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COST OPTIMIZATION OF AN INVESTMENT PROJECT BASED ON CONTRACT STRATEGIES

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Purpose: The article presents the actual problem of determining cost of construction project implementation. Within the conducted research, an analysis of existing approaches to managing project costs in the face of uncertainty was carried out, including the justification of the possibility of using the contract system for the purpose of optimizing the project, as well as identification of possibilities of cost engineering.
Design/methodology/approach: A Case-study method, based on an assessment of the performance indicators of an investment project for the construction of a city boiler house and the project cost analysis using the Earned Value Technique, was used to prove the hypothesis about the effectiveness of using cost engineering.
Findings: The results of evaluating the effectiveness of project implementation was substantiated, and the feasibility of applying the EPC contract for the cost optimization was proven. The projects implemented with the EPC contracts have a high potential. EPC/M contracts are widely used in other countries, but in Russia, this type of contract is just beginning to be used.
Originality/value: In the result of the analysis, it was revealed that the main factors affecting the cost of the boiler house implementation construction project were the imperfection of the pricing system, the presence of unrecorded work and costs, the inadequacy of the rationing system; the violation of technology and timing of implementation.

Keywords: project cost, contract strategy, EPC contract, cost engineering, investment efficiency.

Category of the paper: research paper.

1. Introduction

Effective implementation of large investment projects is a complex task. Over the past 20 years, Russian companies have implemented only a few large-scale investment projects. For example, the construction of transport infrastructure to obtain mineral resources in the

southeast part of the Chita region, with investments of more than RUB 169 billion, or the Nord Stream main gas pipeline between Russia and Germany with a total investment of EUR 7.4 billion.

In some cases, we can observe unsuccessful results of the world's leading companies, with many years of experience and dozens of implemented large-scale projects. One of the most known Russian examples of a lack of required level of cost engineering is the "Gazprom Arena" project (football stadium in St. Petersburg). The project began in 2007 and ended in 2017. The general contractor was changed twice, and the deadlines were repeatedly postponed. The initial cost of building the arena was RUB 6.7 billion at the beginning, but after the completion, the estimated cost, according to the press service of the St. Petersburg Construction Committee, became RUB 41.7 billion.

In the construction sector, especially for new constructions, 72% of projects are implemented exceeding the planned costs, according to the rating agencies (Mattheys, 2015).

The construction of the Gremyachinsky mining and processing plant ("EuroChem" company in the Volgograd region) is in the process since 2005, due to the lack of well-developed contractual schemes and engineering errors. The initial cost of the mine shaft in 2008 was RUB 85 billion. After the implementation of the first stage, an error was discovered in the design, due to the ineffectiveness of the waterproofing technology, which was replaced by deep freezing of soils to prevent a catastrophe. The cost of that project doubled, several times there was a change of contractors, the "EuroChem" company suffered significant losses.

The lack of existing experience in effective project management, the complexity of project conditions, as well as the integration of projects into programs and portfolios, have led to the fact that, today, Russian companies are implementing almost all large-scale projects with significant cost overruns and delays (Rumyantsev, 2017).

These examples confirm the shortcomings in the development of design and working documentation, taking into account the possibilities of cost engineering, risk management, quality, timing and costs.

In this regard, the topic of optimizing the cost of a project, on the basis of contractual relations of Russian companies, is gaining popularity and relevance, due to the lack of significant experience in the implementation of projects with the transfer of engineering, procurement and construction stages to contractors, and the lack of a well-developed methodological framework for calculating the economic effectiveness of the contracting system.

Contract strategies depend on the share of costs and the participation of the customer's working group in the project. EPC (engineering, procurement, construction) is the contract, where a single contractor is responsible for the delivery of the entire volume of work "on a turn-key basis"; EPCM (engineering, procurement, construction, management) is the contract, according to which the work is divided into lots, for which tenders are held by one contractor (Loots, 2007).

EPC contracts (engineering, procurement, construction) are just beginning to be widely used in Russia, despite the 20-year practice of successful application abroad.

The contractor is selected from the best offers for the company on a competitive basis. An EPC contractor performs all the work on the project, they are responsible for the financial risk, the work of subcontractors, the receipt of agreements, the safety of works and so on, before transferring the project results to the customer. Responsibility is distributed in the ratio of 30/70% between the customer and the contractor in the event of EPC "on a turn-key basis" model contract (Kalinenko, 2017). The scope of work and the project implementation period are established from the moment of signing the contract, all contracts with subcontractors are entered into by the EPC contractor. This type of contract allows the contractor to manage the project as a whole, rather than individual works.

