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[implication for Indian CGD companies](https://www.researchgate.net/publication/359219520_A_review_on_prospective_risks_and_mitigation_for_oil_and_gas_projects_implication_for_Indian_CGD_companies?enrichId=rgreq-b96662dfe738264073bea725f163e607-XXX&enrichSource=Y292ZXJQYWdlOzM1OTIxOTUyMDtBUzoxMTM2NDUzMTExMzAwMDk2QDE2NDc5NjI5NDQyOTQ%3D&el=1_x_3&_esc=publicationCoverPdf)

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A review on prospective risks and mitigation for oil and gas projects: implication for Indian CGD companies

Oil and gas projects



Atul Rawat

Department of Energy Management, University of Petroleum and Energy Studies, Dehradun, India

Sumeet Gupta

Department of Finance and Accounting, University of Petroleum and Energy Studies, Dehradun, India, and

T. Joji Rao

Jindal Global Business School, O.P. Jindal Global University, Sonipat, India

Abstract

Purpose – This study aims to focus on identifying the business risks that cause a delay in the oil and gas projects and suggest the way forward toward the better development of the city gas distribution (CGD) sector in India by suggesting the appropriate mitigation strategies.

Design/methodology/approach – The study is a systematic review of literature on risks causing a delay in oil and gas projects. Comprehensive literature was carried out following a seven-step model to develop an exhaustive list of risk classifications and factors, risk identification methods and strategies to mitigate the risks. Weighted average ranking method is used to identify the top ten risks affecting oil and gas projects.

Findings – This research identifies the top ten risks frequently impacting the oil and gas projects, which are project cost, improper project management, change in economic parameters, currency exchange rate, government regulations and laws, contractor and subcontractors issues, lack of skilled labor, delay in approvals, health and safety issues and force majeure. These risks are primarily responsible for cost overrun and project delay. Additionally, this study recommends the implementation of joint risk management to avoid CGD project delay.

Originality/value – The CGD industry is in the growing stage with many projects under construction. However, there is a lack of research to manage risks in the CGD project. This study contributes to the limited literature available on risk management in oil and gas projects. Additionally, it highlights the need for further research to explore the different risks factors affecting the CGD business and its operations and subsequently develop appropriate mitigation strategies.

Keywords Group discussion, Literature review, Natural gas, Risk mitigation, Risk identification, Project delay, City gas distribution

Paper type Literature review

1. Introduction

Natural gas is the third largest contributor in the global energy mix after coal and crude oil and accounts for a 24.2% share ([BP, 2020](#page2)). It is a clean fuel and is seen as a promising alternative fuel for the future ([Leather et al., 2013](#page2); [Furuoka, 2016](#page2)). Natural gas is expected to substitute crude oil and coal as the world’s largest source of energy by 2040 ([Ma, 2017](#page2)).

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| IJESM | Natural gas production has been rising every year. According to British Petroleum (BP) |  |
|  | statistical data, the global natural gas production was 3,989.3 billion cubic meter (BCM) in |  |
|  | 2019, a growth of 3.4% over 2018. The global natural gas demand has grown by 2% |  |
|  | compared to 2015, rising to 3,929.2 BCM ([BP, 2020](#page2)). |  |
|  | In India, natural gas is expected to play an essential role in its energy mix and curb |  |
|  | environmental pollution ([Vijay Kumar et al., 2020](#page2)). Currently, the natural gas share in the |  |
|  | country’s energy mix stands at 6.3% in 2019. However, the Indian Government aims to |  |
|  | increase the share of natural gas to 15% in the energy mix by 2030 ([Rawat et al., 2019a](#page2), |  |
|  | [2019b](#page2)). The Indian Government has introduced targeted policy reforms to develop natural |  |
|  |  |
|  | gas infrastructure, market-based pricing, boost domestic production and expand the city gas |  |
|  | distribution (CGD) network ([Mishra, 2020](#page2)). |  |
|  | Moreover, natural gas as clean energy has the potential to play a strategic role in the |  |
|  | country’s energy mix ([Wang et al., 2020](#page2); [Wang and Su, 2020](#page2); [Sen, 2017](#page2)). Currently, India is |  |
|  | the third largest carbon emitter globally but with a per capita emission of 1.5 metric tonnes |  |
|  | ([Ahmad et al., 2016](#page2); [du Can et al., 2019](#page2)). However, India’s carbon emission is expected to |  |
|  | quadruple on economic growth and large population size. As per nationally determined |  |
|  | contributions, the country has pledged to reduce emission intensity by 33%–35% by 2030 |  |
|  | from its 2005 level ([du Can et al., 2019](#page2)). Natural gas is the least carbon-intensive fossil fuel as |  |
|  | it releases up to 50% less carbon dioxide (CO2) than coal and 20%–30% less than crude oil |  |
|  | on combustion ([Jain, 2021](#page2)). |  |
|  | Power, fertilizer and the CGD are India’s primary natural gas–consuming sectors, |  |
|  | accounting for around 68% of total consumption ([Parikh et al., 2007](#page2); [MoPNG, 2020](#page2)). Driven |  |
|  | by an increased focus on developing the pan-India CGD network since 2014, natural gas |  |
|  | consumption has grown significantly. Currently, CGD accounts for about 17% share of |  |
|  | India’s total natural gas consumption and experiences a year-on-year growth of 7.2% in |  |
|  | FY19 ([MoPNG, 2020](#page2)). So far, the Petroleum and Natural Gas Regulatory Board (PNGRB) |  |
|  | has awarded licenses for 228 geographic areas (GAs), covering 70% of India’s population |  |
|  | and 50% of its GA. Through CGD network expansion, the government aims to ensure piped |  |
|  | natural gas (PNG) connectivity to residential and industrial consumers and establish |  |
|  | compressed natural gas (CNG) as a transportation fuel. The CGD network expansion is |  |
|  | expected to create 60,000 employment opportunities and attract approximately US$33bn of |  |
|  | investment in the next five years ([Rawat et al., 2019a](#page2), [2019b](#page2)). The government aims to have |  |
|  | 50 million PNG customers and establish 10,000 CNG stations through CGD network |  |
|  | expansion in the next seven–eight years ([PIB, 2021](#page2)). The network expansion would allow |  |
|  | the government to promote eco-friendly fuel, reduce liquefied petroleum gas subsidy burden |  |
|  | and reduce crude oil import intensity. However, this would require the timely completion of |  |
|  | the CGD projects. |  |
|  | CGD network is a complex system with lots of branches. Third-party excavation |  |
|  | frequently leads to natural gas supply disruptions for the residential, commercial and |  |
|  | industrial customers ([Sircar et al., 2017](#page2)). The combination of third-party interference |  |
|  | and pipeline route may cause a severe safety risk for the people living near the pipeline ([Jo](#page2) |  |
|  | [and Ahn, 2005](#page2)). Moreover, developing a team of technicians to operate and maintain the |  |
|  | CGD network is a challenge for long-term business ([Gupta et al., 2017](#page2); [Sircar et al., 2017](#page2)). |  |
|  | [Rawat et al. (2021a)](#page2) identified 22 risks causing a delay in the commencement of the CGD |  |
|  | projects and suggested 39 strategies to mitigate those risks. However, the research does not |  |
|  | address all the risks causing a delay in CGD projects and recommends developing a |  |
|  | comprehensive list of risk factors delaying the CGD projects. |  |
|  | It is evident that CGD projects are complex and exposed to multiple risks. Any delay in |  |
|  | CGD projects commencement will negatively affect the country’s mission of attaining a 15% |  |





share of natural gas in its energy mix by 2030. However, this industry in India is in a developing stage, and evidence in the literature indicates a lack of research on managing the project risks.

