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Designing a Model TO Increase the Profitability of EPC Projects

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Abstract

The purpose of this study is to identify the factors affecting on increasing of contractors 'profits of EPC projects and also to estimate the impact of each factor on the increase of contractors' profits. For this purpose, a questionnaire based on the components extracted from previous studies was prepared and sent to EPC project experts. At this stage, the factors affecting on profitability of EPC projects were identified according to the PMBOK standard. Then, the opinion of experts on the importance of each of the factors affecting on increasing EPC contractors' profits was obtained based on the Likert five-choice range and analyzed using SPSS software. The results show that the timely supply of equipment, avoiding of complex administrative bureaucracy, innovation and use of new technologies, adequate expertise and timely financing have the greatest impact on increasing the profits of EPC contractors, respectively.

Keywords

Profit • EPC Project • PMBOK • Expertise • Innovation

Introduction

In industrial projects such as the oil industry, power plants and infrastructure projects that are significantly affected by technological developments, the use of new management methods and structures is inevitable. Using the latest scientific achievements in this field, project managers should avoid using inefficient traditional methods so that they can use new methods to carry out their executive projects within a certain time and budget with the desired quality. Choosing the method of doing the project and choosing the most suitable contract is one of [1] the important decisions of the project. Project implementation system refers to a set of processes in which the type of contract, payment method, the scope of responsibility of each party to the contract, how to resolve disputes between project stakeholders and how to distribute and allocate risk over a lifetime are explained. Due to the importance of choosing the right system, in recent years, several methods have been proposed to select the right system. Choosing the right project implementation method can reduce project costs by an average of 5% and project implementation time by up to 30%, and choosing the wrong system to advance projects can lead to problems such as delays, cost increases, disputes and claims in projects. This choice, which is made in the earliest stages of the project, affects all project implementation processes as well as the efficiency of the project implementation stages. The most common contract methods of project implementation are In-House system, construction management method, Design-Bid-Build system and Design-Build system. From the early twentieth century to the early 1950s, major projects were carried out by architects and engineers involved in the project [2] and managed on their own initiative. In fact, it was in the post-1950s that systematic methods and tools for project management were developed and used. Along with these changes, the methods of project implementation also changed, partly due to the complexity of projects in the years after World War and the specialization of areas such as design and execution, and part of this was due to the employer's need to exercise more precise controls over the performance of the actors involved in the project. The year 1950 marks the beginning of a new era of project management. Gradually, issues such as cost and time management of the project received special attention, and systems such as the three-factor and four-factor methods for project implementation were formed. Given that the three main actions of the project are financing, design and construction; the five main methods of project implementation are as follows: [3]

- **In-House system:** Perform all three main actions within the employer organization.
- **Design-Build system:** Financing by the employer and design and construction separately by external unit resources.
- **Design-Bid-Build system:** financing by the employer and performing design and construction separately by external separate sources.

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- **Construction Management system:** financing by the employer, design and construction by separate external sources, coordination between design and construction by another external source.
- **Build-Operate-Tran:** Provides all three main actions from a single external source.

One of the new methods in project implementation is Engineering, Procurement and Construction (EPC) method, which is also called turnkey method. In this type of contract, the contractor company undertakes and performs the engineering, procurement and supply of all equipment and construction of the project independently or with persons who are on the side of the company. In Turnkey or EPC contracts, the contractor is responsible for the design, procurement and construction, and the other party to the contract (the employer) delivers a completed design according to what has been agreed. The contractor in the EPC project needs to be able to act in accordance with the parameters desired by the buyers of their services). In general, it can be said that EPC contracts combine the three stages of engineering, procurement and construction in one contract. In this method of project implementation, despite the limitations for the employer, by transferring all project activities, including design, supply of equipment and activities related to construction, [4] installation and commissioning to the contractor, the employer is relieved of responsibility in this regard. The implementation of industrial infrastructure projects in recent years in developing countries by the EPC method has expanded so much that today many ongoing activities are carried out using this method. Projects are often carried out by the project team as a means to achieve important organizational programs or services. Project management is the foundation of any construction project. Construction projects are multi-faceted and well-organized operations that consist of many tasks focused solely on the purpose of building and operating a project. Cost, time and scope have been the sides of the Project Management Triangle (PMT) for many years. These limitations have been linked to measuring project management success.

