



## Review on Key Risk Factors in EPC Projects

Nikila G<sup>a</sup>, Prabakaran P A<sup>b</sup>

<sup>a</sup> Student, Department of Civil Engineering, Kumaraguru College of Technology, Coimbatore, India.

<sup>b</sup> Professor, Department of Civil Engineering, Kumaraguru College of Technology, Coimbatore, India.

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### ABSTRACT

This study reports and discusses a quick review of the literature on the key risk factors in EPC projects in the construction industry. Since we know that Risk identification enables businesses to develop plans to minimize harmful events before they arise. Considering the aspect this paper is focused on how risks are identified and mitigated practically are studied.

**Keywords:**EPC, Risk, Mitigation, Procurement.

### Introduction

There is a long history of research into EPC project risk management. In terms of the big picture, systematic research has been done on risk detection, evaluation, and reaction for EPC projects, and the findings of this research have had an impact on risk management for construction projects. The owner structure in the global construction market has recently undergone significant changes due to the large influx of new owners represented by private capital and investment funds and the increased emphasis on intensive management, which has resulted in larger-scale contracting projects and an increase in EPC projects with a total investment of more than 1 billion US dollars. The main connection in EPC projects is procurement. The main connection in EPC initiatives is procurement. International EPC project procurement costs can make up 40–60% of the total investment, which has a significant effect on project cost, schedule, and quality. Since the large-scale trend of international EPC projects makes the amount involved in procurement increasingly extensive, the management of procurement risks is more urgent. Numerous different kinds of equipment and materials are purchased for international EPC projects. As a result, the standards and processes are complex. The procurement process has numerous variables and is influenced by a variety of factors, including laws, policies, the weather, the social atmosphere, and other factors. As a result, vendors are exposed to high procurement risk.

### Previous Studies on Key Risk Factors in EPC Projects

**Jingshi He and Dai Han (2022)** This paper deals with correctly identifying and evaluating the logistics risks of EPC (engineering procurement construction) projects is conducive to strengthening the risk prevention and control of engineering projects. An evaluation index system for the logistics risk factors of overseas EPC projects was established, and the entropy-DEA (Data Envelopment Analysis) method used to evaluate and sort risk decision-making unit (DMU) with risk likelihood and risk consequences as decision variables.

**Qing'e Wang and Jing Wang \* (2022)** In this paper the author illustrates that the the core link of Engineering Procurement Construction (EPC) projects, procurement involves a huge amount of money and has a wide range of influence. Once the procurement risks of EPC projects occur, it is easy to cause a domino effect, which can have a huge impact on the cost, schedule and quality of the construction project. Therefore, this paper took international EPC projects as the research object, identifying 25 risk factors related to procurement through case analysis, literature analysis and expert interviews.

**Enrico Cagno and Guido J.L. Micheli (2011)** This article is intended to provide a risk-based procurement management model. The Procurement Risk Cube (PRC) model originates a systematic approach in the identification of the case-specific risks, their sources, the activities on which they impact and the risk owners. The hierarchical breakdown structure helps data aggregation by simply summing the values of exposure by owner / activity / source, so that establishing a correct intervention priority plan to mitigate downside risks, or to exploit upside risks, becomes easier and more effective.

**Sameh M. El-Sayegh, SolairManjikian, et.al, (2018)** In this paper the author illustrates that here is a big shift towards sustainable construction projects in the United Arab Emirates (UAE). Sustainable construction projects are riskier than traditional projects. The purpose of this paper is to identify and assess the risks in sustainable construction projects in the UAE. This will help project participants to properly manage these risks in their projects. A list of thirty risks was identified based on literature review.

**J.U.D. Hatmoko<sup>1</sup>, R.R. Khasani<sup>1</sup> (2019)** This paper says that more than 80% of oil and gas projects around the world experience delays, which may result in huge financial implications to the contractors and the owners. Therefore, it is important to manage delay risks factors to meet the target of project completion dates. The purpose of this study was to map delay risk factors of Engineering, Procurement, Construction (EPC) projects using a case study of a platform and subsea pipeline of an oil and gas project. Data was collected through observations and analysis of project documents, and interviews with respondents in managerial and engineer levels.

**Wu P., Xu Y., Jin R.\*, Hancock C. (2018)** This study aimed to address the gap in research regarding the application of integrated design and construction (IDC) project delivery into off-site construction Projects (OSC) within China. A questionnaire survey was designed and delivered to reach Chinese professionals in Architecture, Engineering, and Construction (AEC) disciplines to assess their risk perceptions. Risk was considered in terms of probability and severity. Two main research hypotheses were proposed that AEC professionals' perceptions towards applying IDC in OSC projects would be affected by their experience in OSC or in IDC.

**Wenxin Shen, Yongping Wei & Jun Fang (2017)** In this paper the author illustrates that Engineering-Procurement-Construction (EPC) method has increasingly been applied in international markets. In this research, the causes of contractors' claims in international EPC projects are modelled and empirically tested with industry survey, structural equation modelling and case studies from the perspective of Chinese contractors. The established model outlines the causes of contractors' claims as: external risk.

**Yimeng Song\* and Shengyue Hao (2020)** This paper illustrates that in the recent years, with the continuous development of the international engineering contracting market, the industry's requirements for projects have also increased. It has gradually evolved into an international engineering procurement model with higher risk response capabilities and more complex project models. Due to the long construction time, large scale, fixed contract amount and other characteristics of international EPC projects, China's international EPC projects still face multiple risks.

**Qi Guo; Zhong-ping Xu (2010)** This paper deals with the transaction cost theory, analyses the reason of the emergence and development of EPC contract mode, establishes transaction cost model under the traditional mode and the EPC contract mode, which divides the transaction costs into three parts: the contracting cost, the cost for coordination and supervision cost, and make a comparative analysis of the transaction cost between the traditional mode and the EPC contract mode according the three parts respectively.

