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Operational Regulatory to Minimise Risks in the Malaysian Oil and Gas Industry

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Abstract

Unfortunate events persisted in oil and gas projects and operations despite extensive study and collective efforts, highlighting the complexity of the challenges faced by the industry. Moreover, previous studies revealed shortcomings in the regulatory framework, hindering appropriate risk management during operational activities, emphasising the crucial role of effective risk management for overall organisational performance. The persistence of disputes and unfortunate occurrences, despite existing regulations, indicated gaps in current operational processes, underscoring areas for improvement addressed by this study. Through qualitative analysis of semi-structured interviews with participants involved in project and operational roles across various oil and gas organisations, this research identified weaknesses in current systems and recommended enhancements. Recommendations included robust enforcement mechanisms, efficient resource management, enhanced awareness campaigns, streamlined procedures, and the incorporation of technology in operations. Overall, this study contributes to understanding the complexities of regulatory compliance and risk management in Malaysian O&G operations, offering insights for enhancing operational efficiency and minimising risks associated with regulatory implementation.

Keywords: oil and gas, regulatory, regulatory compliance, risks, risk minimisation.

1.0 INTRODUCTION

Unfortunate events persisted in oil and gas (O&G) projects despite extensive study and collective efforts, highlighting the complexity of the challenges faced by the industry (Haugen & Vinnem, 2015; Zara et al., 2023). For example, the Deepwater Horizon disaster in 2010 and the Piper Alpha explosion in 1988 underscored how significant accidents could occur despite existing regulations and safety measures (Broadribb, 2015; Parker et al., 2019). Effective risk management was crucial for overall organisational performance, as it was closely tied to the accurate assessment of technical issues and the implications of regulatory policies (Iqbal et al., 2019; Mohamad & Daud, 2018; Nuhu et al., 2020). Errors in these areas can lead to catastrophic failures. Consequently, there has been a growing focus within both industry and academia on developing reliable and systematic project risk management strategies to reduce project failures (Aberenika et al., 2018; Jaderi et al., 2019; Sharma et al., 2020).

Contemporary literature reviews revealed shortcomings in the regulatory framework, such as incoherent laws, overlapping regulations, breaches, and conflicting regulatory functions were commonly found in the operational activities especially (Fezeka M. et al., 2019; Heiden et al., 2002; Liaropoulos et al., 2016). For instance, the Piper Alpha disaster was partly attributed to inadequate safety procedures and communication failures (Broadribb, 2015). It shows that violations of safety rules and procedures were commonly identified as causal factors in such accidents (Jinoo et al., 2017; Melstrom, 2017). The complexity of the regulatory environment often makes it difficult for regulators to select and enforce appropriate risk constraints effectively (Bayat et al., 2023; Wu et al., 2016). This complexity was evident in the aftermath of the Deepwater Horizon spill, where multiple agencies with overlapping responsibilities struggled to coordinate their efforts (Macini et al., 2018; Norazahar et al., 2014; Tabibzadeh & Meshkati, 2015).

Therefore, extensive knowledge of effective management practices related to improved compliance with safety procedures was essential (Atia et al., 2019). The persistence of disputes and unfortunate occurrences, despite the regulations in place, indicated gaps in current operational processes. These gaps highlighted areas for improvement, which this study aimed to address. The study discussed and categorised the data obtained into five main themes that shaped the findings from the thematic analysis. The final output of this paper recommended appropriate improvement aspects to address risks associated with regulatory implementation and their influence on risk minimisation.

This paper presented findings structured to address the third objective of a research, where the answers perceived by the research participants provided recommendations for the improvement aspects of regulatory implementation toward risk minimisation.

2.0 LITERATURE REVIEW

2.1. Risks within the Oil and Gas Industry

In the O&G industry, projects are complex and economically impactful, but they also carry significant risks (Durant et al., 2016; Mandal et al., 2019). Major accidents had extensive consequences, both in terms of safety and economics (Animah & Shafiee, 2020; Embrey & Henderson, 2011; Li et al., 2020). Despite the hazardous nature of these environments, there can be a false sense of security, especially in older projects where outdated safety concepts may still be in use (Heinrich, 2013; Zhang et al., 2016). These highlight the critical role of risk management in identifying and maintaining operational safety controls, as well as the importance of human performance in mitigating risks.

Previous studies in the field identified various risk sources and events that could lead to significant consequences, hence recognising the importance of safety was crucial for both scientific risk analysis and practical decision-making (Sharma et al., 2020; Stemn et al., 2018; Wu et al., 2019). Therefore, effective risk management strategies were essential during operational execution to prevent severe outcomes (Eser et al.,

2019; Rahman et al., 2019). These studies underscore the necessity of comprehensive risk management approaches to ensure safety and minimise the potential for accidents within the O&G industry.

