

# Cost Overruns in Engineering Procurement Construction (EPC) Fabrication Oil and Gas Megaprojects in Malaysia: The Importance of Resource Allocation (5M)

Farrah Rina Mohd Roshdi, Kharizam Ismail, Nor Suzila Lop and Lilawati Ab Wahab

Department of Built Environment Studies and Technology, Faculty of Architecture, Planning and Surveying Universiti Teknologi MARA, Perak Branch, 32610, Seri Iskandar, Perak, Malaysia.

Corresponding Author Email: [farrahrina@uitm.edu.my](mailto:farrahrina@uitm.edu.my)

To Link this Article: <http://dx.doi.org/10.6007/IJARBSS/v12-i9/14752>

DOI:10.6007/IJARBSS/v12-i9/14752

*Published Date: 21 September 2022*

## Abstract

Every project involved in oil and gas fabrication erected onshore usually experiences cost overruns if lack of monitoring. This cost overrun is closely related to the use of machines, manpower, methods, money, and materials (5M) in order in a project where all these resources require a good financial cycle. However, these cost overruns often occur due to improper management planned resource allocation from 5M. Therefore, this study was aimed to examine the importance on management of resource allocation control from cost overruns specifically in oil and gas fabrication projects as a preliminary study. Semi-structured interviews were conducted with ten (10) qualified specialists in Engineering Procurement Construction (EPC) projects from the Oil and Gas industry. Among the importance that contribute to project controlled are spending within budget, financial control meeting project value, optimizing usage of materials, sufficiently manage machinery and manpower to match project goals. The networks with the ATLAS-ti, it was discovered that money had a greater impact on the allocated resources, and the issue of budget or money allocation that does not meet project requirements is a major issue that led to cost overruns.

**Keywords:** Cost Overrun, Resource Allocation 5M, Engineering Procurement Construction (EPC), Oil and Gas Fabrication Megaprojects

## Introduction

The oil and gas industry is one of twelve (12) National Key Economic Areas (NKEA) identified by Malaysians as globally competitive and serving as the primary driver of economic growth. Upstream, midstream, and downstream are the three segments of the oil and gas industry (Ismail, 2019). Petroliaam Nasional Berhad (PETRONAS) manages Malaysia's petroleum

resources (PETRONAS, 2019). Development and Production (D&P) combines development and production functions for Malaysian assets, international assets, and Centers of Excellence (CoE), resulting in the execution of world-class operations values (PETRONAS, 2019). As part of the Oil and Gas Fabrication project, several structures are delivered to meet the needs of customers all over the world. The Oil and Gas Project investigates the concept's definition, application, and stages of development. Regardless of the Oil & Gas fabrication project, there are numerous factors that influence the overall cost of the project. Due to their complexity and financial requirements, large construction projects have drawn the attention of many scholars (Derakhshanlavijeh, 2017). As a result, onshore fabrication projects for the oil and gas industry typically necessitate a significant capital investment. Direct activities are defined by discipline or scope, whereas indirect activities are determined by the planning and execution stages of the construction phase (Suppramaniam, 2019). Fabricators manage the way they acquire materials and manpower to maximise project value while profiting from Engineering, Procurement, and Construction (EPC) project activities, according to (Aldhaferi et.al., 2016). Currently, during fabrication operations, there is a lack of project management and cost monitoring of resource allocation, and contractor site management and financial management are considered separately. These issues must be addressed in order to keep construction costs under control (Rahman, 2013). The construction industry in Malaysia helps the country's economy grow and develop. Despite this, cost overruns are common in the sector, such as negative cost variances, in which the total cost of the project exceeds the agreed-upon amount (Shehu, 2014). According to Shah, the leading causes of Malaysian project delays and cost overruns are poor contractor planning, poor site management, and poor contractor experience (Shah, 2016).

