

Enhancing Materials Procurement Efficiency in Oil and Gas Projects

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Abstract: Materials procurement in oil and gas projects is a critical element of effective project management, primarily due to its substantial direct and indirect impacts on schedule and cost control. This paper explores how an effective materials procurement control can lead to improved project completion schedule, cost management, and quality control. It identifies key challenges such as limited vendor options, geopolitical influences, raw material price volatility, and stringent local content requirements. The paper emphasizes the necessity of a strategic approach to procurement, which includes diversifying the vendor list, fostering strong vendor relationships, standardizing material specifications, and conducting comprehensive risk assessments. Additionally, it highlights the role of advanced technologies, such as Enterprise Resource Planning (ERP) systems, Digital Twins, and Artificial Intelligence (AI), in streamlining procurement processes, optimizing inventory management, and enhancing inspection efficiencies. By adopting these strategies and technologies, oil and gas companies can effectively navigate through the project complexities and achieve the targeted successful outcomes.

Keywords: critical element, Oil and Gas Projects, Digital Twins, Artificial Intelligence (AI).

1. INTRODUCTION

Materials procurement in oil and gas projects represents the backbone of project scheduling where an effective control of materials procurement requires strategic and detailed planning that begins at the initiation stage of the project. Additionally, the process of materials procurement in oil and gas projects is complex due to the extensive network of suppliers, stringent quality requirements, and the necessity to adhere to tight schedules.

This paper will explain the importance of effective material control and address the main challenges encountered in materials procurement for oil and gas projects. Moreover, it will examine strategic approaches for managing procurement and explore how advanced technologies can enhance materials procurement in oil and gas projects.

Importance of Effective Material Procurement Control

Effective procurement is the most vital factor for a project to be successful in oil and gas fields. This is mainly due to the large volume of the required outsourced materials, coupled with the typical tight overall project schedule (3-5 years) and stringent quality demands. According to Rashid (2020), the material related delays such as material shortage, poor material quality, delay in delivery of material is the main causes of delay in projects.

The delays in material delivery can trigger a domino effect, considering the heavily interconnected links in the typical schedule of oil and gas project which may lead to missed revenue opportunities or costly claims and disputes. On the other hand, efficient procurement management through a standardized process can ensure on-time delivery, minimize costs, and avoid quality issues. Through an effective and streamlined process of materials procurement, oil and gas companies can navigate through the complexities of their projects and achieve the targeted successful outcomes.

One key aspect of effective procurement is ensuring timely delivery. Oil and gas projects are characterized by interdependent activities and long critical paths. Any disruption caused by late materials delivery can significantly impact the overall project schedule. Furthermore, efficient procurement can save the project from claims and disputes, which are

often complicated due to the involvement of multiple parties like clients, contractors, subcontractors, and vendors, also, the cause of liquidated damages caused by the delay varies rapidly between each stakeholder (Harris, 2021). In addition, effective quality management within the procurement cycle is as important as the other aspects such as the schedule and costs. This directly impacts safety, operational reliability, and long-term maintenance costs. High-quality materials minimize the risk of equipment failures and unplanned downtime, ultimately leading to lower overall expenses (Salawu, 2023).

Key Challenges of Material Procurement in Oil and Gas Projects

Oil and gas projects typically feature complicated systems with tailored specifications, large-scale equipment, and a significant magnitude of outsourced and highly interconnected activities. Therefore, managing materials procurement in this field is complex and involves various challenges. The items below identify the main challenges:

Limited Vendors and Suppliers

The oil and gas fields include highly innovative materials that often have very limited vendors to supply them, sometimes resulting in a sole source. In other cases, even with the availability of many vendors to manufacture materials, companies tend to limit the procurement list to a handful of vendors, aiming for consistency and reliability. However, this practice may significantly reduce competition and increase costs, as vendors have less incentive to offer competitive prices. In addition, studies show that the gap between bids increases as the number of bidders decreases (Phillip, 2008). Another aspect is that having limited vendors can risk the project schedule if they are highly loaded or encounter production delays, quality issues, or financial difficulties.

