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**Department of Built Environment Studies & Technology (JABT),
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Resource Allocation Towards Engineering Procurement Construction (EPC) Fabrication Oil and Gas Megaprojects: Exploring Issues on Cost Overrun

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Abstract

Nowadays, cost overrun is prevalent in building construction, infrastructure and oil and gas construction projects. In general, successful project management is a project that can manage resources well according to the project's needs. However, cost overrun can occur due to a lack of management in allocating resources to the correct activities in projects when they are operated. The resources commence with money or capital involving machinery, manpower, and materials to the right method arranged at the Procurement Phase. However, due to the adverse economic conditions and circumstances of the Malaysian oil and gas sector, it is vital to minimize costs, control costs and realign organizational mission towards resource allocation management. Thus, an optimal resource allocation must be made on a cost-effective basis to avoid cost overruns. Therefore, this research aims to explore several previous works of literature on oil and gas fabrication projects management, focusing on issues of cost overrun across the globe. The data was gathered from earlier studies on cost overrun in Oil and Gas megaprojects. The exploration revealed the primary relative importance of the theoretical framework; in the context of the Oil and Gas Industry by a country that focuses on cost overruns issues. This research is expected to raise concerns about the importance of resource allocation management, which is experiencing cost overrun of Oil and Gas Fabrication projects.

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

1.0 Introduction

Projects in the oil and gas industry are characterized by huge investments, massive interfaces and complex engineering endeavors. The size and complexity of these projects require special attention in the project management process. According to Ismail et al. (2014), typical onshore fabrication projects usually have many sub-scopes, such as upstream, midstream, and downstream. A complete range of high-quality project fabrication provides a high standard integrated in-house service on Project Management, Procurement, Engineering, Construction/Fabrication (EPC), Commissioning, and Installation (Suppramaniam & Ismail, 2019). The processes of oil and gas fabrication projects by improving the different phases emphasize planning, human resources, and monitoring performances (Suppramaniam & Ismail, 2019). But on the contrary, inefficient allocation of resources can result in delays and high costs of money. Suppramaniam and Ismail (2019) highlighted that the excess cost persists as a significant concern within oil and gas fabrication megaprojects in the Malaysian context. The main contractor or fabricator in the Oil and Gas structure also deserves cost overrun and delays that negatively impact their profit, business satisfaction, and reputation. The oil and gas industry covers three main sectors: upstream, midstream, and downstream sectors. As mentioned earlier, fabrication projects for the sectors occur in onshore fabrication yards and typically have many activities (Ismail et al., 2014). The Oil and Gas Fabrication project delivers several structures to satisfy customers from all over the world. In general, onshore fabrication projects for the Oil and Gas industry tend to be significant in their capital size. Direct activities are based on discipline or scope, while indirect activities

are raised during the construction phase, which is contained in the planning and execution stages (Suppramaniam & Ismail, 2019). In contrast, Aldhaheeri et al. (2018) claim that fabricators aim the profit from activities involved in the EPC project with caution on managing the procurement of materials and labour towards project value.

Lack of project controlling and monitoring the element of cost in resource allocation during fabrication activities. Factors fall into two categories, namely, contractor site management and financial management category. Therefore improvements in these categories are essential to control rising costs in construction projects (Rahman et al., 2013). The construction industry drives economic growth and development in Malaysia. Still, unfortunately, its projects often suffer from cost overruns, such as negative cost variance such that the final project cost exceeds contract sum (Shehu et al., 2014). Shah (2016) stated that improper contractor planning, poor site management, and inadequate contractor experience are the most driving factors causing project delays and high costs in Malaysia. However, as per Rahman et al. (2013), megaprojects cost overrun due to fluctuation of material prices, contractors' cash flow difficulties, and poor site supervision in management.

In every decision-making situation, managers are expected to control the magnitude of the costs incurred. Specifically, the manager must ensure that: (1) Material price obtained as low as possible; (2) Quantity of materials used during production should not be excessive; (3) The labour cost incurred corresponds to the output achieved; and (4) Production rate handled by employees must be the ones that will reach the targeted level of production (Cletus & Thankgod, 2015). Therefore, this research aims to explore several previous works of literature on oil and gas fabrication projects management focusing on cost overrun across the globe.