The main contractors or fabricators in the Oil and Gas structure are also entitled to cost overruns and delays that have an adverse effect on their profit, satisfaction, and reputation. Cost overruns are common in the construction industry, and the Oil and Gas fabrication project is no exception, with cost overruns caused by poor resource management. Cost overruns continue to be a major concern in Malaysian oil and gas megaprojects, according to Suppramaniam and Ismail (Suppramaniam, 2019). The integrated in-house service for Project Management, Procurement, Engineering, Construction/Fabrication (EPC) is then provided through a variety of high-quality project fabrication activities. By emphasising planning, human resources, and performance monitoring, the various phases of oil and gas fabrication project processes are improved (Suppramaniam, 2019). The study's findings can be used as guidelines for managing EPC projects, particularly Malaysian EPC projects in the oil and gas industry, to avoid and reduce cost overruns. The ATLAS.ti software was used to analyse qualitative data extracted from interview transcripts in order to gather information on the issue of resource allocation in an onshore oil and gas fabrication project.

For conclusion of this preliminary study on cost overruns in Engineering Procurement Construction (EPC) fabrication oil and gas megaprojects in Malaysia, this study is aimed:

- To examine the importance of management of resource allocation control from cost overruns in oil and gas fabrication projects.
- Semi-structured interviews were conducted with ten (10) qualified specialists in Oil and Gas Engineering Procurement Construction (EPC) projects.

- It was discovered that money had a greater impact on the allocated resources in the networks with the ATLAS-ti, and the issue of budget or money allocation that does not meet project requirements is a major issue that led to cost overruns.

### **Research Methodology**

The first phase entails going over previous literature reviews based on the field of study. The goal of a literature search is to learn about current cost issues while also identifying the problem and research gap. As a result, a comparable research area was conducted by synthesising the results of a literature search on identifying importance in managing the oil and gas industry with a focus on onshore fabrication of oil and gas megaprojects in Malaysia. This stage extracts resource allocation issues and contributing factors related to managing oil and gas projects in resource allocation fulfilment. Journals, articles, conference papers, annual reports, and books will be used as secondary data sources for this study (Brinkmann, 2018). The comparable research area's purpose in identifying the resource management issue concluded by Farrah et al asserted that the increase in costs occurred primarily due to a lack of managing resources and poor resource allocation, was identified at the procurement level (Rina, 2021). As a result, qualitative research methods based on case studies were chosen because they are detailed, rigorous, and systematic while still allowing for flexibility and freedom (Farrah Rina, 2021). The case study analyses the cost overrun issue in four major stages, beginning with the creation of open-ended questions and ending with the analysis of survey data (Brinkmann, 2018).

#### *(1) Study on Malaysia oil and gas EPC project*

Some of the reasons why extensive research on Malaysia oil and gas EPC projects is required are as follows:

Natural gas and petroleum EPC projects are large-scale EPC projects carried out in a complex and demanding international environment. EPC execution is accelerated, taking anywhere from a few months to two or three years. The project management team is made up of individuals from various backgrounds, levels, and hierarchies. There are several approaches to project management (Ban,2017).

#### *(2) Questionnaire survey draft*

Interviews with ten (10) randomly selected experts with experience in EPC projects were conducted using open-ended questions (Ban,2017).There are three (3) Engineering experts, four (4) Procurement experts, and three (3) Construction experts for oil and gas fabrication projects to support the data of the research problems and issues. The interviews were conducted until saturation was reached. By analysing the data using open coding, axial coding, and selective coding, the case study was used to strengthen the issues of cost overruns in the oil and gas industry in resource allocation (Rina et.al, 2021; Flick et.al, 2018).

The opening interview question were as follows:

Q1. Determine the importance of resource allocation management (5M) in EPC Onshore Fabrication projects.

The interviewees were informed of the study's purpose as well as the significant effect(s) of common resource allocation issues that result in cost overruns on EPC project performance allocation (Rina, 2021).

*(3) Semi-Structured Interview Form distribution and interview*

Semi-structured interviews and a literature review were also used to collect data from a variety of sources, including engineering, procurement, and construction (EPC) experts (Uwe Flick, 2018). A questionnaire was created for this study that focused on respondents' ideas and opinions on resource allocation issues in EPC projects. Interviews with qualified individuals with EPC project experience were taped.

The following criteria were used to select the participants:

- Engineering, Procurement, and Construction (EPC) Project Team for fabrication projects.
- Individuals involved in Onshore Fabrication Projects that operate on land rather than offshore.
- Individuals who work on Engineering, Procurement, and Construction (EPC) contracts].