This study, therefore, focuses on identifying the business risks that cause a delay in the oil and gas projects and suggest the way forward toward the better development of the CGD sector in India. To achieve the aim of the study, the following questions were addressed:

Q1. What are the critical business risks causing the delay in oil and gas projects?

Q2. What are the top ten risks and what are the mitigation strategies for them?

Q3. What is the implication for the CGD industry?

2. Literature review

Risk is inherent in every project, and it is essential to control them ([Rodney et al., 2015](#page2)). Risk management emphasizes identifying and managing such uncertainties that matter and coming with appropriate responses ([D., 2009](#page2)). Risk management is a process that aims to identify and quantify all the project risks and suggest mitigation strategies ([Flanagan and](#page2) [Norman, 1993](#page2)). According to the Project Management Body of Knowledge, risk management identifies, analyzes and responds to project risks. The process involves six steps: risk management planning, risk identification, qualitative risk analysis, quantitative risk analysis, response planning and risk monitoring and control ([Dey, 2012](#page2)). [Van Thuyet (2007)](#page2) mentioned that project risks often lead to delay and cost overrun due to project manager incapability or inefficiency. The main barriers to on-time project completion are the changes in the project environment ([Chapman, 2006](#page2)). The challenges expand multifold with the project size as project uncertainty increases with size ([Zayed and Pan, 2008](#page2)). Therefore, it is important to anticipate potential events, measure their possible impacts on the project and achieve its objectives ([Rodney, 2015](#page2)).

Risk identification decides the risks that might affect the project and recognize their behaviors. It is an iterative process because of the emergence of new threats through the project life cycle. This process usually leads to qualitative risk analysis ([Van Duijne et al.,](#page2) [2008](#page2)). The early identification and assessment of risks at the planning stage enable the company or contractor to control or absorb them ([Tadayon et al., 2012](#page2)). In other words, identifying the source of risk is to avert the events that can go wrong and cause a hazard ([Redmill, 2002](#page2); [Shen, 1997](#page2)) It is equally important to identify and rank the risks according to their importance. [Clark et al. (1990)](#page2) proposed that any identified risk is not a risk until it is a management problem. Risk identification is both critical and challenging and requires creativity and innovation.

Risk mitigation is a technique for preparing for and reducing the impact of risk on a company or project. It is critical to implement risk mitigation methods and measures in energy projects involving many stakeholders, from government, municipal agencies, residents, employees, contractors and nongovernmental organizations ([Rimšait, 2019](#page2)). However, it requires time, money and resources to design and implement risk mitigation strategies ([Royer, 2000](#page2)).

The oil and gas industry thrives in a project-based environment, where one large project comprises multiple small projects. The oil and gas industry’s efficiency depends on completing numerous smaller projects ([Suda et al., 2015](#page2)). The management needs to manage risks through a comprehensive risk management framework to ensure the success of an oil and gas project. However, despite its capital-intensive nature, risk management is an under-researched area in the oil and gas industry. Most of the studies conducted have focused on