2.0 Literature Review

2.1 Overview of Oil and Gas Projects Globally

Development and Production (D&P) include consolidation of development and production functions for Malaysian Assets, International Assets, and Centers of Excellence (CoE), which provides world-class value implementation of operations (PETRONAS, 2019). The fabrication of the platform falls under the Development stage for production operations. In 2019, PETRONAS contributed more than RM285 million to various corporate social responsibility (CSR) initiatives and programs in Education, Social Welfare and Development, and the Environment. Petronas has custody of petroleum resources in Malaysia (PETRONAS, 2019). The oil and gas sector is among 12 sectors determined by Malaysians to be competitive worldwide and act as the main engine of economic growth under the National Key Economic Area (NKEA). The oil and gas sector is a so-called "multi-billion dollar megaprojects" common in today's industry. The oil and gas industry is essential to the growth of the economy for Malaysia. The project under the Oil and Gas platform development needs to be well managed to avoid cost overrun. The Oil and Gas Project reviews the definition, scope, development phases, and theory adaptation. Large construction projects, with features of complexity and capital requirements, have attracted the interest of many researchers, which addresses crucial problems in cost, as Figure 1.



Figure 1. Overview of Fabrication Oil and Gas Projects that involved Resource Allocation (Money, Material, Machinery, Manpower, and Method) as per project requirements.

2.1 Issues in Oil and Gas Project Management

The planning and managing resource allocation for the secured project is a critical part of any oil and gas project. Meanwhile, it is critically important to proactively manage the transition from planning to construction. According to Badiru and Osisanya (2016), in Oil and Gas project development, allocation of resources starts from money or capital, including allocation of machinery, manpower, and materials. Efficient allocation of resources for fabrication activities requires planning to determine cost-effectiveness (Olsen et al., 2005). On the contrary, inefficient allocation of resources can result in delays and high costs. Al Subaih (2015) asserted that among the factors that cause money to be lost in project implementation are additional expenses for equipment or machinery, materials, recruitment and loss of time for contractors. Most of the causes of rising costs are related to poor resource management (Aljohani, 2017). The time duration of the activity is influenced by the selection of construction methods, materials, and crew size (Kannimuthu et al., 2019). These factors will affect the implementation of the project. One of the potential solutions to reduce the impact of excess cost in fabrication projects is the insertion of adequate resources management systems at the procurement phase in the construction projects.

Therefore, resources allocation management at the early stage, especially during procurement, is essential because it will smoothen the construction phase according to the contract. According to Chavan et al. (2020), the procurement functions in the Engineering Procurement Construction (EPC) project have undergone a significant transformation and now play an essential role in determining profits. Thus, procurement refers to obtaining goods and or services and the processes required to meet the organization's needs (Andersson & Norrman, 2002). Alnoor Akberali Halari (2010) stated that approximately 35% of the oil and gas project's costs are spent on procuring equipment and materials. About half go towards construction, thus making it a key area of focus for cost-effectiveness.

Developing a better understanding of the origins of cost increases in the Procurement phase is the first step to overcoming this recurring problem in practice. This research potentially assists in raising profitability margins for fabricators. Procurement strategy in cost estimates and control on the complex context while onshore erection operates in contracting and subcontracting philosophies O. Ajator (2014). Project management involved managing, allocating, and timing resources to achieve specific goals efficiently. The application of project management in the oil and gas industry is of exceptionally high value in science, technology, and engineering (Al Subaih, 2015). In general, the life cycle of a project determines the resources that will be needed in each phase and specific work to be completed in each phase of the project life cycle. Kannimuthu et al. (2019) express that many execution plans are possible by taking different fabrication methods, materials and crew sizes. Each project involves activities that define differently from other projects in terms of project characteristics (Badiru & Osisanya, 2016). Loch et al. (2007) mentioned that preliminary requirements costs are usually determined by the information provided through project management plans, charters, enterprise's

environmental factors, and organizational process assets. The essence of planning is to ensure that the activity necessary to achieve project objectives includes time, cost, and quality.