**Patricia Galloway (2009)** This literature deals with the The impact of execution risk on a contractor's profitability will depend on the type of contract strategy and may not be linked to the point across the project life at which the problem occurred Across the life cycle of a project, the financial impact of an execution risk may be far more exaggerated for a lump sum than for a cost reimbursable. For example, a technological risk (e.g., change in definition of scope) manifesting itself during the design or procurement phase will negatively affect a project's overall margin less than if it occurred during construction and installation.

**Darren R. Hale, P.E.; Pramen P. Shrestha (2009)** This study compares the performance of design/bid/build and design/build to see if one project delivery method is superior in regards to time and cost. Similar military buildings were used to identify two samples of projects delivered with each of the two delivery methods. These projects provide a meaningful comparison because they include buildings of the same typology (i.e., U.S. Navy Bachelor Enlisted Quarters) delivered using similar design models.

**Shen, W., Tang, W., Yu, W., Duffield ; (2017)** This paper deals with the Engineering-Procurement-Construction (EPC) method which has increasingly been applied in international markets. In this research, the causes of contractors' claims in international EPC projects are modelled and empirically tested with industry survey, structural equation modelling and case studies from the perspective of Chinese contractors. The established model outlines the causes of contractors' claims as: external risk (sociopolitical risks, economic risks, and natural hazards), clients' organizational behavior.

**A Nurdiana and R Susanti (2020)** In this study, the risk of construction projects was reviewed based on the project life cycle of the E.P.C (Engineering Procurement Contract) contract. Risk is part of infrastructure projects, and EPC projects are no exception. Risk is a consequence of uncertainty conditions. In construction projects, the risk cannot be predicted because there are a lot of uncertainties in predicting problems.

**Robert A. Perkins, (2013)** This paper illustrates that there are fewer change orders in design-build due to design errors because the designer (architect/engineer) and contractor are one entity, but there are other causes of change orders. Some literature suggests that changes requested by the owner of the facility are greater with the design-build method. This research examines the causes for construction-phase changes in 14 design-build and 20 design-bid-build projects.

**Zhi Guo Yin\*, Hui Min Li (2013)** This paper describes the current status of our EPC projects in China, noting metallurgical EPC projects as complex process, long construction period, the use of fixed-price contracts, and other features make it faces huge cost risk, so it is necessary to conduct a cost risk management, while the metallurgical EPC project risk identification is the basis for subsequent risk management.

**Banaitienė, N., Banaitis, A., & Norkus, A. (2011)** Risk analysis and management is nowadays a critical factor to successful construction project management, as construction projects tend to be more complex, dynamic, always unique, and competition increasingly tougher. risk management helps the project participants—client, contractor or developer, consultant, and supplier—to meet their commitments and minimize negative impacts on construction project scope, cost, schedule (and quality, as a Result).

### **Risk Analysis in Project Management**

The reference discipline within the EPC industry, risk analysis has also grown in importance in the context of project management as a whole (Cagno et al, 2007). This significance is mostly due to the acceptance of the idea of risk as an unknown event that has the potential to significantly affect project outcomes. In other words, managing project risks contributes to timely and high-quality project completion, cost management, and risk management. In a nutshell, managing project risks entails managing the project as a whole.

Along with the concept of risk (generally defined as an uncertain event that may or may not occur, but which, if it does, has a significant impact on the project outcome; Chapman and Ward, 2003), the concept of the source of uncertainty (any element in the project or its context, be it a situation or a stakeholder, which influences the realization of the project and may give rise to uncertainty), and risk cause (the state of the source that influences the project's realization and may give rise to uncertainty) are used.

The probability of occurrence P (probability that a risk will materialize), the magnitude of the impact M (measure of the deviation from expected project outcome if the risk occurs), and the exposure E (expected value of deviation from forecasted outcome), calculated as the product of the probability of occurrence and the impact magnitude, can all be defined for each risk event that results from a risk cause through a chain of intermediate events. Due to risk's dual nature as a threat and an opportunity, it ought to be recognized that the magnitude might be either positive or negative (Chapman and Ward, 2003).

**Table 1 – Study of Risk Factors**

<b>Initial</b>	<b>Factor</b>	<b>Content</b>
P	political & legal risk	national political system, government policies, laws and regulations, government's attention and intervention, international relations
E1	Economical Risk	Socio economic system, economic structure, economic development status, exchange rate, tax rate, inflation, foreign exchange control
C1	contract risk	contract price, contract clause, claim clause, guarantee clause, design standard, contract termination clause, currency selection, claim clause
S1	social risk	social security, cultural differences, customs, educational levels, religious beliefs
N	natural risk	climate conditions, geological conditions, epidemic diseases, disaster emergency response
O	owner risk	professional capabilities, data provision, design changes, late payments, maintenance frequency
C2	general contractor risk	design plan, procurement preparation, use of tools, construction organization ability, operation and maintenance, worker training, subcontractor management, communication ability
S2	supply system risk	supplier selection, logistics and transportation, supply capacity, quality of building materials

### **Conclusion**

Since construction phase activities consume the largest portion of the project budget and time, most of the previous studies concentrated solely on the performance of construction phase, while the performance of engineering and procurement phases received the least attention. However, the schedule and cost performance of procurement phase can be highly affected by "resource shortage" and "price fluctuation", respectively. Procurement risk was identified as an important category of a project's risk profile. A number of researchers have identified procurement as a major area of constraint and opportunity, which can be exploited to improve the overall project performance. Thus, management of procurement risk is important to ensure the availability of the right item at the right time for the right activity and to avoid any detrimental effect on the success of the project.

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