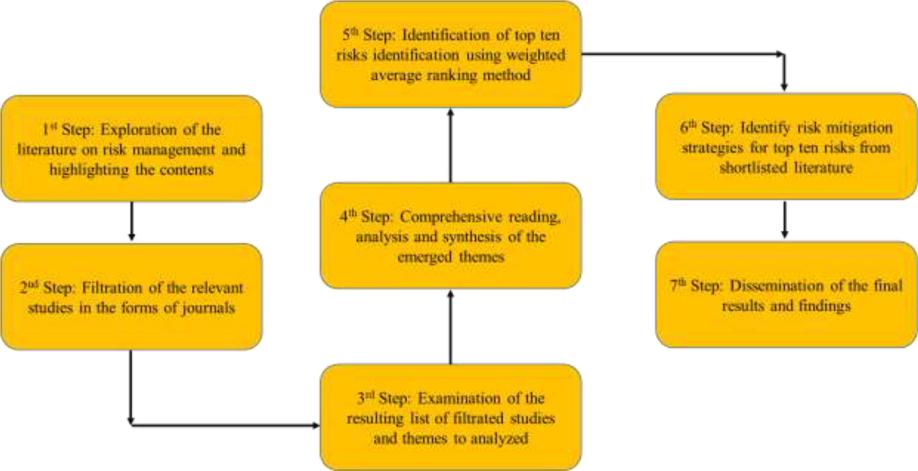
Oil and gas projects





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| IJESM | identifying the risks affecting the oil and gas projects in the Middle East region. However, |  |
|  | the findings of these studies cannot be entirely applied to other areas or countries. There is a |  |
|  | need to adopt or apply more extensive theories, models and risk management frameworks |  |
|  | because of the complex nature of the oil and gas business and complicated risk factors ([Suda](#page2) |  |
|  | [et al., 2015](#page2)). Oil and gas projects are large and complex, use state-of-the-art technology, |  |
|  | involve multiple stakeholders and require analysis from various aspects, including |  |
|  | sustainable development ([Rodhi et al., 2017](#page2); [Dey, 2012](#page2)). |  |
|  | Oil and gas projects are exposed to multiple external risk factors such as economic, |  |
|  | political and government stability. There is a need to probe the impact of external and |  |
|  |  |
|  | internal risk factors and analyze how these factors affect the projects across the oil and gas |  |
|  | value chain ([Kassem et al., 2020a](#page2), [2020b](#page2), [2020c](#page2)). It has also been observed that causes and |  |
|  | the impact behind the schedule delay and cost overrun can differ. Thus, there is a need to |  |
|  | identify the factors that affect time and cost separately and measure their impact on the |  |
|  | project ([Bin Seddeeq et al., 2019](#page2)). Additionally, it is critical to thoroughly examine each risk |  |
|  | factor to ensure the successful commencement of the oil and gas project. The cause and |  |
|  | characteristics of risk factors must be analyzed and appropriate strategies should be |  |
|  | implemented to mitigate them specific to sector requirements ([Van Thuyet et al., 2007](#page2)). |  |
|  | Simulation and sensitivity analysis aids in gaining more insights into the risk factors. The |  |
|  | investigation of segment-specific projects will provide more evidence and comprehensive |  |
|  | results ([Hatmoko and Khasani, 2019](#page2)). |  |
|  | Delay in oil and gas projects is an ongoing concern and has been investigated thoroughly |  |
|  | in various research ([Sweis et al., 2018](#page2)). However, further research on the risk factors and |  |
|  | their ranking should be conducted, as they are essential for developing the CGD industry in |  |
|  | India. The identification and mitigation strategies for the top-ranked risks will lead to |  |
|  | positive results for all the stakeholders and the project. Moreover, detailed content analysis |  |
|  | has not been performed on articles dealing with risk identification techniques, classification |  |
|  | and shared risks in oil and gas projects. |  |
|  | 3. Methodology |  |
|  | This study is a systematic review of the literature on risk affecting causing oil and gas |  |
|  | project delay. The systematic literature review provides a comprehensive and unbiased |  |
|  | synthesis of many relevant studies in a single document ([Khan et al., 2003](#page2); [Tricco et al.,](#page2) |  |
|  | [2011](#page2)). Moreover, it focuses on research that reports data than concepts or theory |  |
|  | ([Aromataris and Pearson, 2014](#page2)). A review consists of relevant studies used as secondary |  |
|  | data and assessment of information published in different journals to identify risks causing |  |
|  | a delay in oil and gas projects and appropriate strategies to mitigate them. It is followed by |  |
|  | the content analysis for risk classification, identification techniques and common risks using |  |
|  | the weightage average ranking method. |  |
|  | In this study, we have followed the seven-step framework as shown in [Figure 1](#page2), which |  |
|  | replicates the exploration, interpretation and communication phases, primarily used in a |  |
|  | comprehensive literature review ([Onwuegbuzie and Frels, 2016](#page2)). The first step involves the |  |
|  | investigation of the literature on risk management in oil and gas projects and highlighting |  |
|  | the contents. The terms such as “oil and gas project,” “city gas distribution,” “project risks,” |  |
|  | “risk identification” and “risk mitigation” were used to explain the topic. Second, we |  |
|  | prepared an initial list of similar but relevant topics identified through Google Scholar and |  |
|  | then completed it through snowball sampling ([Bishoge et al., 2019](#page2)). Google Scholar is used |  |
|  | as a bibliographic database because of its broad coverage of sources. Researchers combined |  |
|  | the pair of words from risk management concepts and the natural gas sector. Each search |  |
|  | led to many hits, which were filtered down to relevant studies in the form of research papers, |  |





book chapters, reports, etc., containing the keywords related to the oil and gas risks. However, we consider research papers in this study. All hits in the list were probed for potential selection. Some studies were found unsuitable as they did not cover the business risks affecting the oil and gas projects. The period of the studies ranged from 1990 to 2021.

After selecting the relevant studies, we identified the classification used for risk categorization, which helped determine the critical risk factors affecting the oil and gas projects, followed by the techniques used for risk identification. A total of 105 unique risks were identified after conducting an extensive review and content analysis of the literature. The key risks affecting oil and gas projects are thoroughly examined and evaluated. To ensure the reliability and validity of the data, comprehensive reading, analyzing and synthesizing were done to achieve the set objectives. The top ten risks were identified using the weighted average rank method. Post that, an exhaustive review was conducted to develop mitigation strategies for the shortlisted risks.

4. Result

4.1. Risk identification in oil and gas projects

Oil and gas projects are very capital intensive and face many uncertainties, ambiguity and complexity during different project stages ([Xie et al., 2010](#page2)). Additionally, during the life cycle, the petroleum project involves various risks such as political, economic, environmental, price volatility, strategic, technical and regulatory ([Pandian, 2005](#page2); [Stephens](#page2) [et al., 2008](#page2); [Ferreira et al., 2003](#page2); [Norberg-Bohm, 2000](#page2); [Asrilhant et al., 2007](#page2)). [Leung et al.](#page2) [(1998)](#page2) presented an integrated knowledge-based system to identify six risk factors and 38 corresponding project risks. [Van Thuyet (2007)](#page2) identified risk factors affecting oil and gas projects in Vietnam. The identified risk factors are bureaucratic government systems and lengthy project approval procedures, poor design, incompetence of the project team, inadequate tendering practices and late internal approval processes from the owner. [Dey](#page2) [(2012)](#page2) proposed an integrated analytical framework for project risk management using multiple criteria decision-making techniques and decision tree analysis. The risk factors are classified under technical; financial, economic and political; organizational; natural hazards; and statutory clearance categories. [Rodhi et al. (2017)](#page2) classified risks under the external and

Oil and gas projects



Figure 1. Seven-step model used in the study





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| IJESM | internal categories with ten and 12 factors, respectively. They also highlighted the need for |  |
|  | performing risk analysis from various aspects and integrated it with sustainable |  |
|  | development aspects. [Suda et al. (2015)](#page2) conducted a study on identifying risks associated |  |
|  | with oil and gas projects across the value chain in Canada. They classified risks under six |  |
|  | categories with 21 corresponding risks. and highlighted the importance of conducting |  |
|  | extensive research on project risk management in the oil and gas industry. [Kassem et al.](#page2) |  |
|  | [(2019b)](#page2) and [Kassem et al. (2019a)](#page2) identified 13 risk factors with 51 corresponding risks that |  |
|  | might affect construction projects in Yemen’s oil and gas sector. The most severe risks |  |
|  | affecting oil and gas projects are wrong project cost estimation and schedule, political |  |
|  |  |
|  | instability, improper project feasibility study, delay in decision-making, poor quality |  |
|  | construction materials, shortage of trained labor, change in design and lack of |  |
|  | infrastructure. [Bin Seddeeq et al. (2019)](#page2) identified 38 causes of time and cost overrun in |  |
|  | Saudi Arabian oil and gas construction projects. The significant causes of time and cost |  |
|  | overrun are change in design and scope during construction; poor planning and scheduling |  |
|  | of the project, design errors, inadequate comprehension of the content of work at the bidding |  |
|  | stage and underestimating of cost and schedules/overestimating of benefit. Construction |  |
|  | projects in the oil and gas industry are also exposed to external risks factors such as |  |
|  | economy, political, security and stability ([Kassem et al., 2020a](#page2), [2020b](#page2), [2020c](#page2)). In developing |  |
|  | nations, political stability ensures sustainable economic activities and foreign investments. |  |
|  | Political unrest causes migration of skilled labor and delay of projects ([Khodeir and](#page2) |  |
|  | [Mohamed, 2015](#page2)). Force majeure, commonly known as the “act of God,” is also considered as |  |
|  | the reason behind the project delay ([Alaghbari et al., 2007](#page2)). Often, projects fail to achieve |  |
|  | their objectives within the budget, resulting in cost overrun ([Abusafiya and Suliman, 2017](#page2)). |  |
|  | The project success is measured on three parameters: schedule, budget and quality. These |  |
|  | parameters can get affected by multiple risks of different types, which depend on many |  |
|  | factors, as construction projects have a unique character, complexity and requirements |  |
|  | ([Kashwani and Nielsen, 2017](#page2)). [Ruqaishi and Bashir (2015)](#page2) identified poor site management |  |
|  | and supervision by contractors; problems with subcontractors; inadequate planning and |  |
|  | scheduling of the project by contractors; poor management of contractors’ schedules; delay |  |
|  | in delivery of materials; lack of effective communication among project stakeholders; and |  |
|  | poor interaction with vendors in the engineering and procurement stages as a significant |  |
|  | factor causing oil and gas project delay in Oman. Similarly, [Berends (2007)](#page2) and [Salama et al.](#page2) |  |
|  | [(2008)](#page2) studied the cause of delays in oil and gas construction projects and reported similar |  |
|  | findings. |  |
|  | In the midstream sector, oil and gas pipelines consider being the most economical and |  |
|  | environmentally friendly mode of transport. Still, they are exposed to multiple challenges |  |
|  | caused by risk factors. [Kraidi et al. (2019)](#page2) analyze oil and gas pipeline risk factors using a |  |
|  | systematic and holistic risk management framework. [Dey (2010)](#page2) found that the risk factors |  |
|  | in project level are caused because of external factors such as customers, competitors and |  |
|  | politics, whereas the operational risks are created due to internal factors such as lack of |  |
|  | material and implementation issues. [Fallahnejad (2013)](#page2) identify and rank the causes of delay |  |
|  | in natural gas pipeline projects in Iran. The study identified ten major delay factors: |  |
|  | imported materials, unrealistic project duration, client-related materials, land expropriation, |  |
|  | change orders, contractor selection methods, payment to the contractor, obtaining permits, |  |
|  | suppliers and contractor’s cash flow. [Mubin and Mubin (2008)](#page2) proposed risk management |  |
|  | model to identify critical risks associated with construction and operation of natural gas |  |
|  | pipeline projects in Pakistan. The risk classification is based on technological, |  |
|  | organizational, political, natural climatic, security and environmental factors. [Hatmoko and](#page2) |  |
|  | [Khasani (2019)](#page2) found 28 delay risk factors of engineering, procurement and construction |  |