The issues of project cost management, cost engineering, including those based on contractual strategies, were dealt by such scientists as Mazur, I., Shapiro, V.D., Malakhov, V.I., Dorozhkin, V.R., Roy, R., and Mattheys, K.

The works (Korkishko and Shadkova, 2016; Marinina and Nevskaya, 2017) considered the principles, the essence of optimizing the cost of construction and installation projects, current trends and problems of cost management of projects in the mineral resource sector.

The analysis of domestic and foreign literature in the subject area of project management shows that, nowadays, the main problems of ineffective implementation of cost engineering at different stages of project implementation are: the lack of a well-developed methodological base of cost engineering, adapted to Russian conditions and fixed by regulatory acts at the state level; the lack of standards, normative reference books for the purposes of planning all types of works, as well as methodological recommendations in companies; the lack of professional staff (cost engineers), who, at the same time, have competences in the field of calendar-network planning, programming and production technology (Marinina, and Marinin, 2017; Ponomarenko, 2016).

The objective of this work is to prove the possibility of optimizing the cost of the project through the application of the EPC contract.

2. Methodology

To prove the hypothesis about the effectiveness of using EPC contracts during the construction stage, we used the following research methods: "Case-study" to characterize the process; estimation of the net cost of the projects implementation in the baseline, actual and project version, taking into account the EPC contract (indicators: NPV, IRR, PI, PP); a graphical method for creating a network schedule for the project; The Earned Value Technique to assess the project implementation budget in terms of cost and time. The Earned Value Technique is

based on the following indicators: the cost variance index (CV), the index of schedule variance (SV), the cost performance index (CPI) and the schedule performance index (SPI), the estimate at completion (EAC), the estimate to complete (ETC) and the variance at completion (VAC).

According to the basic plan, the construction project of the city boiler house for Nizhnevartovsk should be completed in 9 months of 2018. Duration: 1-3 quarter of 2018.

Construction includes the following: engineering works; site preparation; construction of the first stage of the boiler room; commissioning.

3. Results and discussion

The basic (first) network schedule of the investment project is presented in Table 1.

Table 1.
Network schedule for the boiler house construction (basic version)

Statement of works	2018								
	1	2	3	4	5	6	7	8	9
Engineering works									
Site preparation									
Construction of a boiler room (construction activities)									
Installation of equipment									
Integrated automation of internal networks and start-up system, as well as adjustment works									
External network									
Emergency fuel tanks with pumping									
Improvement and technical supervision									
Commissioning									

The construction deadlines of boiler plants depend on many options. At any construction site, the delay is one of the main risks affecting the project. The extension of the deadlines does not always depend on the enterprise implementing the project. The reasons may be a long communications connection, the work of contractors and suppliers or work on coordination with the authorities.

There are factors affecting the cost and timing of the construction project of an automated gas boiler:

- capacity of boiler house – the bigger the capacity of boilers, the more time is needed for their manufacture. In practice, when developing a business plan, companies predict standard delivery time of equipment, not taking into account this parameter,
- assembly – the delivery time of gas boilers is longer than steam boilers, so the production time will increase,

- seasonality and availability of orders in a work progress – in the season of boiler rooms construction, namely from August to December, it is necessary to take into account the increase in the delivery time of equipment. It usually increases from two to six weeks,
- remoteness of the facility, where the project is implemented, from the place of equipment production.

The project manager can accurately predict the risks listed above and correct them in time for each option, but sometimes there are risks that the company cannot predict:

- delay in processing and issuing conciliation documents and legal construction permits,
- untimely provision of a land plot for project implementation,
- delay in conducting surveys,
- environmental risk,
- dishonest work of contractors and suppliers.

This project also included extending the deadlines, which resulted in an increase in the cost of this project:

- extending the time of engineering works stage by three months, due to a long process of obtaining the construction permit and the postponement of the non-governmental examination, as well as the delay in obtaining approval of the local gas transmission division of PJSC "Gazprom", due to the 2 stages of commissioning and the increase of the boiler house capacity in the future, including the delay in obtaining the permits of the Federal Service Administration for Ecological, Technological and Nuclear Supervision (Rostekhnadzor);
- prolongation of the engineering works stage, due to the land issue. The boiler house's location had an outdated topographic plan of the area – older than 3 years;
- the process of complete coordination of the project, including the collection of all the initial input permits, took four months, instead of the planned two;
- at the project implementation stage, the construction phase also increased by two months, due to the disruption of the materials supply at the scheduled date, also due to the correction of errors at the construction installation stage, due to inaccurate accounting of the requirements of subcontractors. Another reason for the increase of the construction phase was weather conditions, which led to a deterioration in the work of the contractor;
- commissioning and final coordination in administrative instances took six weeks.