Experts showed that 14% of projects are completed for more than the contract amount, while more than 70% of all construction projects are delayed and 10% of the project consumables remain as waste. The construction industry is a project-specific industry, and it is difficult to evaluate the overall performance of construction projects due to the lack of standard method development. The nature of the project, effective project management tools, and the adoption of innovative management approaches are Critical Success Factors (CSF) for construction projects. Therefore, the CSF must be determined at the beginning of the project. By focusing on these factors, which are the main input of the project management system, the probability of project success increases. CSF explicitly affects the main objectives of the project including time, cost and scope. Many factors affect the cost of EPC projects. Contracting companies that carry out EPC projects are looking to make a decent profit. Factors such as project pricing method, design and engineering, quality and duration of equipment supply, project execution time, project execution quality, human resource quality, use of information systems, etc. are effective in increasing contractors' profits. In this study, we intend to analyze the relationship of each of the factors affecting the profitability of EPC projects.

Material and Methods

Theoretical foundations and research background

EPC project management includes the management of the three main indicators of the EPC concept, namely engineering, procurement and construction and combining them with different financial areas, project scope, time, manpower, communications, risk, [5] supply of goods and quality. The three elements of time, cost and quality are known as the sides of the project triangle. Prerequisite for managing financial costs and proper planning in a project is having a complete scenario of feasible actions and obligations of the employer and the contractor. The Project Management Body of Knowledge (PMBOK) is a recognized standard for the project management profession that provides guidelines for individual project management. The PMBOK standard is a comprehensive set of related knowledge, which forms work skills. As a result, this phrase means a comprehensive set of project management knowledge. Project management means the application of knowledge, skills, tools and techniques related to project activities in order to meet project requirements. This application of knowledge requires effective management of appropriate processes. The main goal of project management is to complete the project on time and according to the defined budget. In addition, the project manager needs to work closely with the client and must ensure that the project results meet customer expectations (PMI, 2017). The surest way to understand the success of a project is to evaluate it with the strategic goals of the organization. In order for both project management and project success to occur, it is imperative that the criteria for success be formulated and explained from the initial phase. It is important to note that traditional criteria focus [6] only on the economic aspects, while the social and environmental aspects are also important in determining the success of projects. Therefore, for successful project management, a balance and harmony must be established between these parameters so that a successful project can be achieved in the end. Therefore, projects can be considered a failed project even if they are completed on time and on budget. According to the project management standard, Experts identified the effective risks in EPC projects in order to obtain the critical path, and analyze the impact points experts conducted research on professional construction knowledge of project management. In this study, a model was proposed in which the effect of various factors on the success of the project is related to the areas of knowledge studied. These areas of knowledge included project scope, time, project cost and quality, procurement management, risk, human resources and communications. Poor performance of construction projects, especially in terms of time and latency, additional costs and quality defects, has attracted the attention of many construction researchers and project managers. Numerous studies have been conducted in recent years to identify the factors affecting over time and cost in construction projects around the world. These factors include defects in contract management, payment for work performed, imported materials, changes in design and defects in subcontractors, and supplier performance. In addition to the mentioned factors, a combination of variables such as poor labor [7] productivity, material shortages, inaccuracies in estimating required materials, fluctuations in material costs, insufficient experience about the type and location

of the project are also the main reasons for increasing time and cost identified during an EPC project in Indonesia. Other factors that have led to poor performance in relation to an EPC project in Hong Kong include errors and inconsistencies in design, poor site management and monitoring, and delays in approvals, in the article Examining the existing weaknesses in cost management, examines the method of cost management in construction projects, the current attention to them in the project and identifying their strengths and weaknesses, as well as identifying the factors that are currently for cost management of this type of project is considered paid. They consider providing a precise schedule based on the analysis performed at the time of price bidding as a factor to achieve a successful cost management and also [8] they know providing accurate daily reports away from any numbering to the project control department at any time for optimal cost management. In a study on the effect of project management knowledge on the achievements of construction projects, Chou and Yang stated that external, operational, project management, engineering and financial factors have the greatest impact on project success by using PMBOK in projects. Examining the efficiency of using PMBOK in construction projects, Rodrigues and Crispim stated that cost control indicators, fluctuations, differences in construction design, material shortages or supply delays can play a major role in reducing project efficiency, which by Using PMBOK in these projects, these indicators should be considered to reduce costs, conducted a study on the impact of project management on project success. They consider time and cost as the basis of project success. They first examined the success factors of the projects and then, considering the factors influencing the success of the project, which were mostly provided by qualified experts, they examined various standards in this field and finally noticed the effect of cost and time factors as the most important. Project success factors and project management standard became the most complete standard for project success. In the article Factors Affecting the Cost of Construction Tenders, Discuss the points of view of cost-effective surveyors based in the UK. [9] They identified about 67 variables that affect the estimation of the pre-tender construction cost through works and interviews. These factors are divided into 6 categories including customer characteristics, consultant and design parameters, contractor characteristics, project characteristics, contract method, procurement method, external factors and market conditions. Then a questionnaire was used to evaluate and rank these factors. The results show that the costs of construction projects are more influenced by architects and consultants, In the article Factors affecting construction time and cost increase in long-term projects in Indonesia, factors affecting additional construction time and cost in developing countries such as Nigeria, Saudi Arabia and Indonesia and the relationship between the two Analyzed. The scope of this particular study focused only on long-term projects. In this study, thirty-one managers working on long-term construction projects were interviewed and the following factors were identified as factors affecting the cost of long-term projects in Indonesia: Unpredictable weather conditions, increased material costs due to inflation, incorrect estimation, increased costs due to environmental constraints, insufficient experience of project location, insufficient experience of project type, insufficient experience of local regulations.