projects in the oil and gas industry. Oil and gas pipelines also suffer from third-party disruption, corrosion, planning, design and constructions defects; natural hazards; and operational errors. Globally, third-party risk has been considered the dominant cause of oil and gas pipeline failures ([Wan, 2010](#page2)).

Interestingly, the risk factors identified in the oil and gas projects are more or less similar to the critical infrastructure projects. [Table 1](#page2) presents a risks classification and identification in oil and gas projects.

The most common risk identification techniques in the oil and gas projects are a questionnaire survey, literature review, brainstorming, Delphi method and focused group interviews, as shown in [Table 2](#page2). In most of the research studies, the questionnaire survey has been developed with the help of an extensive literature review.

4.2. Risk mitigation in oil and gas projects

Risk mitigation defines a strategy to manage a particular risk in the right and economical manner. In another way, it can be defined as developing alternatives and actions to reduce risks. Multiple studies have been conducted on identifying and analyzing the oil and gas project risks. However, only a few researchers suggest effective risk mitigation strategies for oil and gas projects. Therefore, we have also included the risk mitigation strategies



Oil and gas projects



|  |  |  |  |
| --- | --- | --- | --- |
| No. risk |  |  |  |
| classification |  | No. of risk |  |
| category | Project type | factors | Author |
|  |  |  |  |
| 5 | Petroleum pipeline | 13 | ([Dey et al., 1994](#page2)) |
| 8 | Pipeline | 38 | ([Mubin and Goryainov, 2007](#page2)) |
| Not specified | Oil and gas construction project | 59 | ([Van Thuyet, 2007](#page2)) |
| 8 | Natural gas pipeline | 32 | ([Mubin and Mubin, 2008](#page2)) |
| 12 | Crude oil pipeline projects | 48 | ([Dey, 2010](#page2)) |
| 4 | Health and safety in construction | 10 | ([Chan, 2011](#page2)) |
| 5 | Refinery | 20 | [[Dey (2012)](#page2) project risk management |
|  |  |  | using multiple criteria decision-making |
|  |  |  | technique and decision tree analysis: a |
|  |  |  | case study of Indian oil refinery] |
| 9 | Natural gas pipeline | 43 | ([Fallahnejad, 2013](#page2)) |
| 7 | Oil and gas energy performance | 162 | ([Mubin, 2013](#page2)) |
|  | contracting (EPC) contract |  |  |
| 6 | Oil and gas construction project | 21 | ([Suda et al., 2015](#page2)) |
| 8 | Oil and gas construction project | 44 | ([Ruqaishi and Bashir, 2015](#page2)) |
| 2 | Oil and gas construction project | 22 | ([Rodhi et al., 2017](#page2)) |
| 2 | Engineering, procurement and | 16 | ([Altyib and Alhakim, 2018](#page2)) |
|  | construction |  |  |
| 13 | Oil and gas construction project | 51 |  |
| 5 | Oil and gas pipeline project | 30 | ([Kraidi et al., 2019](#page2)) |
| 6 | Oil and gas construction project | 20 | ([Kassem et al., 2019c](#page2)) |
| 7 | Oil and gas construction | 38 | ([Bin Seddeeq et al., 2019](#page2)) |
| 13 | Oil and gas construction | 51 | ([Kassem et al., 2019](#page2)) |
| 3 | Platform and subsea pipeline | 28 | ([Hatmoko and Khasani, 2019](#page2)) |
| 13 | Oil and gas construction | 51 | ([Kassem et al., 2019c](#page2)) |
| 7 | Oil and gas construction | 33 | ([Kassem et al., 2020c](#page2)) |
| 13 | Oil and gas construction | 61 | ([Kassem et al., 2020a](#page2), [2020b](#page2), [2020c](#page2)) |
| 5 | CGD | 22 | ([Rawat et al. (2021b)](#page2), CGD projects delay |
|  |  |  | in India: a critical assessment of risks) |



Table 1.