3.0 Methodology

The first phase is exploring the literature reviews from the specified field of study by the previous researchers. The importance of literature search is to gain the current issues incurred on cost while determining the problem and research gap. A similar area of study is required to capture the issues in managing the oil and gas industry with various oil and gas megaprojects. At this stage, exploring the issues in managing resource allocation and contributing factors related to managing oil and gas projects in fulfilling the resource allocation are extracted. The secondary data sources for this research will be collected from journals, articles, conference papers, annual reports, and books.

4.0 Result and Discussion

Table 1 shows the summary of cost overrun existence in oil and gas megaprojects experienced by Korea, Iran, Australia, Malaysia, and Norwegian. Most of these countries are experienced in managing cost overrun in oil and gas projects. Among all, Iran is a country that is rapidly developing and involving oil and gas megaprojects. With their complexity and capital requirements, large construction projects have attracted the interest of many researchers who address significant issues in cost and time management methods and suggest new techniques for controlling them in construction projects (Derakhshanlavijeh & Teixeira, 2017).

Table 1. Cost Overrun Existence for the Oil and Gas megaprojects worldwide

Authors	Country	Issues on oil and gas management reported	Contributing Factors	Oil and Gas Industry	Focus area
Jo et al. (2018)	Korea	<ul style="list-style-type: none"> ● mismanagement of the project schedule ● Theory of Constraints (TOC) 	<ul style="list-style-type: none"> ● material procurement management ● resource competition ● buffer management. 	Offshore EPC project (fabrication of oil and gas production facilities)	Offshore fabrication
Derakhshanlavijeh & Teixeira, (2017)	Iran	<ul style="list-style-type: none"> ● Project Management 	<ul style="list-style-type: none"> ● inaccurate cost estimations, ● improper planning, ● frequent design changes, ● inadequate labour/skill availability, ● inflation of costs of machinery, labour, ● raw material and transportation prices 	Gas-Oil construction projects	Fabrication projects
Olaniran et al. (2015)	Australia	<ul style="list-style-type: none"> ● Chaos theory on cost overrun 	<ul style="list-style-type: none"> ● Sensitive Dependence on Initial Conditions ● Positive Feedback, Mechanism ● Strange attractors 	Oil and Gas megaprojects	Hydrocarbon megaprojects
Suppramaniam & Ismail, (2019)	Malaysia	<ul style="list-style-type: none"> ● Expedite activities at the construction phase 	<ul style="list-style-type: none"> ● Direct Activities ● Indirect Activities 	Oil and Gas megaprojects	Project Management at the construction phase
Lorentzen (2017)	Norwegian	<ul style="list-style-type: none"> ● project size is the most frequently used explanatory variable 	<ul style="list-style-type: none"> ● Diversion ● Complexity ● Priority 	Oil and Gas megaprojects	Petrochemical projects

Cost overruns in projects have been studied extensively throughout the decades. Cost overruns are crucial issues whereby most Korean EPC contractors are currently experiencing huge deficits and losses in implementing mega offshore EPC projects of fabrication of oil and gas production facilities (Jo et al., 2018). Consequently, issues of mismanagement of the project schedule and application Theory of Constraints (TOC) have raised factors in managing material procurement, resource competition, and buffer management. From this can be considered resources allocation shall be controlled in the quick to catch the project timeline. Thus, effective decision making needed to recover all the constraints.

Excess costs in fabrication projects are a common problem affecting project performance, and Gas-Oil construction projects in Iran are no exception (Derakhshanalavijeh & Teixeira, 2017). Thus, the issues are from the project management and contributing factors by inaccurate cost estimates, improper planning, frequent design changes, inadequate labour/skill availability, inflation of machinery, labour, raw material, and transportation prices. Hence, resources management is the request for manpower, material machinery, and the method starts with money that will run the project's cost either to be a success or not in controlling considerations and strategies.