According to the existing literature and talking to the managers of large companies contracting EPC projects, the hypotheses of the present study are presented as follows: [10-15]

Hypothesis 1: Proper design and engineering has a positive effect on increasing the EPC contractors' profit.

Hypothesis 2: Proper project planning has a positive effect on increasing the EPC contractors' profit.

Hypothesis 3: Timely financing has a positive effect on increasing the EPC contractors' profit.

Hypothesis 4: Timely supply of equipment has a positive effect on increasing the EPC contractors' profit.

Hypothesis 5: Quality manpower has a positive effect on increasing the EPC contractors' profit.

Hypothesis 6: The project manager and workshop manager with knowledge have a positive effect on increasing the EPC contractors' profit.

Hypothesis 7: Project control has a positive effect on increasing the EPC contractors' profit.

Hypothesis 8: Avoiding complex bureaucracy has a positive effect on increasing the EPC contractors' profit.

Hypothesis 9: Quality materials and equipment have a positive effect on increasing the EPC contractors' profit.

Hypothesis 10: The selection of quality subcontractors has a positive effect on increasing the EPC contractors' profit.

Hypothesis 11: The lack of successive changes in the project implementation team has a positive effect on increasing the EPC contractors' profit.

Hypothesis 12: Adequate expertise in the project area has a positive effect on increasing the EPC contractors' profit.

Hypothesis 13: Proper installation, commissioning and troubleshooting of equipment has a positive effect on increasing the EPC contractors' profit.

Hypothesis 14: Receive money up to 30 days after sending the invoice has a positive effect on increasing the EPC contractors' profit.

Hypothesis 15: Applying project cost management has a positive effect on increasing the EPC contractors' profit.

Hypothesis 16: Applying project risk management has a positive effect on increasing the EPC contractors' profit.

Hypothesis 17: Applying project communication management has a positive effect on increasing the EPC contractors' profit.

Hypothesis 18: Creating innovation and using new technologies in the project has a positive effect on increasing the EPC contractors' profit.

Hypothesis 19: Economic stability has a positive effect on increasing the EPC contractors' profit.

Hypothesis 20: Coherence of organizational structure has a positive effect on increasing the EPC contractors' profit.

Results

Hypothetical Research Model

Based on the hypotheses presented, the hypothetical model of the present study is shown in figure 1.

