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Factor Identification and Mitigation Strategy for the Delay in Project Execution in the Oil and Gas Sector: Using ISM-MICMAC Technique

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Abstract

The oil and gas sector plays a vital role in the Indian economy. It employs a large number of people and makes a significant contribution to the country's GDP. Oil and gas industry projects are huge, multifaceted, and multidisciplinary, requiring considerable time and capital investment. It is common for oil and gas industry projects to face delays. A delay in the project's execution may result in increased expenses, a higher likelihood of material replacements, higher labor costs, an impact on other projects that rely on the delayed project, harm to relationships with stakeholders, and other adverse consequences. Due to the importance of the oil and gas sector and the impact that delays can have on it, it is imperative to assess the reasons for delays in project execution in the Indian scenario. Thus, the present research has focused on determining the factors causing delays in India's oil and gas industry. Further, mitigation strategies will be identified. The research used central tendency tests and interpretive structural modeling (ISM)-MICMAC (Multi-Criteria Decision Making) technique. The study identified the top ten factors causing delays and the corresponding top seven mitigation strategies. The most critical factors (drivers) identified are "bureaucratic government system and long project approval procedure," "improper project feasibility study," and "lack of cooperation from the government." The top five mitigation strategies identified are "Effective teamwork improvement," "Empowerment," "Good relationship with environmental authorities and NGOs," "Detection enhancement for collusive tendering and legal enforcement enhancement," and "High commitment of all people involved."

Keywords

Oil and gas sector, Delays, Mitigation Strategies, Project Execution.

1. Introduction

The oil and gas sector plays a vital role in the Indian economy. It employs large number of people and contributes to the country's GDP. The sector also provides essential raw materials for various industries. The oil and gas sector has been a major contributor to the country's economic growth (Ram Mohan & Kant Yadav, 2021; Vikas & Bansal, 2019). The industry has also helped reduce dependence on imported crude oil and gas. The extraction of crude oil and natural gas represents a significant portion of India's overall economic output. The industry contributes approximately 4% of the nation's overall GDP and is one of the most important sources of government revenue (Kataria et al., 2020). Additionally, the industry is responsible for employing millions of people. The extraction of oil and natural gas in India is a significant factor in the country's overall level of exports. About twenty percent of the nation's total exports come from this industry (Mishra et al., 2013). Crude oil, refined petroleum products, and natural gas are the primary commodities that are exported.

India's economic growth is closely tied to its energy demand. Moreover, its oil and gas requirements are expected to increase further, making this sector hold enormous significance for the nation. As of 2021, India retained its position as the world's third-largest oil consumer (IBEF, 2022). The projects of the Oil and Gas industry are huge, multifaceted, and multidisciplinary, which then require a comparatively long time and a significant capital investment. It is common that projects in the oil and Gas industry face delays. Delays occur in the completion, which range from 5 to 20% of the project duration (Salama et al., 2008).

A delay in the project's execution may result in increased expenses, one of the potential effects of the delay. This is because the longer it takes to complete a project, the greater the likelihood that some materials will need to be replaced or repaired, as well as the fact that labor expenses will increase. Additionally, delays may create disturbances to the project's timetable, which can impact other projects that rely on the delayed project (Honrao & Desai, 2015). Lastly, delays may harm relationships with stakeholders, who may lose faith in the project team's ability to deliver outcomes on time. A lot of unfavorable outcomes may result not only for the company but also for the personnel working on the project if there is a delay. To minimize these adverse effects, it is essential to avoid delays whenever feasible. Various factors may contribute to delays, including the following: scope creep, Insufficient Resources, Difficulties with Dependencies, Poor project management, and ineffective use of available resources (Mohajeri Borje Ghaleh et al., 2021; Muralidhar et al., 2018). The sluggish pace at which projects are being carried out has harmed the environment, making it difficult to invest in India's oil and gas sector. As a result of the delays, several international investors have withdrawn their funding from the projects (Masood, 2019).