Risk classification

and identification in

oil and gas projects



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | IJESM | |  |  |  |
|  | Risk identification technique | Reference |  |
|  |  |  |  |
|  |  |  |  |  |  |
|  |  |  | Literature review | ([Rodhi et al., 2017](#page2); [Suda et al., 2015](#page2); [Kraidi et al., 2019](#page2); |  |
|  |  |  |  | [Kassem et al., 2020a](#page2), [2020b](#page2), [2020c](#page2); [Ruqaishi and Bashir,](#page2) |  |
|  |  |  |  | [2015](#page2)); [[Dey (2012)](#page2) project risk management using multiple |  |
|  |  |  |  | criteria decision-making technique and decision tree |  |
|  |  |  |  | analysis: a case study of Indian oil refinery]; ([Kassem et al.,](#page2) |  |
|  |  |  |  | [2019](#page2)); ( [Bin Seddeeq et al., 2019](#page2)); ([Kassem et al., 2020c](#page2); |  |
|  |  |  |  | [Fallahnejad, 2013](#page2); [Kassem et al., 2020c](#page2); [Kassem et al., 2019](#page2); |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  | [Mubin and Mubin, 2008](#page2); [Hatmoko and Khasani, 2019](#page2)); [[Dey](#page2) |  |
|  |  |  |  | [(2010)](#page2), managing project risk using combined analytic |  |
|  |  |  |  | hierarchy process and risk map]; ([Mubin, 2013](#page2); [Mubin and](#page2) |  |
|  |  |  |  | [Goryainov, 2007](#page2); [Chan, 2011](#page2)) |  |
|  |  |  | Questionnaire survey | ([Kraidi et al., 2019](#page2); [Kassem et al](#page2)., [2020a, 2020b](#page2); [Ruqaishi](#page2) |  |
|  |  |  |  | [and Bashir, 2015](#page2); [Van Thuyet, 2007](#page2); [Kassem et al., 2019](#page2); |  |
|  |  |  |  | [Altyib and Alhakim, 2018](#page2); [Bin Seddeeq et al., 2019](#page2); [Kassem](#page2) |  |
|  |  |  |  | [et al](#page2)., [2020c, 2019](#page2)); ([Mubin, 2013](#page2); [Chan, 2011](#page2)) |  |
|  |  |  | Interviews | ([Van Thuyet, 2007](#page2); [Altyib and Alhakim, 2018](#page2); [Bin Seddeeq](#page2) |  |
|  |  |  |  | [et al., 2019](#page2); [Hatmoko and Khasani, 2019](#page2); [Dey et al., 1994](#page2)) |  |
|  |  |  | Others (cause and effect; expert judgement; | [[Dey (2012)](#page2), project risk management using multiple |  |
|  |  |  | focus group discussions, Delphi technique) | criteria decision-making technique and decision tree |  |
|  | Table 2. | | | analysis: a case study of Indian oil refinery]; ([Kassem et al.,](#page2) |  |
|  | Risk identification | | |  |
|  | [2019](#page2)); ([Kassem et al., 2020c](#page2); [Fallahnejad, 2013](#page2)); [[Dey (2010)](#page2), |  |
|  | techniques in oil and | | | managing project risk using combined analytic hierarchy |  |
|  | gas projects | | | process and risk map]; ([Dey et al., 1994](#page2)) |  |
|  |  |  |  |  |  |



developed for critical infrastructure projects. [Van Thuyet (2007)](#page2) suggested various risk mitigation strategies for oil and gas construction projects, such as reforming the government system, training project executives, foreign collaboration, implementing contractor evaluation using multiple criteria decision-making techniques and enhancing project managers’ authority. [Chan (2011)](#page2) identified fatigue as the leading accident risk in the construction industry and suggested new responses to the causes of the accident. [Bigliani](#page2) [(2013)](#page2) explored the operational risks impacting oil and gas companies’ performance and suggested using information technology to mitigate those. [Rui et al. (2018)](#page2) recommended a set of practices to reduce technical and nontechnical risks (local content, community, security and partnership) to develop oil and gas projects to help project planners, international companies, investors and policymakers. [Sadeghi et al. (2016)](#page2) suggested effective risk management strategies to mitigate engineering, procurement and construction risks. [Dey (2012)](#page2) proposed an integrated analytical framework for refinery project risk management by combining multiple criteria decision-making techniques and decision tree analysis. [Sadeghi (2016)](#page2) defined the risk mitigation strategies for each risk group identified through an extensive literature review. The effectiveness of each method was evaluated using the survey. [Agrawal (2012)](#page2) suggested the risk mitigation strategies for the identified project finance risks affecting renewable energy projects. The proposed mitigation strategies help address the broad spectrum covering contracts to project selection indicators. [Lee and Schaufelberger (2014)](#page2) suggested risk management strategies for general and project-specific risks. The private sector cannot be the only participant in the risk management of the projects working on private-public partnerships. The other studies reviewed found the risk management strategies for the infrastructure projects, as shown in [Table 3](#page2).



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| No. of | No. of risk |  |  |  |
| critical risk | mitigation |  |  |  |
| identified | strategies | Project type | Country | Source |
|  |  |  |  |  |
| 9 | 32 | International construction | Singapore | ([Bing and Tiong, 1999](#page2)) |
| 12 | 37 | Build-operate-transfer (BOT) | China | ([Wang, 2000](#page2)) |
| 5 | 17 | Oil and gas construction | Vietnam | ([Van Thuyet et al., 2007](#page2)) |
| 21 | 50 | Road construction | Sri Lanka | ([Perera et al., 2009](#page2)) |
| 3 | 27 | International project | Vietnam | ([Ling and Hoang, 2010](#page2)) |
| 4 | 20 | BOT | East Asia | ([Bokharey et al., 2010](#page2)) |
| 20 | 45 | Water utilities | Portugal | ([Marques and Berg, 2011](#page2)) |
| 10 | 20 | Renewable | India | ([Agrawal, 2012](#page2)) |
| 6 | 53 | Architectural, engineering and | Gulf countries | ([Abdul-Rahman et al., 2012](#page2)) |
|  |  | construction |  |  |
| 4 | 22 | Green supply chain | India | ([Mangla et al., 2014](#page2)) |
| 8 | 10 | Engineering, procurement and | Hong Kong | ([Lee et al., 2015](#page2)) |
|  |  | construction |  |  |
| 7 | 73 | Engineering, procurement and | Iran | ([Sadeghi et al., 2016](#page2)) |
|  |  | construction |  |  |
| 7 | 39 | Wind parks | Germany | ([Gatzert and Kosub, 2016](#page2)) |
| 11 | 26 | Hydro | China | ([Pham and Phan, 2018](#page2)) |
| 5 | 8 | Infrastructure projects | India | ([Kumar et al., 2018](#page2)) |
| 6 | 21 | Oil and gas construction | Nigeria | ([Rui et al., 2018](#page2)) |
| 5 | 9 | Highway | India | ([Kumar et al., 2018](#page2)) |
| 5 | 39 | CGD | India | ([Rawat et al. (2021a)](#page2) risk |
|  |  |  |  | analysis and mitigation for |
|  |  |  |  | the CGD projects) |



Oil and gas projects



Table 3.

Risk mitigation

strategies for critical

infrastructure

projects including oil

and gas

4.3. Top ten risks aﬀecting oil and gas projects

Developing mitigation strategies for all 105 risks would not be feasible in this research. Therefore, this study has considered only the top ten risks causing a delay in oil and gas projects for developing the mitigation strategies in the research’s best interest. The frequency of risk and its rank mentioned in the research papers is considered for calculating the weighted average rank. The formula used is as follows:

Weighted Average Rank x ¼ XiYi= Yi

where

Xi = risk mentioned in a number of paper; and

Yi = risk ranking.

The top ten risks identified are shown in [Table 4](#page2).

4.4. Risk mitigation strategies for identified risk factors

Post risk identification, it is imperative to develop mitigation strategies to successfully commence oil and gas projects. The mitigation strategies for the top ten risk factors have been mentioned in [Table 5](#page2).

5. Implication for city gas distribution industry

The study has identified ten critical risks that are responsible for causing a delay in oil and gas projects. This section discusses each risk and its potential implication for the CGD sector in India.

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Table 4.