In fact, during 2012, companies such as Chevron, Woodside, BG, Santos, and Exxon Mobil experienced a total of \$25 billion in cost overruns in Australia alone (Olaniran et al., 2015). He also claimed that cost overruns are a persistent problem in oil and gas megaprojects. Thus, the Chaos Theory in project management knowledge can be considered for any type, location, size, scope, time and costs, and critical concepts. Large construction projects with features of complexity and capital requirements have attracted the interest of many researchers, which addresses fundamental problems of cost. The issue contributes to sensitive dependence on initial conditions, positive feedback and mechanism strange attractors. The issues and contributing factors represent the chaos of managing the project and resources on the operation of each task.

Lorentzen (2017) reported an average cost overrun of 64% on global projects in the oil and gas industry. Over the past decade, EPC (Engineering, Procurement, and Construction) megaprojects (> 1 billion USD), especially in the petrochemical and oil and gas industries, have been experiencing issues on project size that are contributing factors to diversion, complexity, and priority. Often, these loads and delays impressed the contractor. Delay factors are generally and applicable to most projects, grouped under eight major categories namely: (1) project-related; (2) client-related; (3) design team-related; (4) contractor-related; (5) materials; (6) labour; (7) plant/equipment; and (8) external factors. These factors represent some intrinsic project features, which clients, consultants, and contractors control. Consequently, project size and complexity require engineering expertise and all stakeholders to work in dynamic management to achieve project success in project management.

Cost overrun is a global phenomenon in the construction industry. Cost overruns persist as a significant concern within oil and gas megaprojects in Malaysia's overview, as Suppramaniam and Ismail (2019) highlighted. Subsequently, the range of high-quality project fabrication activities provides a high standard integrated in-house service on Project Management, Procurement, Engineering, Construction/Fabrication (EPC), Commissioning, and Installation. The processes of oil and gas fabrication projects improve the different phases, emphasizing planning, human resources, and monitoring performances (Suppramaniam & Ismail, 2019). The researchers contribute to the direct and indirect activities involved in the projects. As a result, in project operations, the first step is to identify the activities engaged in discovering resources represented at each milestone, whether direct or indirect.

The construction industry drives economic growth and development in Malaysia. Unfortunately, its projects often suffer from cost overruns, which negative cost variance such that the final project cost exceeds the contract sum (Shehu et al., 2014). On the other hand, the main contractor or fabricator in the oil and gas projects rationalizes avoiding cost overruns and delays that affect their profit, company satisfaction, and reputation. To sum up, the findings obtained from the literature search on the issues in managing oil and gas projects that are focussing on cost overrun are as follows:

- i) Mismanagement of project schedule
- ii) Project size and complexity
- iii) Expediting the resources towards the construction phase reflected in activities

The above-mentioned issues necessitate a unique strategy and concentration in monitoring and controlling the project cost. Accordingly, factors contributing to cost overrun have also been identified. The findings on contributing factors are listed as follows:

- i) Material procurement management
- ii) Inaccurate cost estimates
- iii) Improper planning
- iv) Frequent design changes
- v) Inadequate labour/skill availability,
- vi) Inflation of the expenses of machinery and labour

Identifying these factors is very important to oil and gas project management, mainly in planning resources, monitoring allocated project resources, and controlling project costs to achieve project success.

5.0 Conclusion

The significance of this research has contributed to improving the understanding and knowledge of cost overrun. Therefore, an exploratory analysis of the resource allocation process for onshore fabrication for oil and gas will fill the knowledge gap by identifying the contributing factors to cost overruns in a project. Based on the results, the increase in costs mainly occurred due to a lack of managing resources and poor resource allocation, especially at the procurement level. Hence, it is essential to explore the cost elements of resource allocation in future studies. This research will be valuable to the onshore fabricator’s practitioners, organizations, and stakeholders specifically involved with Engineering and Construction/ Fabrication.

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Tarikh : 20 Januari 2023

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Tuan,

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Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

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Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
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