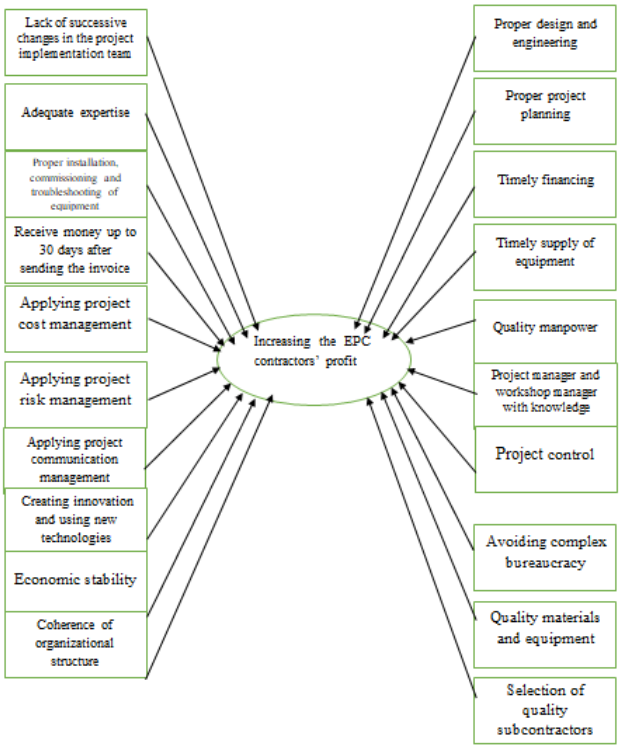

Figure 1. The hypothetical research model

This research was conducted in a descriptive-survey manner. A questionnaire was used to collect information, which included three general sections. The first part included a guide to the questionnaire and the method of answering the questions, the second part was related to the demographic characteristics of the individuals and the third part was the questions related to the research problem. The statistical population of the present study is the managers and [12] experts of contracting companies in the field of EPC projects. The method used is the Delphi method and the sample size is 40 people; the snowball method was used to select the specialists. In this study, to prove the validity of the questionnaire, first a number of questionnaires were provided to experts and after reviewing the opinions of each expert, the questionnaire was modified and the final questionnaire was developed. Thus, the content validity of the questionnaire was confirmed by a number of experts. Cronbach's alpha was used to evaluate the reliability of the questionnaire. The Cronbach's alpha value obtained using SPSS software was 0.89. If the Cronbach's alpha value is higher than 0.7, the questionnaire has good reliability. The highest frequency was related to the age group of 41 to 45 years with 40%. The highest level of education belongs to the master's degree group with 42.5%. The highest job title belonged to the project manager group at 45%. The [13] highest frequency is related to metro projects at 52.5%. The Anderson-Darling test was used to determine the normality of the data. If the null hypothesis of the Anderson-Darling test is confirmed, the data have a normal distribution and therefore parametric tests can be used to analyze the data. The results of this test are shown in Table 1. According to the obtained results, because the significance level of all variables is more than 0.05, the null hypothesis of Anderson-Darling test is confirmed and the data [14] have a normal distribution. To test the research hypotheses, one-sample parametric t-test was used. In this test, H1 indicates the acceptance of the hypothesis and H0 indicates the non-acceptance of the hypothesis. Table 2 shows the results of data analysis on research hypotheses, Table 1.

p-value	Statistics	Variable
0.192	0.094	Proper design and engineering
0.2	0.124	Proper project planning
0.165	0.087	Timely financing
0.085	0.134	Timely supply of equipment
0.119	0.079	Quality manpower
0.076	0.185	Project manager and workshop manager with knowledge
0.112	0.086	Project control
0.087	0.093	Avoiding complex bureaucracy
0.134	0.157	Quality materials and equipment
0.085	0.143	Selection of quality subcontractors
0.188	0.076	Lack of successive changes in the project implementation team
0.121	0.147	Adequate expertise
0.067	0.153	Proper installation, commissioning and troubleshooting of equipment
0.085	0.076	Receive money up to 30 days after sending the invoice

0.087	0.093	Applying project cost management
0.0131	0.152	Applying project risk management
0.065	0.167	Applying project communication management
0.112	0.079	Creating innovation and using new technologies
0.113	0.154	Economic stability
0.072	0.188	Coherence of organizational structure

Table 1. Anderson-Darling test results to determine the normality of the data

Table 2, due to the smaller significance level of all variables than 0.05, all research hypotheses were confirmed. The Friedman ranking test was used to prioritize the factors affecting on increasing EPC contractors' profits [15-18].

Test value = 48						
					95% confidence interval of the difference	
Variable	**t-statistics**	**Degrees of freedom**	**Sig. (2-tailed)**	**Mean difference**	**Lower bound**	**upper bound**
Proper design and engineering	6.21	39	0.001	8.12	6.59	14.71
Proper project planning	5.78	39	0.021	5.67	5.43	11.1
Timely financing	7.01	39	0.003	6.23	5.96	12.19
Timely supply of equipment	7.58	39	0.0001	8.35	6.71	15.06
Quality manpower	6.92	39	0.001	7.23	6.31	13.54
Project manager and workshop manager with knowledge	6.32	39	0.001	8.12	6.59	14.71
Project control	6.12	39	0.004	6.35	6.02	12.37
Avoiding complex bureaucracy	8.11	39	0.0001	8.36	6.7	15.06
Quality materials and equipment	7.13	39	0.012	4.21	5.61	9.82
Selection of quality subcontractors	5.26	39	0.024	4.13	5.01	9.14
Lack of successive changes in the project implementation team	5.41	39	0.016	4.19	5.32	9.51
Adequate expertise	5.96	39	0.004	6.34	6.03	12.37
Proper installation, commissioning and troubleshooting of equipment	6.45	39	0.002	7.84	6.49	14.33
Receive money up to 30 days after sending the invoice	7.05	39	0.001	8.14	6.61	14.75
Applying project cost management	5.48	39	0.017	4.16	5.3	9.46
Applying project risk management	4.67	39	0.031	7.36	6.37	13.73