*(4) Survey data collection and organising*

All survey data (document numbers) were collected. The survey data was collected by hand by the interviewees. The information was then converted to text format for further analysis. The survey data was transferred and organised into a formatted Excel spreadsheet, with column prefix headings indicating the required variable to be highlighted in the research (Susanne Friese, 2019).

*(5) Data Analysis via ATLAS.ti*

Thematic analysis was performed on all of the formatted and organised survey data using the ATLAS.ti software version 9 [14]. The interviewee information was analysed using a coding process to determine the significant impact of resource allocation issues on EPC project performance (Rina, 2021). The methodology presented in the manuscript exemplifies one method for using qualitative data analysis on survey data. Methodology, Findings, and Discussion sections were organised according to each step of the assessment process, allowing readers to clearly understand how the data was processed and follow the implications of the process and results (Rina, 2021).

**Result and Discussion**

Malaysia's construction industry propels the country's economic growth and development. Cost overruns are unavoidable in industrial projects. Cost overruns are defined as a negative cost variance in which the total project cost exceeds the contract amount (Shehu, 2014). Prior literature on the chosen topic must be reviewed in order to further investigate this issue. This identified importance necessitate the creation of a distinct strategy centred on project cost monitoring and control. Aside from the issues, factors that contribute to cost overruns were identified. The following are the findings on contributing factors:

- Inadequate material procurement management
- Inaccurate cost estimates
- Inadequate planning
- Frequent design changes
- Insufficient labour/skill availability, Machinery, and labour cost inflation

Meanwhile, Rahman et al. claimed that cost overruns occur as a result of unpredictability in material prices, cash flow problems with contractors, and poor management site supervision (Rahman, 2013). To successfully complete a project, resource planning, resource monitoring, and cost control are all critical aspects of oil and gas project

management. As a result, qualitative data from interviews were analysed in accordance with the case study's coding stages in order to identify resource factors that have a significant impact on project performance in oil and gas EPC projects. The insights gained from interviews that addressed the typical qualitative study's how and why questions.

(1) *Finding analysis Importance encountered during managing resource allocation involving Project Team*

The ATLAS.ti analysis identified five resources on each issue: method, money, machine, manpower, and material. Figure 1 depicts the discovery of the issues and their significance.

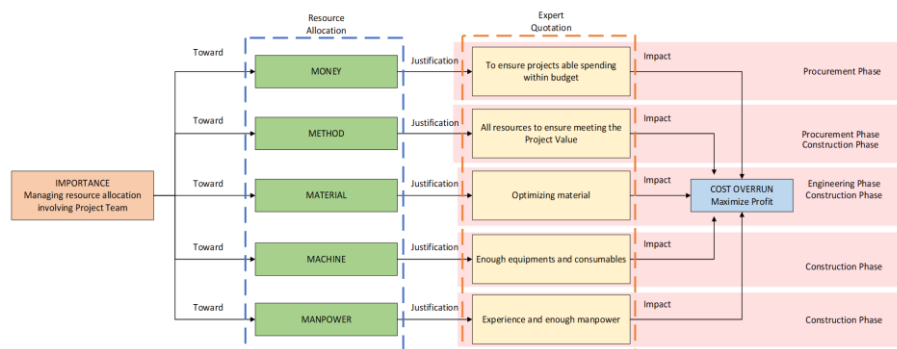


Figure 1. Resource Allocation Importance network on onshore fabrication project.

Based on the findings of the Importance on the Resource Allocation of the EPC Onshore Fabrication Project, it is possible to conclude that every resource influences the cost overrun of a project. The resource allocation method's management discussed how the available resource allocation was not optimised because construction management did not assign it consistently. Another effect of the delivery period was that the time work and manpower hours increased as the cost of other resources increased concurrently. Aside from that, the price of materials that were not available in the local market had an impact on the project cost, as the price of the materials exceeded the allocated budget. Furthermore, due to a lack of appropriate skilled resources in completing the fabrication project, there was a high demand for highly skilled workers, which would also have an impact on the cost overrun. Money had a greater impact on the allocated resources, according to the discussed and analysed networks as processed by the ATLAS.ti software. A major issue that drives procurement is budget allocation that does not meet project requirements, resulting in cost burst and fabrication project cost overrun in Figure 1.