As industries progressed with technological advancements, the O&G sector was no exception, moving towards digital maturity to enhance productivity and efficiency while cutting costs (Alabi, 2020; Botheju, 2018). However, varying skill levels and experiences, influenced by technology disruptions and regulatory demands, underscored the need for collaboration among industry players, educational institutions, professional bodies, and regulators to address skill gap issues comprehensively (Jawad & Ledwith, 2020; Zara et al., 2023). The shortage of knowledge in relevant technologies, especially in operational activities like project management, engineering, regulatory compliance, and site preparation, was identified as a concern in the industry (Bucelli et al., 2018; Craig, 2004).

Given the hazardous nature of O&G operations, stringent safety measures were imperative to manage major accident hazards effectively (Hylton, 2004; Inayat-Hussain et al., 2018; Ma et al., 2020). Most operating plants were classified as hazardous installations due to the handling of flammable, explosive, and toxic substances, necessitating adherence to regulations such as the Occupational Safety & Health Act 1994 and Control of Industrial Major Accident Hazards Regulations 1996 (Embrey & Henderson, 2011; Yu et al., 2017). Standardisation of components within regulatory frameworks is also crucial, ensuring consistency and quality control across operations, thus enhancing safety and efficiency while minimising risks (Imbus et al., 2006; Zhang et al., 2020).

The existence of risks in the O&G industry underscored the necessity of regulations and standards to protect organisations and employees from potential harm (Korppoo, 2018; Morgan et al., 2015). Compliance with these regulations not only helped avoid fines but also ensured a safe working environment (Korppoo, 2018; Linda et al., 2018). Therefore, regulations such as those enforced by OSHA played a vital role in ensuring safe working conditions for employees in the O&G sector (Abboud et al., 2020; Heinrich, 2013).

2.2. Regulatory in Risk Management within the Oil and Gas Industry

The O&G industry operates under extensive government regulations, with compliance being crucial to avoid severe consequences (McGrath & Conversi, 2004). Non-compliance can lead to various penalties such as fines, prosecution, work stoppages, and even physical security threats (Melstrom, 2017). Therefore, companies must exercise caution and ensure adherence to all mandatory regulations throughout their projects. In Malaysia, the Petroleum Development Act, 1974 serves as the primary legislation governing the O&G industry, supplemented by numerous statutes, ordinances, and regulations (Wan Zahari & Shuaib, 2021). Legislative efforts concerning worker safety and health date back to the early 1900s, with the establishment of the Department of Occupational Safety and Health in 1970 and subsequent legal developments aimed at enhancing workplace safety standards (Hamzah et al., 2017).

Additionally, risk management emerged as a vital area for firms within the O&G industry, driven by past failures and the increasing role of legislation and regulations in mandating risk mitigation measures (Kohout et al., 2019; Rawat et al., 2021). Companies were urged to consider various intrinsic risks such as business interruption, pollution, injuries, and property damage, and develop relevant policies to manage these risks effectively (Giri, 2018; Naderpour & Khakzad, 2018). Plus, the findings of studies by Azmee and Ariffin (2018) and Tasmin and Muazu (2017) provided valuable insights into capacity building for staff, resource allocation for risk management functions, implementation of information technology in risk management units, and improving overall compliance with regulations, thereby contributing to the sustainability and operational excellence of O&G firms.

Efforts in managing risks within the O&G industry have been supported by various work procedures and standards. However, a crucial aspect highlighted by Rui et al. (2017) was the necessity for project teams to conduct thorough preparation work to gain a deeper understanding of their projects. One of the identified challenges was the incomplete understanding of uncertainties, which could hinder the success of regulatory

frameworks (Chen et al., 2020; Thomas & Johnson, 2019). Respectively, risk management was integral to policy development, with guidelines typically offering several options for appropriate risk management, including risk avoidance, mitigation, sharing, and retention (Wu et al., 2021; Zapata et al., 2018).

Accident procedures in the industry were closely intertwined with defining and supporting risk constraints across different roles, including regulators, companies, and the work environment (Garcia De Almeida & Vinnem, 2020). Also, a lack of regulatory requirements or supervision could inadvertently contribute to unfavourable conditions for major accident prevention, despite assigning safety responsibilities to companies (Hileman et al., 2021; Mahajan et al., 2018). Moreover, addressing the absence of regulatory requirements or supervision is crucial, as it can create unfavourable conditions that undermine safety efforts, despite assigning safety responsibilities to companies (Pasika et al., 2019). Therefore, improving regulatory frameworks and active supervision are essential to implementing comprehensive accident prevention measures.