Applying project communication management	5.13	39	0.023	7.98	6.52	14.5
Creating innovation and using new technologies	6.15	39	0.0001	8.47	6.73	15.2
Economic stability	5.32	39	0.008	8.19	6.61	14.8
Coherence of organizational structure	4.89	39	0.012	4.85	5.76	10.61

Table 2. One-sample parametric t-test results

Table 3, the parameters of Timely supply of equipment, Avoiding of complex administrative bureaucracy, innovation and use of new technologies, adequate expertise and timely financing have the greatest impact on increasing the profits of EPC contractors, respectively [19-23].

Impact Factor	Rank	Description	Variable
6.846165	1	Timely supply of equipment	X1
6.690402	2	Avoiding complex bureaucracy	X2
6.20086	3	Creating innovation and using new technologies	X3
6.097018	4	Adequate expertise	X4
5.978341	5	Timely financing	X5
5.896751	6	Receive money up to 30 days after sending the invoice	X6
5.696484	7	Applying project cost management	X7
5.444296	8	Proper design and engineering	X8
5.288533	9	Project manager and workshop manager with knowledge	X9
5.177273	10	Quality manpower	X10
4.873164	11	Proper project planning	X11
4.769322	12	Applying project risk management	X12
4.465213	13	Economic stability	X13
4.205607	14	Selection of quality subcontractors	X14
4.027592	15	Project control	X15
3.997923	16	Proper installation, commissioning and troubleshooting of equipment	X16
3.894081	17	Quality materials and equipment	X17
3.738318	18	Lack of successive changes in the project implementation team	X18
3.471295	19	Applying project communication management	X19
3.241359	20	Coherence of organizational structure	X20

Table 3. Prioritize the factors affecting on increasing EPC contractors' profits

According to Table 3 and the results obtained the proposed model for increasing the profitability of EPC projects is presented as follows, in which the variable "y" indicates the level of profitability [24-29].

$$Y=6.84x1+6.69x2+6.20x3+6.09x4+5.97x5+5.89x6+5.69x7+5.44x8+5.28x9+5.17x10+4.87x11+4.76x12+4.46x13+4.20x14+4.02x15+3.99x16+3.89x17+3.73x18+3.47x19+3.24x20$$

Conclusion

According to the existing literature, factors such as poor contract management, payment for work performed, delay in import of materials and equipment, changes in design and defects in subcontractors, poor supplier performance, poor labor productivity, material shortages, inaccuracies in estimating required materials, fluctuations in material costs, insufficient experience about the type and location of the project are also the main reasons for increasing time and cost identified during an EPC project in Indonesia. Other factors that have led to poor performance in relation to an EPC project in Hong Kong include errors and inconsistencies in design, poor site management and monitoring, and delays in approvals. Examining the efficiency of using PMBOK in construction projects, Rodrigues and Crispim stated that cost control indicators, fluctuations, differences in construction design, material shortages or supply delays can play a major role in reducing project efficiency, which by Using PMBOK in these projects, these indicators should be considered to reduce costs. Also Unpredictable weather conditions, increased material costs due to inflation, incorrect estimation, increased costs due to environmental constraints, insufficient experience of project location, insufficient experience of project type and insufficient experience of local regulations leads to increased costs.

The results of the present study confirm all previous studies. On the other hand, in this study, we calculated the effect of each factor on increasing the profit of EPC contractors. The results show that if EPC contractors design their structure in such a way that it is far from any complex administrative bureaucracy and uses specialized human resources and exploits new technologies and innovations, the project will be completed in a short time and it will be done with high quality, which will reduce costs and increase profits. In this regard, the procurement and purchase of project equipment must be done according to a strict schedule, which requires financing for the project. For this purpose, the cash flow of the project must be carefully designed first, the critical points in it must be identified, and the cash flow chart must be updated on a monthly basis.

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