As a result, the actual network plan looked as follows (Table 2):

Table 2.
Network schedule for the boiler house construction (actual version)

Statement of works	2018												2019		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Engineering works															
Site preparation															
Construction of a boiler room (construction activities)															
Installation of equipment															
Integrated automation of internal networks and a start-up system, as well as adjustment works															
External network															
Emergency fuel tanks with pumping															
Improvement and technical supervision															
Commissioning															

The deadline for the gas boiler construction project took 15 months, instead of the planned 9, which led to an increase in the cost of the project and a decrease in performance indicators.

The investment costs of building a boiler house are presented in Table 3.

Table 3.
Investment costs of the boiler house construction, in millions of rubles

Statement of works	2018								
	1	2	3	4	5	6	7	8	9
Engineering works	13.79	2.44	1.57						
Site preparation		17.50	5.00						
Construction of a boiler room (construction activities)				14.30	16.656	13.80	7.801	7.44	
Installation of equipment					44.40	37.20	31.80	6.60	
Integrated automation of internal networks and system of starting-up and adjustment works						108.31	9.89	6.30	
External network						2.76	5.64	3.60	
Emergency fuel tanks with pumping							10.48	1.52	
Improvement and technical supervision									10
Commissioning	13.79	33.73	40.3	54.6	115.656	277.726	343.337	368.80	378.80
(total result)									

To estimate the cost of the project, taking into account the backlog of construction time and an increase in the investment budget, the Earned Value Technique was used (Table 4).

Table 4.
Project cost

Month	PV	AC	EV	CV	SV	CPI	SPI	EAC	ETC	VAC
1	13.79	15.51	11.45	-4.07	-2.34	0.74	0.83	513.42	497.91	-134.62
2	33.73	36.95	30.97	-5.98	-2.76	0.84	0.92	451.93	414.98	-73.13
3	40.30	45.00	37.27	-7.72	-3.03	0.83	0.92	457.30	412.30	-78.50
4	54.60	60.64	50.72	-9.93	-3.88	0.84	0.93	452.94	392.30	-74.14
5	115.66	125.04	108.55	-16.48	-7.10	0.87	0.94	436.32	311.28	-57.52
6	277.73	298.77	267.93	-30.84	-9.79	0.90	0.96	422.40	123.63	-43.60
7	343.34	369.56	331.49	-38.07	-11.85	0.90	0.97	422.31	52.75	-43.51
8	368.80	397.42	356.17	-41.25	-12.63	0.90	0.97	422.67	25.25	-43.87
9	378.80	408.68	363.67	-45.01	-15.13	0.89	0.96	425.68	17.00	-46.88
Total result	378.80	408.68	363.67	-45.01	-15.13	0.89	0.96	425.68	17.00	-46.88

Under this scenario, there is a significant increase in the cost of the project, because within months, the real cost of the performed work exceeds the estimated amount planned (the project budget). The difference between the estimated volumes of actually completed and planned works, throughout the entire life cycle of the project, remains negative; therefore, every month of the project's implementation, the general deadline for its completion is postponed. As a result of applying the Earned Value Technique, we found out that the implementation of the analyzed project with a schedule delay will increase its cost by RUB 46.88 million.

Based on the data, we made the following conclusions. The analysis of the actual project implementation showed a deviation in deadlines, as a result of an increase in the time required to obtain the coordination documentation and implementation of the construction and installation stages. Prolongation of time increases the cost of the project and has a negative impact on performance indicators.

In this project, the main cost derives from the stages of design and construction, namely the E-P-C chain (engineering, procurement, construction). In Russian practice, the experts point out, that obtaining administrative approvals and proving compliance with legal regulations can lead to a 25% increase in the project cost. To solve the problems and downtime arising in the project, a solution was proposed – a turnkey EPC contract, namely the execution by the general contractor of the necessary scope of works with the completed work to the customer. This choice was also due to the implementation of a new type of activity for the company in the framework of a concession agreement in the field of heating.

The turnkey contract value was chosen according to the Cost + model, meaning that the construction costs are fully compensated by the customer. The contract establishes the upper limit of the project cost, that is acceptable to the customer. The excess of the project cost is borne by the EPC general contractor. Often, the profits of an EPC contractor are fixed and

amount up to 15% of the project cost, depending on the complexity of the planned work. This pricing model will meet the deadlines and reduce the cost of the project.