Impact of Geopolitical Factors

Geopolitical factors are becoming more significant these days due to instability in multiple regions around the world. This instability highly impacts shipping prices and schedules as it forces shipping companies to choose different routes. Additionally, the increase in insurance premiums for these risks further affects costs. For example, the cost indicators for shipping containers by sea had risen by over 500% from pre-pandemic levels, and the cost of shipping bulk commodities by sea had tripled for the period between January 2020 and October 2021 (Swallow et al., 2022). These factors substantially influence the overall expenses and logistics of materials procurement in the oil and gas industry.

Volatility in Materials Prices

Volatility in materials prices poses significant challenges for project procurement. Fluctuations in raw material costs introduce uncertainty into project planning. According to Steel Trading Economics (2024), steel prices have varied considerably over the past decade, ranging from a low of \$210 per metric ton to a high of \$750 per metric ton. Given that steel is a primary component in many oil and gas equipment and materials, these fluctuations significantly impact project costs and schedules. Therefore, it is crucial for project teams to carefully consider both the timing of procurement and the terms and conditions of contracts.

Local Contents Requirements

Oil and gas companies often mandate certain percentages of local content in procurement to support their domestic economies. However, striking the right balance between local content and global sourcing imposes a significant challenge as excessive mandates for local content can result in higher costs, delays in delivery schedules, and compromised quality when the necessary expertise is not readily available.

Strategic Approaches to Procurement Management

With oil companies continually investing in capital projects and frequently collaborating with vendors and suppliers, effective materials control in oil and gas projects demands strategic approaches. These approaches must prioritize cost efficiency, quality, reliability, risk management, and timely delivery. Here are some essential strategies that oil and gas companies should consider for their projects.

Diversified Vendor List

A diversified list of qualified vendors and suppliers within oil and gas companies offers many benefits due to competition. Firstly, from a cost-effectiveness perspective, each vendor will try to offer better prices than others to win the contract, as

cost is usually a major factor in awarding contracts. Secondly, it improves scheduling, with suppliers competing to provide more favourable delivery schedules. Additionally, a diversified vendor list grants better access to expertise and innovative solutions.

On the other hand, relying on a single-source vendor may offer a streamlined procurement process and consistent quality and standards; however, it may lead to increased vulnerability to supply chain disruptions and significantly higher cost due to lack of competition.

Relationships with Vendors

Companies should maintain a good relationship with all vendors that are built on trust. This relationship can significantly improve delivery schedules and cost management. Trust between a company and its vendors can be fostered through open communication, which helps identify challenges faced by either party in a specific project. Additionally, mutual respect and timely payments further strengthen this bond, ensuring smoother operations and better outcomes for both parties.

Standardization of Materials Specifications

Standardizing specifications that match international standards and minimize customization will significantly improve delivery schedules. It will reduce review and approval times and attract better interest from global vendors for material manufacturing. Additionally, standardized specifications will significantly reduce errors and rework and will allow for a more systematic process for quality control.

Another major advantage of standardized specifications is that they enable oil and gas companies to build and manage their inventory for critical materials more effectively. With predictable materials, companies can ensure that supplies are readily available when needed. The standardizing materials and purchasing procedures is important and may help firms to meet their materials expenditure targets, and increase the quality of materials, on-time delivery from suppliers, and inventory performance (Rodríguez et al, 2006)

Risk Assessment and Market Analysis

It is crucial for oil and gas companies to have a dedicated risk assessment team capable of analyzing various critical risk factors affecting project procurement and proposing mitigation plans (AlQubaisi et al, 2022). This team shall monitor geopolitical concerns globally, identifying potential risks such as political instability, sanctions, or regulatory changes in key regions. Another major expected outcome from risk team is the analysis of raw material markets, including predicting price fluctuations and assessing global economic conditions. Additionally, the team monitors the financial health indicators of key vendors to anticipate potential difficulties that can impact their ability to deliver materials or services. This proactive approach enables the company to effectively adapt strategies, mitigate disruptions, and maintain project schedules.