It is possible to prevent delays in project execution by employing various strategies (Anugerah et al., 2021). These include ensuring that the project is planned appropriately from the outset, establishing reasonable timelines, and having backup plans in place if unforeseen issues arise. Due to the importance that the Oil and gas sector holds and the impact that delays can have on this sector, it is imperative to assess the reasons for delays in project execution in the Indian scenario.

1.1 Objectives

The study outlines the following objectives.

1. To identify the factors that are responsible for causing delays in project execution in the oil and gas sector in India, using an exhaustive literature review and FGD
2. To identify the critical factors with the help of experts, responsible for delays in the Oil and Gas industry projects in India, using the Delphi method
3. To establish the relationships and categorize the factors into different segments using ISM -MICMAC.

The findings of this research will enhance the Oil and gas industry's understanding of the factors responsible for delays, allowing for more effective addressing of these issues. This will then increase the industry's profit and make resource utilization more sustainable and efficient. This will, in turn, contribute to the nation's overall .

2. Literature Review

In the oil and gas industry, project execution may be delayed for various reasons at any given time. Delays in project execution may be attributed to various factors, but in most cases, they indicate that the project is not progressing as quickly as initially anticipated. This may be the result of multiple concerns, such as issues with the contractor, delays in obtaining clearances, or problems with the project itself (Vlassopoulos et al., 2015). In the oil and gas industry, delays are sometimes caused by the need to obtain permissions or clearances from various government authorities. This process can take anywhere from a few months to several years. Additionally, the sector is subject to different environmental laws, each of which has the potential to delay specific projects.

Oil and gas are a capital-intensive business, and projects sometimes require significant up-front financial commitments. If the necessary funds are not in place, this may cause the project to be delayed. Oil and gas firms may be discouraged from proceeding with projects in a timely manner if the high expenses of exploration, development, and production are taken into consideration. Additionally, the lengthy permitting process for oil and gas projects may create further delays in project completion (Al-Hajji & Khan, 2016). Another factor that may cause delays in oil and gas projects is the unpredictability of oil prices. When oil prices are low, some projects may not be economically viable, whereas when oil prices are high, they may result in cost overruns. These cost overruns may place further pressure on the organization's finances, potentially leading to delays in project execution. Additionally, delays may be caused by geopolitical unrest in areas where oil and gas projects are being developed. Oil and gas production may be severely hindered by insurgent groups, civil conflicts, and international sanctions, all of which can also lead to delays in project implementation (Zadeh et al., 2016).

Second, the sector is subject to various regulatory barriers, each of which has the potential to add a substantial amount of time to the overall project timeframe. Obtaining permissions from multiple government authorities is among the most significant factors contributing to delays in the oil and gas industry. It is very unusual for projects to be delayed for months or even years while the necessary permissions are being obtained, as the process of acquiring licenses can be time-consuming and challenging (McLachlan et al., 2019). Furthermore, the oil and gas industry is subject to various environmental regulations, all of which have the potential to slow down project development. For instance, the completion of an Environmental Impact Statement (EIS), which is required for a significant number of oil and gas projects, might take several months or even many years. Problems with

contractors are another primary reason for delays in the oil and gas industry. It's possible that a project's contractors may not be able to complete it by the deadline, or that they may encounter issues that push back the completion date (Muhadi & Yudoko, 2021).