Table 1

*Co-occurrence Importance of Resource Allocation in Fabrication Project*

CO-OCCURANCE (IMPORTANCE)	RESOURCE ALLOCATION				
PHASE PROJECT	MACHINE	MANPOWER	MATERIAL	METHOD	MONEY
Construction Phase	0	2	1	7	<b>2</b>
Engineering Phase	0	0	1	5	<b>1</b>
Procurement Phase	<b>1</b>	<b>2</b>	<b>4</b>	<b>5</b>	<b>11</b>

As shown in Table 1, the expert's analysis of the importance of resource allocation management revealed that the most common occurrences highlighted by the expert were

allocation of funds, which involved procurement phase management, being the most affected in the fabrication project than engineering and construction. As the expert mentioned, it is critical to ensure that the project can spend within budget to achieve efficiency and meet money allocations while minimising profit and illuminating cost overruns. Money, according to Alnoor Akberali Halari's research, would burst the cost overrun (Halari's, 2012). He also stated that purchasing equipment and materials accounts for approximately 35% of the total cost of an oil and gas project (Halari's, 2012). Construction, on the other hand, accounts for roughly half of total spending, making cost-cutting efforts critical (Halari's, 2012).

Following the resolution of these recurring issues in practise, the next step in this research is to better understand the effects of cost increases during the procurement phase. Fabricators may benefit from this research by increasing their profit margins. Contracting and subcontracting principles govern onshore erection, whereas procurement is concerned with cost estimation and control in a complex environment (Ajator, 2014). Project management entails effectively managing, allocating, and scheduling resources in order to meet specific objectives. In science, technology, and engineering, project management in the oil and gas industry is extremely valuable (Al Subaih, 2015). In general, the project life cycle determines the resources required in each phase as well as the specific work that will be completed in each phase. Kannimuthu et al. imply that different execution plans are possible by varying fabrication methods, materials, and crew sizes (Kannimuthu, 2019). Each project has activities that distinguish it from others in terms of project characteristics (Badiru, 2016). Preliminary requirements costs are typically determined using information provided by project management plans, charters, the enterprise's environmental factors, and organisational process assets, according to Loch et al (loch, 2007). The goal of planning is to ensure that all activities required to meet project goals are completed on time, on budget, and to a high standard.

## **Conclusion**

This study's significance has contributed to a better understanding and new knowledge about cost overruns that occur during resource allocation. An exploratory analysis of the resource allocation process for onshore fabrication for oil and gas will fill the knowledge gap by identifying contributing solutions in protecting the project from cost overruns using decision making theory. As a result, future research must look into the cost components of resource allocation. This study will assist practitioners, organisations, and stakeholders in the Engineering, Procurement, and Construction (EPC) fields in achieving success based on resource-based view theory, which represents the organisational performance focus in controlling cost overruns related to return on investment. All significant cost overrun issues were identified using case study methodologies and data analysis. Semi-structured interviews were conducted to confirm the issues that arose during the coding process to arrive at the final results. According to the interviews with ten specialists who work on EPC projects, the most important resource allocation is managing money and maximising all resources. These qualitative findings, along with the findings of this research, can be used by EPC management to develop a resource-based framework for improving EPC project performance, particularly in cost control. The data analysis using ATLAS.ti qualitative software revealed that every resource influences the cost overrun of a project. The primary causes of the cost increase were insufficient resource management and allocation, which were inconsistently assigned by construction management.



Furthermore, it is widely acknowledged that financial resource management has an impact on all allocated resources. Given the study's limitations, the following areas of potential future research are highlighted. Because this study focuses solely on EPC projects in Malaysia's oil and gas sector, the effects of variances in other countries were not discussed. Given the current issues with cost overruns in managing resource allocation in the context of 5M, this study recommends additional research on project methodologies. Making strategies based on the issues discovered can assist EPC projects in more effectively managing resources.

### Acknowledgments

The authors are thankful to the Centre of Graduate Studies, Universiti Teknologi MARA (UiTM) Perak Campus Seri Iskandar for knowledge contribution and to all respected participants who are willing to participate in this research.