Leveraging advanced technology in managing the Procurement

With the complexity of projects, the numerous vendors, and the vast amount of information that needs to be processed, adopting technology within the procurement process of oil and gas fields appears to be the only solution to streamline and manage this complexity. Technology has significantly improved the following aspects:

Centralized Procurement Process

Through advanced software and Enterprise Resource Planning (ERP) systems, the procurement process can be streamlined into a centralized platform that connects clients and vendors, while also integrating with other company functions. (Poon et al, 2010). Clients can submit their requisition requests online, which are instantly accessible by all registered vendors and vendors can then submit their bids through the same platform. This approach significantly improves transparency, reduces costs, and enhances efficiency throughout the entire procurement process, from start to finish.

Optimized Inventory Level

Technology has significantly transformed inventory management. Firstly, it enables real-time tracking of materials and equipment by providing up-to-date information about inventory levels, locations, and conditions. This capability helps reduce the risk of stockouts or overstocking. Another major breakthrough in inventory control is the use of advanced technology to predict future inventory needs by analyzing historical data and market trends. Additionally, technology has

minimized the need for manual data entry by utilizing barcode and QR scanning, thereby enhancing the efficiency and accuracy of inventory management processes.

Emerging Technology: Digital Twin

The digital twin is a revolutionary technology in the procurement of mega projects, primarily because it provides a detailed visualization model of the entire facility before construction begins. This visualization helps in several critical aspects of procurement and project management.

Optimizing Materials Planning and Logistics

The generated 3D model can help the project team accurately determine the types and quantities of materials needed at each phase of construction. Additionally, it aids in visualizing the sizing of major equipment, allowing the project team to better plan the logistics of transportation and installation. This enhanced planning capability ensures that materials and equipment are delivered and installed efficiently, reducing the risk of delays and cost overruns.

Monitoring Material Progress and Real Time Installations

With the support of digital twins, the project team can now remotely visualize the actual progress of construction and materials installation in real time. The model updates in real time as construction progresses, providing accurate insights into project status. The model also facilitates 3D simulation comparisons between the planned progress and the actual progress. By analyzing these models and identifying differences, the team can make informed decisions to optimize workflows, effectively manage resources, and promptly address any deviations from the plan.

Enhancing Inspection Efficiency

Digital twins significantly optimize inspection processes within oil and gas projects. They enable inspectors to remotely inspect equipment, visualize facilities more effectively, compare as-built models with design models, store detailed inspection information, and access material specification details.

Emerging Technology: Artificial Intelligence

Artificial intelligence (AI) has already revolutionized material procurement and will continue to rapidly elevate efficiency within oil and gas projects. This is primarily due to its enormous capabilities in prediction, analysis, and decision-making. Here are some key applications of AI in materials procurement:

Predictions

AI is heavily utilized to predict demand and manage inventory levels for critical materials required in oil and gas projects. It can analyze and forecast market trends and raw material prices with high accuracy. This predictive capability ensures that procurement teams can anticipate needs and secure materials at optimal times, reducing the risk of shortages and cost fluctuations.

Analysis

AI excels in analyzing vast amounts of data within the procurement process of an oil and gas project. It can provide insights into supplier performance, identify delays, and suggest schedule improvements. This analytical power helps procurement teams make informed decisions, optimize supplier selection, and enhance overall project management.

Automations:

AI has the potential to streamline and automate many processes within materials procurement in capital projects. It can automate tasks such as material requisitions and bid analysis which will significantly improving efficiency and reducing human error. However, the application of AI in this field is still not matured compared to its predictive and analysis capabilities.

2. CONCLUSIONS

Effective materials control plays a vital role in the success of oil and gas projects. Achieving this requires strategic planning, risk analysis, and market analysis that are set in place from the early stages of the project. Each project is unique with its own challenges; therefore, a special attention must be given to the details of the materials procurement sub-process throughout the project by implementing an effective tracking mechanism to identify potential delays in any process and

make timely decisions. Additionally, companies should invest in advanced technologies such as digital twins and AI to streamline the procurement process. These technologies enhance efficiency, predict demand, analyze vast data sets, and automate routine tasks. In conclusion, companies can navigate the challenges of procurement, ensuring timely delivery, cost efficiency, and high-quality outcomes through an effective and standardized material control mechanism.

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