Reasons for delays in project execution in the Oil and Gas Industry

According to the findings of a recent study (Salama, 2008), delays in the completion of oil and gas projects in the United Arab Emirates (UAE) are likely due to delays occurring inside the Oil and Gas Projects in Abu Dhabi. Ruqaishi & Bashir (2015) suggested that the following seven significant variables contributed to the late completion of the project: poor site management and supervision by contractors, issues with subcontractors, inadequate project planning and scheduling by contractors, and a lack of effective communication among the various project stakeholders. Reducing the time it takes to implement projects is one of the most significant challenges that oil and gas project managers must address. Eleven different issues were mentioned in the authors' (Kazemi et al., 2018) reports as potential reasons for the delay in the oil and gas building project. The owner, the contractor, the consultant, the equipment, the labor, the materials, the design, the contract and the contractual relations, the rules and regulations, the management considerations, and the environmental aspects were all included in this list. Sweis et al. (2019) observed factors that contribute to Iranian oil and gas projects running behind schedule. According to the research, weariness appears to be the primary risk factor contributing to delays in building projects involving Chinese oil and gas companies. The category of issues related to finances is responsible for only 14.91 percent of the project delay. The downstream industry receives investment from a significant chunk of total building project funding. Some of the findings might be seen as a consolidation of earlier studies in this field; the top three contributing elements were identified as "imported material," "unrealistic project time," and "land expropriation."

In the context of the Indian situation, a weakness in project management skills was identified by more than half of the respondents as the reason for execution delays. Frequent procurement delays occurred as a result of the absence of a mechanism to perform prior verification of the current order book of suppliers in relation to supply capacity, which was exacerbated by vendors' tendency to overbook orders. The situation was made much more difficult by the restricted availability of suppliers who have the necessary technical qualifications to provide equipment. Some of the causes cited for the delays in procurement include suppliers located in distant areas, infrastructure constraints, particularly in the last-mile connection to remote project sites, and others (Cantarelli et al., 2018). Due to the decentralized nature of project-specific procurement and stock maintenance, there was often duplication of work, resulting in inefficiencies in material management. The system for inventory management was also not operating in real time, which resulted in either over-ordering or a lack of supplies. The fact that the contract did not fully describe every significant part of the project scope led to delays, which were caused by extensive chains of discussions, arbitration, and/or reduction, re-contracting, and other such activities (Khan & Sharma, 2019). The PSU projects were delayed for several reasons, including a drawn-out and slow decision-making process, as well as a failure to respond promptly. The inability to properly plan and adjust the distribution of personnel to meet the project's cyclical needs resulted in periodic shortages of manpower, which in turn caused delays in the project's completion.

The significant time overruns of the projects, which were caused by external variables such as delays in land acquisition, rehabilitation, and resettlement, as well as regulatory permissions, are an example of the inefficiencies in the risk management methods being followed. The majority of respondents reported that time scheduling and/or cost planning were based on previous projects, with minimal project-specific review conducted at the project site (Moreno-Trejo et al., 2012). The inability to productively engage the appropriate external players (landowners, local government entities, political parties, non-governmental organizations, and regulators, among others) was noted as the primary factor leading to the delays in getting land and regulatory permissions. Other contributing considerations include legal complexities, delays in court procedures, and other similar issues.

Nearly two-thirds of respondents cited inefficient procurement management as a significant factor contributing to the project's high costs. This included a failure to reap the benefits of economies of scale due to a lack of centralized procurement, a delayed start, and/or a slow process, as well as other similar issues (Vlassopoulos et al., 2015). An incomplete or inaccurate project scope definition in the contract, which resulted in lengthy chains of renegotiations, arbitration, and/or mitigation during the project, was a common cause of time overruns and expense increases. Ineffective material management, including faulty planning and estimating, the absence of a real-time stock management system, and other factors, often resulted in either excessive over-ordering or hasty purchases due to shortages. The lack of a coherent policy framework that is easy to understand and follow is one of the primary factors (Desikan & Devi, 2022). Delays in environmental clearances, property acquisition, and regulatory permits are among the other causes of this situation. The business is also struggling with a lack of experienced laborers and outdated or inadequate equipment.