### References

- Azadeh, A., Shabanpour, N., Gharibdousti, M. S., and Nasirian, B. (2016) Optimization of supply chain based on macro ergonomics criteria: A case study in gas transmission unit, *J. Loss Prev. Process Ind.*, 43, 332–351, doi: 10.1016/j.jlp.2016.05.024.
- Halari's, A. A. (2012) *Effective Project Management of Oil & Gas Projects: A Model for Oil Sands'SAGD Plants*, Library and Archives Canada, Bibliothèque et Archives Canada, ISBN 0494752645, 9780494752647
- Al Subaih, A. (2015). *Integrated Project Delivery: A Paradigm Shift for Oil and Gas Projects in the UAE and the Middle East Region. Oil and Gas Facilities.* <https://doi.org/10.2118/171722>
- Badiru, A. B., & Osisanya, S. O. (2016). *Project Management for the Oil and Gas Industry.* In *Project Management for the Oil and Gas Industry.* <https://doi.org/10.1201/b13755>
- Derakhshanlavijeh, R., & Teixeira, J. M. C. (2017). Cost overrun in construction projects in developing countries, Gas-Oil industry of Iran as a case study. *Journal of Civil Engineering and Management*, 23(1), pp 125–136, doi.org/10.3846/13923730.2014.992467
- Roshdi, F. R. M., Ismail, K., Lop, N. S., and Ab Wahab, L. (2021) Conceptual framework of resource-based cost allocation at procurement phase for onshore fabrication oil and gas project, *The 5th International Conference on Rebuilding Place, IOP Conf. Series: Earth and Environmental Science* 881 012021, doi:10.1088/1755-1315/881/1/012021.
- Rahman, I. A., Memon, A. H., and Karim, A. T. A. (2013) Significant factors causing cost overruns in large construction projects in Malaysia, *J. Appl. Sci.*, (13)2, 286–293, doi: 10.3923/jas.2013.286.293.
- Kannimuthu, M., Raphael, B., Palaneeswaran, E., & Kuppaswamy, A. (2019). Optimizing time, cost and quality in multi-mode resource-constrained project scheduling. *Built Environment Project and Asset Management*, 9(1), 44–63. <https://doi.org/10.1108/BEPAM-04-2018-0075>
- Loch, C. H., De Meyer, A., & Pich, M. T. (2007). *Managing the Unknown: A New Approach to Managing High Uncertainty and Risk in Projects.* <https://doi.org/10.1002/9780470172377>
- Shah, R. K. (2016) An Exploration of Causes for Delay and Cost Overruns In Construction Projects: Case Study of Australia, Malaysia & Ghana, *J. Adv. Coll. Eng. Manag.*, doi: 10.3126/jacem.v2i0.16097.

- Brinkmann, S., Kvale, S. (2018), *Doing Interviews (Qualitative Research Kit) Second Edition*, SAGE Publications, ISBN 1473912954, 9781473912953.
- Susanne Friese. (2019), *Qualitative Data Analysis with ATLAS.ti Third Edition*, SAGE Publications, ISBN: 9781526458926.
- Ismail, S., Abd, H., Sabri, R., Berhad, P. N., Rahman, A., and Rahim, A. (2014). Project Management of Oil and Gas Project in Malaysia Project Management of Oil and Gas Project in Malaysia
- Suppramaniam, S. U. K., and Ismail, S. (2019). Critical Construction Activities of the Oil and Gas Projects in Malaysia, 1(1), 9.
- Flick, U. (2018), *Designing Qualitative Research (Qualitative Research Kit) Second Edition*, SAGE Publications, ISBN-13: 978-1473911987
- Ajator, O. D. U. (2014). Costing of Oil and Gas Projects for Efficient Management and Sustainability. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, 8(12), 70–84. <https://doi.org/10.9790/2402-081217084>
- Shehu, Z., Endut, I. R., Akintoye, A., and Holt, G. D. (2014) Cost overrun in the Malaysian construction industry projects: A deeper insight, *Int. J. Proj. Manag.*, doi: 10.1016/j.ijproman.2014.04.004.