In addition, the EPC contract also provides the contractor with a clear timeline for commissioning and date of completion of the project, as well as a system of remuneration and fines for the general contractor. It also provides a degree of customer's control for the actions of the contractor and subcontractors. It is worth noting, that the contractor's financial liability is limited to the amount of their profit (Malakhov, 2017).

This EPC system allowed to reduce the project implementation period at the expense of parallel operations (Table 5.). Design and survey works were reduced to two months, due to the absence of errors in the preparation of agreements and the correct passage of the coordinating instances. The contractor began the construction works in parallel with the signing of the latest agreements. As a result, the project was implemented in 7.5 months.

Table 5.
Network schedule of the boiler house designed with the EPC-contract

Statement of works	2018								
	1	2	3	4	5	6	7	8	9
Engineering works									
Site preparation									
Construction of a boiler room (construction activities)									
Installation of equipment									
Integrated automation of internal networks and a start-up system, as well as adjustment works									
External network									
Emergency fuel tanks with pumping									
Improvement and technical supervision									
Commissioning									
Deliver the project to the customer									

Due to the fact that the EPC contract provides the general contractor with freedom to make decisions, it was possible to reduce the cost of construction and installation works by 10%, due to staff optimization and using "guaranteed" suppliers, as well as an established system of construction and installation works, with the contactor's fee set in the amount of RUB 15 million. The cost of engineering works has also been reduced, due to the shorter implementation period. The capital investments would amount to RUB 359.15 million, subject to the commissioning of the first stage. The overall investment scheme for a project under an EPC contract is presented in Table 6.

Table 6.
The capital investments during the project implementation period, in millions of rubles

Statement of works	2018 year								
	1	2	3	4	5	6	7	8	9
Engineering works	15.99		-	-	-	-	-	-	-
Site preparation	22.5		-	-	-	-	-	-	-
Construction of a boiler room (construction activities)	-	295.65					-	-	-
Landscaping and technical supervision	-	-	-	-	-	-	10	-	-
Commissioning the first stage (total result)	-	-	-	-	-	-	344.15	-	-
Deliver the project to the customer	-	-	-	-	-	-	359.15	-	-

The events for attraction of EPC contractor will improve project performance indicators (Table 7).

Table 7.
Project performance indicators

Indicators	Units	Value with EPC - contract	Fact	Plan
Total investment	million rubles	409.15	458.70	428.80
Discount rate	%	12	12	12
NPV	million rubles	40.761	-8.8	21.11
PP	years	4.9	5.6	5.2
DPP	years	6.5	8.6	7.3
PI	units	1.11	0.98	1.06
IRR	%	16.05	11.22	14

An overview of the results of the EPC contract performance indicators demonstrates the improvement of the project management and the quality management of the timing and cost by the general contractor. There is a large deviation between the actual NPV and the planned one (-29.91% without using of the EPC contract); therefore, the IRR indicator is reduced from 14 to 11.22, and finally, the payback period of this project increases from 5.2 to 5.6 years. But, at the same time, subject to the use of the EPC contract – the NPV indicator increases from 21.11 to 40.761, the IRR indicator increases from 14 to 16.05 and the payback period of this project is reduced from 5.2 to 4.9 years. Consequently, the EPC contract increases the efficiency of the project by reducing the time of coordination with the licensing state bodies and more effective interaction with suppliers, resulting in the reduction of the construction costs.

4. Conclusions

The projects implemented with the EPC contracts have a high potential. EPC/M contracts are widely used in other countries, but in Russia, this type of contract is just beginning to be used. The main reason for the underdevelopment of the EPC contracts is: the lack of a well-developed methodological base of cost engineering, adapted to Russian conditions and fixed by state-level regulatory acts; the lack of standards, regulatory reference books for the purposes of planning all types of work, and methodological recommendations in companies; as well as the lack of professional staff (cost engineers), who, at the same time, have competencies in the field of calendar-network planning, programming and production technology.

In the result of the analysis, it was revealed that the main factors affecting the cost of the boiler house implementation construction project were the imperfection of the pricing system, the presence of unrecorded work and costs, the inadequacy of the rationing system; the violation of technology and timing of implementation. To a greater extent, an increase in the project budget depends on the timing of coordination with the government authorities and interaction with the suppliers. In this regard, the use of a contracting system for the implementation of such projects is an effective solution based on value engineering.

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