The government must take action to modernize the policy framework and expedite the approval process. Additionally, the sector must invest in the education and advancement of its workforce. Due to the delays in project implementation, the oil and gas sector in India is now under significant strain (Basak & Mitra, 2020). Both the government and the sector need to move quickly to find solutions to the problems and bring the industry back from the brink. One of the most significant contributors to India's overall economy is the petroleum and natural gas industry (Al-Hajji & Khan, 2016). The sector makes a substantial contribution to the nation's overall gross domestic product. The sector's growth has been negatively impacted, and the delays in project implementation have been a barrier to that expansion.

3. Methodology

The study employed the Delphi method and ISM-MICMAC to analyze and evaluate the research objectives.
Qualitative research: A review of the relevant literature led to the identification of 58 factors affecting Delay in Project Execution. A Delphi technique, combining focus group discussions (FGDs) and surveys of 125 employees from the Oil and gas industry with more than 10 years of experience, was used to identify the most relevant 10 factors. A combination of the mean (> 3.5) of the response and the coefficient of variance (COV 0.2) was used to identify the factors (Gupta & Shaikh, 2024; Shang et al., 2022) in a Table 1.

Table 1. Relevant factors as an outcome of the Delphi

Labels	Factor	Mean	COV
F1	Bureaucratic government system and long project approval procedure	4.71	0.16
F2	Late internal approval process	4.43	0.18
F3	Inadequate project organization structure	3.91	0.17
F4	Improper project planning and budgeting	3.91	0.17
F5	Inadequate tendering	4.26	0.18
F6	Work conditions differing from the contract	4.48	0.19
F7	Improper project feasibility study	4.48	0.16
F8	Inefficient and poor performance of the ground-level team	4.22	0.19
F9	Design changes	4.39	0.18
F10	Lack of cooperation from the government	3.91	0.18

Quantitative research: The ISM-MICMAC method was used to categorize the factors obtained through the Delphi technique into Autonomous, dependent, independent, and linkage groups based on the linguistic views of 10 experts with more than 20 years of experience in Oil and gas projects. Finally, the most critical factors (based on driving power) are identified. The Study used the steps outlined by Gupta and Goyal (2021) and Kannan et al. (2009).

1: Develop a Structural Self-Interaction Matrix (SSIM) to exhibit pair-wise linkages between the variables using VAXO. Considering the top 10 identified delay factors from the output of the Delphi technique, SSIM is obtained (Table 2).

Table 2: SSIM

Delay j → / Delay i ↓	F10	F9	F8	F7	F6	F5	F4	F3	F2	F1
F1	X	V	O	A	O	O	O	O	O	--
F2	O	V	X	A	V	V	X	X	--	
F3	O	V	X	O	O	V	A	--		
F4	A	V	V	A	O	V	--			
F5	O	O	O	A	O	--				
F6	O	V	V	A	--					
F7	A	V	V	--						
F8	O	V	--							
F9	A	--								
F10	--									

2: Develop an Initial Reachability Matrix by binary digitizing the Structural Self-Interaction Matrix with 0 and 1
3: By using the transitivity method, the concealed connections are explained, for ex., if n -> m, and m -> k, then n -> k.
4: The Final Reachability Matrix is obtained by eliminating the transitivity with driving and dependence power (Table 3)

Table 3. Final reachability matrix

	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Driving power	Rank
F1	1	0	0	1	0	0	1	0	1	1	5	III
F2	0	1	1	1	1	1	0	1	1	0	7	II
F3	0	1	1	1	1	1	0	1	1	0	7	II
F4	0	1	1	1	1	1	0	1	1	0	7	II
F5	0	0	0	0	1	0	0	0	0	0	1	IV
F6	0	1	1	0	0	1	0	1	1	0	5	III
F7	1	1	1	1	1	1	1	1	1	1	10	I
F8	0	1	1	1	1	1	0	1	1	0	7	II
F9	0	0	0	0	0	0	0	0	1	0	1	IV
F10	1	1	1	1	1	1	1	1	1	1	10	I
Dependence power	3	7	7	7	7	7	3	7	9	3	64	
Rank	III	II	II	II	II	II	III	II	I	III		

