commissioning of a premises at a specified time with a fixed cost and ensuring the required work quality and safety. The most critical feature of the EPC regime is to make the most of the role of market mechanisms. The project owner will not firstly only consider it as an investment project, but it is also necessary to account for all the project participants' interests prioritizing designers and contractors.

The aim of the study is to identify and investigate the problems associated of controlling EPC contract budgets.

Materials and Methods. The study made use of the methods of comparative analysis of a traditional general contractor agreement with an EPC contract. Given that a fixed contractual price is used while signing an EPC contract, an EPC

contractor has hardly any possibility of changing the price, except for emergencies. This compels an EPC contractor at the tender selection stage to perform a detailed calculation of its price, accounting for a meticulous analysis of prices for building materials and technological equipment, and launch preliminary negotiations with potential subcontractors on pricing policies for certain construction and installation works.

Problems of EPC contract budget control are as follows:

1. Insufficiently justified development of a construction project budget based on the existing methodology of managing it.

First of all, the internal control mechanism of EPC-contract enterprises is flawed. Some EPC contractors choose to ignore the significance of internal control management, and their management system has serious flaws making the company not able to manage budgeting effectively, which ultimately impacts the financial stability and efficiency of a project [1]. In some cases, a project budgeting method is not always scientifically viable. While preparing a project budget, employees of some EPC contractors rely only on historical data, i.e., they budget based on cost data for the previously completed projects neglecting the influence of external factors such as changes in market conditions and introduction of new technologies, which results in budget deviation from the actual costs. Finally, budgeting information is not transparent, and data is not updated in a timely manner leading to incomplete and accurate budgeting information, which increases risks of a project failure.

2. Flawed change management in a project.

EPC contracts involve lots of participants influenced by adjustments to technical parameters, changes in a customer's needs and a market environment, etc. In order to ensure unconditional completion of a project, an EPC contractor might make changes to the scope of work in the course of construction if necessary and on a customer's consent.

Changes in a project will inadvertently impact an EPC contract's budget control system, and there are budget control risk points in each aspect of change management in an EPC contract. Some changes in a project might not be detected in a timely manner resulting in uncontrolled change management; even if changes were identified, due to insufficiently effective assessment methods and the management personnel's professional level, the assessment of changes in a project was insufficiently accurate, which might have a negative impact on management decision-making. On the other hand, communication channels and negotiations between an EPC contractor and interested parties do not always run smoothly, and project changes are not always responded to well, which has further impact on the accuracy and reliability of project budget control [2].

3. Disruptions in the management of supply chains of material resources.

Some EPC contractors do not manage the supply chain of material resources in a proper way frequently causing the following situations to occur. Firstly, delays in the supply chain might result in the equipment and materials needed for the construction of the facility not being delivered to the construction site on time having a serious effect on the progress of a project. Secondly, the quality of the materials or equipment supplied might not comply with regulatory requirements and design solutions so that an EPC contractor has to spend time and/or financial resources on repairing and replacing the equipment at hand increasing the actual cost of a project. Thirdly, a supplier itself might have financial difficulties causing a violation of contractual obligations. On top of that, other unforeseen circumstances might occur during the implementation of the ICP, and an EPC contractor's contingency plan might be flawed, which increases the uncertainty around implementing an EPC contract.

4. An unconventional approach to managing budget overspending.

In the course of project management, it is necessary to constantly keep track of the budget of an EPC contract. A project budget might be seriously affected by changes in market prices for equipment being used that can have a fairly large range of fluctuations compelling an EPC contractor to constantly keep track of the prices and make timely changes to a project implementation strategy [3]. Secondly, some insufficiently substantiated provisions in the tender documentation might also lead to budget overspending, e.g., the subject of a contract is not clear and a contractor will have to take unwise decisions on additional responsibility, etc.

Research Results. A strategy for responding to EPC contract budget control issues is as follows.

1. Standardization of project budgeting management procedures.

First of all, while signing an EPC contract, an enterprise should pay attention to an internal control mechanism, specify the responsibilities and powers of each individual department and employee, and comprehensively strengthen control and

management of all the budgeting aspects [4]. Relying only on data from previously implemented similar projects in budgeting might easily lead to bias, so an EPC contractor's management staff should employ a range of budgeting methods. In addition to data on similar projects, the impact of changes in current market conditions, introduction of new technologies and other factors should be considered, data search and analysis methods applied, project characteristics combined with a trend analysis and risk assessment in order for a scientific assement of the cost structure of the budget. Finally, while implementing EPC contracts, an EPC contractor is to identify the channels for collecting and transmitting information so that relevant information can be transmitted to the employees in a timely and accurate manner for decision-making to take place.

2. Improvement of change management in a project.

In order to enhance the quality and effectiveness of project budget control, an EPC contractor is to improve the following aspects of its work. First, an EPC contractor is to come up with comprehensive change management policies and procedures, specify the process of identifying, registering, evaluating, approving, and introducing changes, to ensure consistency and transparency in change management, and reduce the number of unauthorized changes. Secondly, an EPC contractor is to create a project office, i.e., an interdepartmental group for assessing changes that emerge during project implementation including the finance director, the project manager, the heads of the estimated contractual and production departments, the head of construction and other experts.

The Project Office has a special responsibility for assessing the validity, necessity and impact of changes and decides on the approval of certain directives to ensure that the changes are in line with the overall interests of the project. In addition, EPC contractors need to make use of modern information technologies in order to design an intelligent change management system and a system for predicting their impact on a project budget based on accumulated data [5].