Top ten risk factors in oil and gas projects

|  |  |  |
| --- | --- | --- |
|  | Weighted |  |
| Risk factors | average rank | Sources |
|  |  |  |
| Project cost escalation | One | ([Kassem et al., 2019](#page2), [2020c](#page2), 2020a, 2020b; [Hamzah et al., 2019](#page2); |
|  |  | [Kassem et al., 2019c](#page2)); [[Dey (2012)](#page2), project risk management using |
|  |  | multiple criteria decision-making technique and decision tree |
|  |  | analysis: a case study of Indian oil refinery]; ([Bin Seddeeq et al.,](#page2) |
|  |  | [2019](#page2); [Altyib and Alhakim, 2018](#page2)) |
| Improper project | Two | ([Kassem et al., 2019](#page2), [2020c](#page2), 2020a, 2020b; [Hamzah et al., 2019](#page2); |
| management |  | [Kassem et al., 2019c](#page2); [Rawat et al. (2021a)](#page2) risk analysis and |
|  |  | mitigation for the CGD projects) |
| Change in economic | Three | ([Khodeir and Mohamed, 2015](#page2); [Van Thuyet et al., 2007](#page2); [Kassem](#page2) |
| parameter (inflation, |  | [et al., 2019](#page2); [Altyib and Alhakim, 2018](#page2); [Kassem et al., 2020c](#page2); |
| interest rate) |  | [Hamzah et al., 2019](#page2); [Mubin and Mubin, 2008](#page2); [Kassem et al., 2019c](#page2); |
|  |  | [Mubin and Goryainov, 2007](#page2)); [[Dey (2012)](#page2), project risk management |
|  |  | using multiple criteria decision-making technique and decision tree |
|  |  | analysis: a case study of Indian oil refinery]; ([Van Thuyet et al.,](#page2) |
|  |  | [2007](#page2); [Rawat et al. (2021a)](#page2) risk analysis and mitigation for the CGD |
|  |  | projects) |
| Change in the currency | Four | ([Kassem et al., 2020a](#page2), [2020b](#page2), 2019, 2020c; [Hamzah et al., 2019](#page2); |
| exchange rate |  | [Mubin and Mannan, 2013](#page2); [Kassem et al., 2019c](#page2); [Rawat et al. (2021a)](#page2) |
|  |  | risk analysis and mitigation for the CGD projects) |
| Changes in government | Five | [[Dey (2010)](#page2), managing project risk using combined analytic |
| regulations and laws |  | hierarchy process and risk map]; ([Ruqaishi and Bashir, 2015](#page2)); [[Dey](#page2) |
|  |  | [(2012)](#page2), project risk management using multiple criteria decision- |
|  |  | making technique and decision tree analysis: a case study of Indian |
|  |  | oil refinery]; ([Van Thuyet, 2007](#page2); [Kassem et al](#page2)., [2019, 2020c](#page2); [Mubin](#page2) |
|  |  | [and Mubin, 2008](#page2); [Mubin and Mannan, 2013](#page2); [Kassem et al](#page2)., [2020a,](#page2) |
|  |  | [2020b](#page2); [Ruqaishi and Bashir, 2015](#page2)) |
| Contractors and | Six | ([Ruqaishi and Bashir, 2015](#page2)); [[Dey (2012)](#page2), project risk management |
| subcontractor issues |  | using multiple criteria decision-making technique and decision tree |
|  |  | analysis: a case study of Indian oil refinery]; ([Van Thuyet, 2007](#page2); |
|  |  | [Kassem et al., 2019](#page2); [Bin Seddeeq et al. 2019](#page2); [Kassem et al., 2020c](#page2); |
|  |  | [Fallahnejad, 2013](#page2); [Kassem et al](#page2)., [2020a, 2020b](#page2); [Hamzah et al., 2019](#page2); |
|  |  | [Kassem et al., 2019c](#page2); [Rawat et al. (2021a)](#page2) risk analysis and |
|  |  | mitigation for the CGD projects) |
| Unavailability of | Seven | ([Fallahnejad, 2013](#page2); [Mubin and Mubin, 2008](#page2); [Kassem et al., 2019c](#page2); |
| skilled labor |  | [Kassem et al](#page2)., [2020a, 2020b](#page2); [Bin Seddeeq et al. 2019](#page2); [Ruqaishi and](#page2) |
|  |  | [Bashir, 2015](#page2); [Kassem et al., 2019](#page2); [Hamzah et al., 2019](#page2); [Mubin and](#page2) |
|  |  | [Goryainov, 2007](#page2); [Rawat et al. (2021a)](#page2) risk analysis and mitigation |
|  |  | for the CGD projects) |
| Delay in approvals | Eight | ([Mubin and Mubin, 2008](#page2); [Mubin and Goryainov, 2007](#page2); [Kassem](#page2) |
| from the government |  | [et al., 2019c](#page2); [Hamzah et al., 2019](#page2); [Van Thuyet, 2007](#page2); [Bin Seddeeq et](#page2) |
| bodies |  | [al. 2019](#page2)) |
| Health and safety | Nine | ([Kassem et al., 2020a](#page2), [2020b](#page2), [2019](#page2); [Altyib and Alhakim, 2018](#page2); [Kassem](#page2) |
|  |  | [et al., 2020c](#page2); [Hamzah et al., 2019](#page2); [Kassem et al., 2019c](#page2); [Rawat et al.](#page2) |
|  |  | [(2021a)](#page2) risk analysis and mitigation for the CGD projects) |
| Force majeure | Ten | ([Van Thuyet et al., 2007](#page2); [Kassem et al., 2019](#page2), [2020c](#page2), 2020a, 2020b; |
|  |  | [Hamzah et al., 2019](#page2); [Kassem et al., 2019c](#page2)) |



5.1 Risk 1: project cost escalation; weighted score: 23.8

The cost escalation has been the most cited risk in the previous research. The weighted score of this risk is 23.8, with the majority of research papers ranking among the top five risks. The Indian CGD industry has been experiencing rapid economic growth due to the