5: Level partitions are created by assigning each variable a distinct level.
6: Based on Level partitions, the ISM model is constructed (Figure 1)

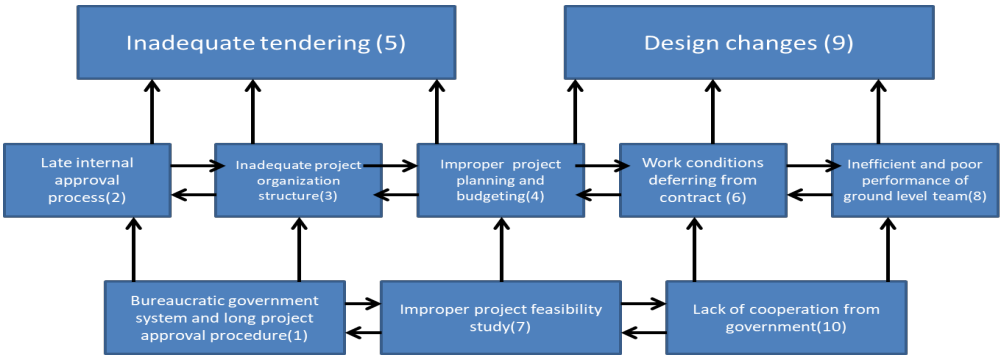

Figure 1. ISM-Based Hierarchical Model

7: The MICMAC analysis was deployed to determine the driving and dependence power of the factors (Figure 2)

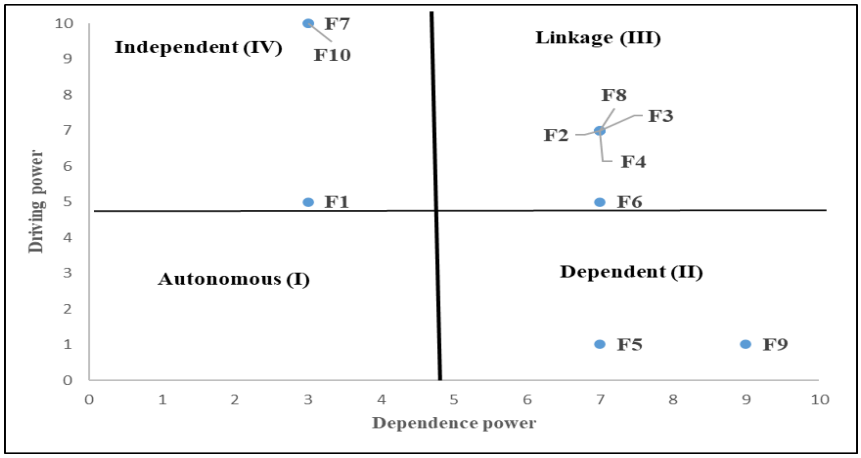

Figure 2. MICMAC Analysis

4. Results and Discussion

It can be inferred from the above ISM structuring that out of the top ten delay factors identified, factors 1, 7, and 10 are responsible for the delay at level 2 (factors 2, 3, 4, 6, and 8). In other words, the bureaucratic government system, lengthy project approval procedures, improper project feasibility studies, and a lack of cooperation from the government are leading to a delayed internal approval process, along with other delay factors at level 2. These five factors at level two are thus causing the occurrence of delay factors 5 and 9.

Similarly, using MICMAC analysis, based on driving and dependence power, the following factors were identified as critical due to their high driving power: "Bureaucratic government system and long project approval procedure (F1)", "Improper project feasibility study (F7)", and "Lack of cooperation from government (F10)". These factors drive all other factors, especially "Inadequate tendering (F5)" and "Design changes (F9)" due to high dependence on power. The factors like "Late internal approval process (F2)", "Inadequate project organization structure (F3)", "Improper project planning and budgeting (F4)", "Work conditions deferring from contract (F6)", and "Inefficient and poor performance of ground level team (F8)" due to their high dependence and driving power also grouped as linkage factors. These linkage factors drive the dependent factors and, in turn, are driven by independent factors.