3. Optimization of supply chain management of material resources.

While managing logistics, i.e., supply chains of material resources, EPC contractors are to comprehensively assess potential suppliers, i.e., their technical capabilities, reliability, experience, quality management system, etc. Use big data analysis technology in order to improve the efficiency and accuracy of supplier assessment and ultimately design a supplier assessment database. Such a database could be employed in order to select cooperation partners. Partners with a good reputation and reliability should be chosen to ensure the stability of material supply chains. At the same time, EPC contractors are to develop and submit requests for suppling material resources to supplier databases in a timely manner in order to design a long-term supply management mechanism. When it comes to the issues in the existing supply chain, an EPC contractor is expected to switch to alternative suppliers in a timely manner in order to avoid grave consequences jeopardizing a project [6].

4. A viable solution to the problem of project budget excess.

An EPC contractor is to account for a market landscape and actual financial condition of an enterprise, keep track of the budget of each project, increase the ability of integrated management of project, procurement and construction activities, and design and develop a common cost management and budgeting model for a project accordingly. In order to design a profitability management system for the project, identify the point of balance of profit and loss as well as positioning of an enterprise in a market and to create a target budget limit system [7].

In particular, an enterprise management should take the following measures to scientifically address the problem of budget excess. First, an EPC contractor is to design a flexible and dynamic procurement mechanism, establish long-term cooperative relations with suppliers in order to obtain large price concessions, and adjust the procurement plan in a timely manner for adapting to market price changes. Secondly, an EPC contractor is to reinforce the interaction of structural units while drafting tender documents to ensure clarity of the scope of a proposal, viability and feasibility of a customer's requirements, as well as avoid unreasonable provisions on unlimited liability. At the same time, EPC contractors are to build a professional legal team to confirm the compliance of the tender documents in order to avoid legal disputes and increase the costs of an enterprise. Finally, EPC contractors can plan and coordinate budget control work ahead of time, reinforce communications between a contractor and a customer, identify a target date for project completion, forecast and adjust as early as possible during budget preparation in order to facilitate project progress and monitor costs.

5. Improvement of budget assessment mechanisms.

In order to further improve the quality and efficiency of an EPC contract budget control, contractors are to improve the project budget assessment mechanism and comply with the principles of targeted management, as well as to design a personnel management system [8].

On the other hand, EPC contractors are to come up with proper standards and budget estimates for employees in compliance with the content of their work they are held accountable for. For project managers and employees directly accountable for a project workflow, more specific and quantifiable indicators such as cost management levels and work completion levels can be employed to assess budget efficiency [9].

By now, China has already gained positive experience in implementing investment and construction projects based on EPC contracts.

Let us consider as an example an implemented project based on an EPC contract "Construction of a Photovoltaic Power Plant with a Capacity of 50 MW".

The total contract value is 250 million yuan (including design, purchase of equipment and construction).

The duration of an ICP implementation is 12 months.

The aim of budget control is to maintain the cost deviation within ± 3%.

1. Budget preparation stage.

1.1. Detailed budget breakdown by cost items (Table 1).

Table 1

Contract budget

Cost item	**Budget value, yuan**	**%**	**Recommendations**
Project	12,000,000	4.8	Reducing the number of changes
Purchasing photovoltaic modules	120,000,000	48	Accounting for exchange rate fluctuations
Buying an inverter	30,000,000	12	Receiving discounts for a purchasing volume
Construction and installation fees	60,000,000	24	Time management of workers and construction machines
Project management fee	15,000,000	6	Reduction of optional expenses (e.g., transportation)
Risk reserve	13,000,000	5.2	Reserving financial resources due to weather conditions, increased material prices, etc.

1.2. Key control indicators.

Project optimization: using a BIM model for more accurate calculation of excavation volumes, which will cut the budget by 2 million yuan.

A contract with a supplier of components is signed according to the "open contract" scheme stipulating a price fluctuation of no more than ± 2% [10].

2. Dynamic control of a project during its execution.

2.1. Monthly expense analysis (month 6).

Table 2 shows the actual figures for the 6 months of a project implementation.

Table 2

Budget: planned, actual, deviation

Indicators	Budget, thousand yuan	Actual expenses, thousand yuan	Deviation, %	Analysis of the causes	Corrective measures
Photovoltaic panels. Solar panels	6 000	6 300	+ 5	Increase in prices for silicon materials causes introduction of price adjustment provision.	Risk reserve budget of 3 million yuan
Construction and installation	3 000	2 700	– 10	Using ready-made brackets saves time	The remainder of the budget funds is transferred to the risk reserve
Design changes	200	500	+ 150	Owners' new requirements for the storage system energy	Initiating submitting an application for changes

2.2. Management tools.

Early warning mechanism: if individual expenses exceed the budget by 5%, this automatically triggers management audit.

Purchase record journal: real-time update of information on equipment delivery and payment avoiding overspending on advance payments.

Table 3

Final project indicators

Result	**Data**
Total cost	253 million yuan (+ 1,2 %)
Savings	Construction optimization has saved 4 million yuan
Overspending	Design changes increased the costs by 3 million yuan
Conclusion	The cost deviation is maintained within the target range

Discussion and Conclusion. An analysis of the work of EPC enterprises in China on budget control has shown that there are still some issues to be resolved.

Based on the results of the analysis (Table 3), the following conclusions can be made:

1. Equipment purchasing calls for preliminary price fixing (price calculation based on analyzing market offers).

2. The resulting savings from construction can be employed for overspending compensation caused by the other budget items.

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