|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Risk factors | Mitigation strategies | |  |  |
|  |  |  |  |  |
| Project cost |  | Penalty deductions | ([Kumar et al., 2018](#page2); [Lee et al., 2015](#page2); |  |
|  |  | Fixed price contracts for the supply of | [Perera et al., 2009](#page2); [Wang et al.,](#page2) |  |
|  | [2004](#page2)) |  |
|  |  | construction materials |  |
|  |  |  |  |
|  |  | Develop a clear and appropriate plan and |  |  |
|  |  | control schedule and cost |  |  |
|  |  | Obtain payment and performance bonds |  |  |
|  |  | from local and international banks |  |  |
| Improper project |  | Create interim milestones | ([Royer, 2000](#page2); [Perera et al., 2009](#page2); |  |
| management |  | Hire a competent project management team | [Kassem et al](#page2)., [2020a, 2020b](#page2); |  |
|  |  | Employ local staff with bilingual ability | [Sadeghi et al., 2016](#page2); [Wang et al.,](#page2) |  |
|  | [2004](#page2)) |  |
|  |  | Clear definition of each staff’s scope of work |  |
|  |  | Conflict resolution clause in the contract |  |  |
|  |  | and specify construction extension clause in |  |  |
|  |  | the contract if the client causes the delay |  |  |
|  |  | Provide notice provision and notice period |  |  |
|  |  | in the contract |  |  |
| Change in economic |  | Get letter of credit from local government | ([Perera et al., 2009](#page2); [Ling and](#page2) |  |
| parameter |  | Obtain payment and performance bonds | [Hoang, 2010](#page2); [Kumar et al., 2018](#page2); |  |
| (inflation, interest | [Pham and Phan, 2018](#page2); [Wang et al.,](#page2) |  |
|  | from local and international banks |  |
| rate) |  | [2000](#page2); [Wang et al., 2004](#page2)) |  |
|  | Secure standby financing |  |
|  |  |  |
|  |  | Adopt alternatives to contract payment, e.g. |  |  |
|  |  | land development rights and resource swap |  |  |
|  |  | Specify extension or compensation clauses |  |  |
|  |  | in the contract for payment |  |  |
| Change in the |  | Obtain government’s guarantees of the | ([Perera et al., 2009](#page2); [Ling and](#page2) |  |
| currency exchange |  | exchange rate and convertibility, e.g. fixed | [Hoang, 2010](#page2); [Kumar et al., 2018](#page2); |  |
| rate |  | rate or to adjust tariff or extend concession | [Pham and Phan, 2018](#page2); [Wang et al.,](#page2) |  |
|  |  | to cover the cost | [2000](#page2); [Sadeghi et al., 2016](#page2); [Wang](#page2) |  |
|  |  | Use dual-currency contracts, other | [et al., 2004](#page2)) |  |
|  |  | transactions dominated in foreign exchange |  |  |
|  |  | Use hedging tools, e.g. forward and Swap |  |  |
| Changes in |  | Maintain a good relationship with local | ([Wang et al., 2000](#page2); [Pham and Phan,](#page2) |  |
| regulations and |  | fi | [2018](#page2); [Royer, 2000](#page2); [Wang et al.,](#page2) |  |
| laws |  | government and higher of cials | [2004](#page2)) |  |
|  | Obtain insurance for political risks |  |
|  |  |  |
|  |  | Include clauses for delays and additional |  |  |
|  |  | payments in contract, which occur due to |  |  |
|  |  | new rules or change in the law |  |  |
| Contractors and |  | Obtaining the performance bond from the | ([Perera et al., 2009](#page2); [Kumar et al.,](#page2) |  |
| subcontractor |  | contractor | [2018](#page2); [Kassem et al](#page2)., [2020a, 2020b](#page2); |  |
| issues | Having a long-standing stake with | [Sadeghi et al., 2016](#page2); [Wang et al.,](#page2) |  |
|  |  | employees and subcontractors which | [2004](#page2)) |  |
|  |  | encourages good workmanship |  |  |
|  | Regular monitoring and strict supervision |  |  |



of the workmanship of both subcontractors

and their own

(continued)



Oil and gas projects



Table 5.

Risk mitigation

strategies for the top

ten identified risks



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|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Risk factors | Mitigation strategies | |  |  |
| Unavailability of |  | Train staff | ([Ling and Hoang, 2010](#page2); [Royer,](#page2) |  |
| skilled labor |  | Hire skilled staff | [2000](#page2); [Kassem et al](#page2)., [2020a, 2020b](#page2); |  |
|  | [Wang et al., 2004](#page2)) |  |
|  |  | Reprioritize skilled staff efforts to align |  |
|  |  |  |



with strategic objectives

Table 5.



Approval delays

from the

government bodies

Health and safety

Force majeure

Ensure the feasibility study report and contract depict local government, local partner and foreign party’s actual intentions (like anticipated profits and risk-sharing)

Prepare and submit all necessary documents and feasibility study report promptly to local government departments

Familiarity with approval procedures, local laws and regulations

Maintain a good relationship with local government and higher officials

Ask the local government to establish a one-stop agency for all approvals

Ensure that construction and operation are as per examination and concerned approving authority’s expectation

Get third-party insurance for compensation to the general public and staff study and implement the local accident regulations stringently and effectively

Adopt proper safety control program, management system, supervision, incentives and preventive measures mitigation measures

A party which fails to meet his contractual obligation due to force majeure must notify the other one within a reasonable time

Obtain local government guarantee to adjust tariff or extend concession period (for BOT projects)

Insure all of the insurable force majeure risks

Obtain local government’s guarantee to

provide financial help when needed

Include delay clauses for a contingency plan in contract mitigation



[[Lee et al. (2015)](#page2), Risks in EPC projects]; ([Perera et al., 2009](#page2); [Wang](#page2) [et al., 2000](#page2); [Ling and Hoang, 2010](#page2); [Sadeghi et al., 2016](#page2); [Wang et al.,](#page2) [2004](#page2))

([Perera et al., 2009](#page2); [Chan, 2011](#page2); [Sadeghi et al., 2016](#page2); [Wang et al.,](#page2) [2004](#page2))

([Wang et al., 2000](#page2); [Pham and Phan,](#page2) [2018](#page2); [Perera et al., 2009](#page2); [Sadeghi](#page2) [et al., 2016](#page2); [Wang et al., 2004](#page2));

government focus on increasing the natural gas share in the energy mix. Hence, CGD is expected to play a critical role in achieving the set target and ensuring sustainable economic growth. However, the CGD industry growth has been affected by frequent cost overruns in projects due to complexity. According to the infrastructure monitoring report published by the Indian Government, 438 projects, including CGD projects, each worth INR 150 crore or more, are reporting cost overrun issues ([PTI, 2021](#page2)). Cost overruns are considered one of the



primary reasons for failure in oil and gas projects. Therefore, it is essential to manage cost risks to ensure project success. The critical cost overrun mitigation strategies are imposing a penalty on contractors for delays deductions, going for fixed-price contracts to supply construction materials, developing a clear and appropriate plan and control schedule and cost and securing payment and performance bonds from local and international banks.

5.2 Risk 2: improper project management; weighted score: 33.0

Project management failure has been featured among the top five risks affecting oil and gas projects. Project management is a process of controlling the achievement of the project objectives ([Munns and Bjeirmi, 1996](#page2)). According to Project Management Institute, it uses specific knowledge, skills, tools and techniques to deliver value ([PMI, 2021](#page2)). It is believed that 40% of oil and gas construction projects are affected by project cost overruns and poor management ([Ruqaishi and Bashir, 2015](#page2)). Generally, the causes behind poor management are unrealistic cost estimates and schedules, incomplete scope definition and inappropriate project strategies. Failure in project management adds to the costs and ruins the company’s market reputation. Time-bound completion of the CGD projects is critical for expanding natural gas share in the energy mix. Its development requires support from other contractors, government departments and regulatory authorities. A small error in planning has the potential to push the project backwards. Therefore, it is essential to set realistic goals, ensure transparency in communication, plan and measure the performance periodically.