4.1 Mitigation factors

The factors identified through the Delphi study were further assessed through focus group discussions with industry experts and a literature review. The mitigating factors obtained were: "Request for administrative reform from the government", "Good relationship with government", "Good relationship with environment authority, NGOs", "Familiarity with approval procedures, local laws and regulations", "High commitment of all people involved", "Empowerment", "Partnering", "Employment of experienced third party companies", "Concurrent engineering", "Hiring of competent consultants for evaluations", "Proper training and education of the employees and team members", "Good staffing", "Effective teamwork improvement", "Enhancement of MCS", and "Detection enhancement for collusive tendering and legal enforcement enhancement".

The top five mitigation strategies identified for addressing project delays in the oil and gas industry in India are Effective teamwork improvement, Empowerment, good relationships with environmental authorities and NGOs, Detection enhancement for collusive tendering, legal enforcement enhancement, and High commitment from all parties involved.

Factor "Effective teamwork improvement" has the highest mean value (mean=4.29) with a standard deviation of 1.057. Thus, this is the top identified mitigation strategy for the identified factors responsible for causing delays in project execution in the oil and gas sector in India. Working on big projects, like those in the Oil and Gas industry, is not the work of a one-man army; instead, it is a team's collaboration on which the successes depend. Each team member brings in a unique set of competencies, perceptions, and outlook. These competencies and perceptions, when combined, lead to success, thereby mitigating all the delays along the way. A research study conducted by Van Ban and Hadikusumo (2017) on the Oil and Gas industry in Vietnam found that practical group work can help avoid delays in oil and Gas sector projects. Thus, the findings support the findings of the present research.

5. Conclusion, future scope, and limitation

The present research focuses on assessing the causes of delays in project execution in the oil and gas sector in India. "Bureaucratic government system and long project approval procedure" was found to be the leading causes of delay in project execution in the oil and gas sector in India. Though these are two distinct factors, as one is dependent on the government while the other is dependent on internal stakeholders, both are the most significant contributors to delay. Apart from these three major identified delay factors, other significant factors include inadequate project organization structure, improper project planning and budgeting, and inadequate tendering.

The perception of different stakeholders regarding these delays was also assessed in the present research. It was found that the procurement department thoroughly considers the "Bureaucratic government system" to be the most significant delay cause, while suppliers were found to disagree with the same totally. Furthermore, the suppliers were also found to disagree that inadequate tendering was a factor causing delay. Also, the Commissioning team was mostly found to be neutral towards most of the delay factors.

Furthermore, the research also identified the top seven mitigation strategies for addressing these delay factors. Effective teamwork improvement is one strategy that was found to be the most effective mitigation strategy for tackling the identified delays. Request for administrative reform from the government was determined to be the next best mitigation strategy.

Finally, ISM modeling was used to present the hierarchical model of delays in the Oil and Gas sector in India. The present research has shed light on the Oil and Gas sector regarding the causes of delays and mitigation strategies for these issues. If these mitigation strategies are implemented, the industry may be able to avoid delays, thereby saving a significant amount of resources. Since the research has identified the exact factors causing the delay, the oil and gas sector can pinpoint these issues and resolve them.

The research recommends that the identified mitigation strategies be applied in real-time scenarios in the oil and gas sector. Furthermore, the identified delays should be assessed at the department level to determine which delay factors impact each department the most. This will further filter the research, thereby providing accurate and focused findings.

The findings of the present research are based on responses from 125 internal stakeholders and 10 experts in the Indian oil and gas industry. The study can be generalized through feedback from a multi-country or cross-country study. To enhance the robustness of the outcome, fuzzy multi-criteria decision-making (MCDM) techniques can be employed. A robustness check based on different weights on expert feedback can also be used.

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Biography

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