5.3 Risk 3: change in economic parameter (inflation, interest rate); weighted score: 44.3 Many researchers believe that changes in economic factors can significantly affect project dynamics. These risk factors are relatively uncontrollable by the project team. Generally, project delays often result in a revenue loss for the CGD companies and increased expenses for the contractor. It may be in the form of a rise in the cost of capital and inflation effect manifested in the increasing prices of the material and other factors. Furthermore, raising money for the project is more challenging for small CGD businesses with limited natural gas sales development potential. To fund long-term investments, most companies rely on short-term borrowings. The financial institution usually charges these businesses a high-interest rate to reduce their risks. The CGD company’s liquidity is further impacted by the protracted payback time. The companies can mitigate these risks by obtaining a letter of credit from the local government, securing performance bonds from local banks or standby financing, adopting the alternative mode of payments to contractors and including extension clauses in the payment contracts.

5.4 Risk 4: change in currency exchange rate; weighted score: 57.6

Oil and natural gas are global commodities traded across multiple exchanges in various currencies. Therefore, the currency exchange rate features prominently among the list of multiple researchers. India is heavily dependent on gas imports to meet its domestic demand. However, currency exchange is one such risk that all CGD enterprises in India do not experience. Only a few CGD businesses distribute liquefied natural gas supplied from other countries, and they rely on natural gas marketing corporations for import and re-gasification services. Gas marketing businesses typically sign back-to-back foreign currency–based price agreements with exporters. As a result, they, too, bill CGD companies in dollars.

On the other hand, the CGD enterprises pay in Indian currency, putting them at risk of currency fluctuations. If the Indian currency depreciates, CGD enterprises may be forced to pass on the cost increases to their customers. The CGD companies can hedge against it by using derivatives or seeking a guarantee for currency mismatch from the government.

Oil and gas projects





|  |  |  |
| --- | --- | --- |
| IJESM | 5.5. Risk 5: changes in regulations and laws; weighted score: 62.6 |  |
|  | Natural gas distribution projects are exposed to multiple law and regulations as they |  |
|  | involve many risks and hold national importance. The companies seek clearance from |  |
|  | multiple governmental agencies before commencing operations. Any sudden change in laws |  |
|  | and regulations may lead to project delays and significantly increase costs. Building a |  |
|  | relationship with the government and considering political risks under contracts may help |  |
|  | mitigate these risks. |  |
|  | 5.6 Risk 6: contractors and subcontractor issues; weighted score: 66.8 |  |
|  |  |
|  |  |
|  | CGD is a complex network of pipelines and requires highly advanced technology, equipment |  |
|  | and skilled labor. Generally, the companies procure these technologies, equipment and |  |
|  | workforce through multiple contractors or subcontractors. Any lapse or error from them |  |
|  | may increase the project risk multifold. The CGD companies can mitigate these risks by |  |
|  | signing performance bonds with the contractor, building a deep relationship with the |  |
|  | subcontractors and ensuring regular monitoring to maintain quality and meet timelines. |  |
|  | 5.7 Risk 7: unavailability of skilled labor: 68.7; weighted score: 68.7 |  |
|  | CGD is a fast-growing industry facing an increasing shortage of skilled labor for developing |  |
|  | and managing infrastructure. With the continuous thrust on expanding CGD networks, the |  |
|  | issue of a skilled workforce looms large. Therefore, PNGRB and the industry should focus |  |
|  | on establishing a human resource training institute to meet rising demand and develop |  |
|  | strategies to use skilled staff experience judiciously. |  |
|  | 5.8 Risk 8: approval delays from government bodies; weighted score: 74.6 |  |
|  | The oil and gas projects’ execution requires multiple approvals from various central and |  |
|  | state authorities. The delay in approvals despite paying the fee may increase capital costs |  |
|  | and discourage companies from investing in the sector. CGD companies, too, need multiple |  |
|  | approvals from various departments before laying down the natural gas pipelines to |  |
|  | develop the network ([Rawat et al., 2019a](#page2), [2019b](#page2)). Since building a CGD network is technical |  |
|  | work, getting approval should be time-bound. The approval delay causes wide customer |  |
|  | expectations and project execution gaps. The provision of one window clearances, |  |
|  | partnership with the local government and proactive liaison with government departments |  |
|  | could significantly reduce the risk. |  |
|  | 5.9 Risk 9: health and safety issues: weighted score: 77.0 |  |
|  | The petroleum industry pays enormous importance to health, safety and environmental issues |  |
|  | as its operations’ failure may lead to substantial social and economic losses. CGD operations |  |
|  | deal with natural gas, which is highly flammable, and its leakage could be detrimental for the |  |
|  | locality and its population. The CGD industry should invest more in research and development, |  |
|  | specifically in designing safe equipment for gas pipelines, maintaining quality standards, going |  |
|  | for third-party insurance and incentivizing the employees’ health, safety and environment |  |
|  | performance. |  |
|  | 5.10 Risk 10: force majeure events: weighted score: 86.5 |  |
|  | These events are the unforeseeable circumstances that affect the project schedules. The term |  |
|  | includes war/hostile situations, riots, civil commotion, earthquakes, floods and restrictions |  |
|  | imposed by central or state governments. The CGD industry too is exposed to this risk. The |  |





companies can mitigate this risk through insurance, obtaining guarantees from the local government, incorporating clauses in the contract, etc.

It is evident from the above discussion that the government and the CGD industry need to adopt a collaborative approach for developing joint risk management (JRM) programs to ensure the time-bound completion of the projects and mitigate the risks. The successful implementation of JRM will help the companies reduce financial, operational and regulatory risks. JRM will also help the government increase the natural gas share to 15% in the energy mix by 2030 and reduce carbon emissions.

6. Conclusion

The CGD expansion is a key to achieving the Indian Government target of increasing natural gas share to 15% by 2030. The expected surge in natural gas usage will enable the Indian Government to meet the emissions targets, promote clean fuel and diversify fuel baskets. However, it requires the time-bound development of the CGD industry. The CGD industry is in a nascent phase and exposed to multiple risks causing project delays.

This research reviews the risks affecting the oil and gas projects and their implication on the CGD industry. Through an exhaustive literature review, the study identified 105 unique risks under different categories affecting projects across the oil and gas value chain. The weighted average ranking method is used to rank the top ten risks. The identified critical risks are diverse and need to be addressed to ensure project success. Thus, the study also suggested strategies to mitigate the short-listed risks.

The findings of this study will enable the CGD companies and the government to build an understanding of the various risks causing project delay and develop appropriate mitigation strategies. However, there is the need for further research to create a framework to adopt a JRM approach by the government and the CGD company to ensure project success.

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About the authors

Mr Atul Rawat is working as an Assistant Professor with the Department of Energy Management in School of Business, University of Petroleum and Energy Studies. He has more than 12 years of experience in energy research and consulting domain. His area of specialization is petroleum fiscal regimes, oil and gas markets. Atul Rawat is the corresponding author and can be contacted at: [atul.26r@gmail.com](mailto:atul.26r@gmail.com)

Dr Sumeet Gupta, Senior Associate Professor (Finance), Department of General Management, has more than 19 years of academic experience. He has published several research papers and case studies in renowned journals. He is a certified Public Forensic Accountant from Institute of Forensic Accountants, USA.

Dr T. Joji Rao is a Senior Associate Professor (Finance) at the Department of General Management. He did his PhD from Sambalpur University and has more than 18 years of academic and industry experience. His area of specialization is oil and gas accounting, risk management and insurance.



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