2.3. Risk Minimisation Through Regulatory Implementation

The O&G industry faces substantial challenges in maintaining operational safety and complying with regulations due to inherent risks (Pecanha et al., 2016; Pitblado et al., 2020). Despite their economic significance, O&G projects carry the potential for major accidents, particularly in hazardous and remote environments (Gessoni et al., 2020). This underscores the critical need for robust risk management frameworks to identify and sustain operational risk controls.

Regulatory compliance is a cornerstone in the industry, with various government regulations governing operational activities (Chai, 2017; Ismail et al., 2019). Failure to comply with these regulations can result in significant consequences, such as financial losses and work stoppages (Kassem et al., 2020). Specifically, in Malaysia, the Petroleum Development Act of 1974 is the primary legislation overseeing the industry, along with additional statutes and regulations focusing on worker safety and health (Wan Zahari & Shuaib, 2021).

To effectively address risks, regulatory frameworks must be integrated into policy development, providing options to avoid, eliminate, or mitigate risks (Ali Shah et al., 2022; Stella Emeka-Okoli et al., 2024). However, the success of such frameworks depends on a thorough understanding of uncertainties, highlighting the importance of rigorous preparation and risk assessment (Hileman et al., 2021). Also, regulatory practices may vary due to social, cultural, and political factors, necessitating collaboration among industry stakeholders, educational institutions, and regulatory bodies (Kumar et al., 2021; Tang et al., 2018).

Standardisation also plays a vital role in ensuring consistency and quality control across operations, enhancing compliance with regulations, and promoting operational safety (Imbus et al., 2006; Zhang et al., 2020). By adhering to standards, organisations not only minimise the risk of accidents but also protect employees and assets (Ghulam & Abushammala, 2023; Kominas et al., 2012). Compliance records serve as evidence of adherence to regulations, guiding continuous improvement efforts and promoting a culture of safety and excellence within the industry (Wang & Li, 2020).

Several noteworthy case studies demonstrate the implications of strong risk management and regulatory compliance in the Malaysian oil and gas (O&G) industry. One significant example is the Petronas Carigali Sdn Bhd (PCSB) operations. In 2012, PCSB experienced an offshore platform fire at the Miri Crude Oil Terminal, which underscored the importance of stringent safety measures and compliance with regulations (The Borneo Post, 2012). This incident led to a thorough investigation and the implementation of improved safety protocols, including enhanced emergency response plans and stricter maintenance procedures. The lessons learned from this incident have had lasting impacts, prompting other Malaysian O&G companies to review and upgrade their own safety and risk management frameworks (Quoquab et al., 2018).

Another pertinent case is the Sabah-Sarawak Gas Pipeline (SSGP) explosion in 2014. The explosion resulted from a gas leak due to a corrosion-related issue, causing extensive damage and highlighting the need for better corrosion management and pipeline integrity practices (Department of Occupational Safety and

Health [DOSH], 2014). This incident prompted regulatory authorities to tighten pipeline safety standards and required companies to adopt more rigorous inspection and maintenance routines. The SSGP explosion serves as a reminder of the critical need for continuous monitoring and proactive risk management strategies to prevent such occurrences (Zaim Aiman, 2020). Consequently, Malaysian O&G companies have increased their focus on pipeline integrity management and compliance with updated safety regulations.

In another example, the oil spill at Petronas's Kerteh Refinery in Terengganu in 2017 illustrated the environmental risks associated with O&G operations. The spill was caused by a ruptured storage tank, leading to significant environmental damage and operational disruptions (Petronas, 2017). In response, Petronas initiated comprehensive reviews of their storage tank integrity management practices and emergency response strategies. This incident emphasised the necessity of rigorous risk assessments and the integration of environmental protection measures into the regulatory framework (Zakaria & Muhammad, 2024; Jong, Tan & Kessler, 2021).

These Malaysian case studies underscore the practical benefits of implementing robust risk management and regulatory compliance frameworks in the O&G industry. They highlight how incidents have led to regulatory enhancements and improved safety practices, ultimately contributing to the industry's operational efficiency and sustainability. By learning from these real-world examples, Malaysian O&G companies can better navigate the complexities of their operations, minimise risks, and foster a culture of safety and regulatory adherence. This proactive approach not only safeguards the environment and communities but also enhances the industry's reputation and economic viability. After all, effective risk management through regulatory implementation is essential for mitigating hazards and ensuring the sustainability and operational excellence of the O&G industry.

3.0 METHODOLOGY

This study utilised a qualitative research design to investigate the phenomenon of regulatory compliance and risk management within the Malaysian O&G industry. It's targeted to gain a comprehensive understanding of the viewpoints and experiences of professionals engaged in project and operational activities within this sector. Data collection took place through semi-structured interviews conducted between March 2022 and August 2022. These interviews were designed to be adaptable, allowing for the exploration of various aspects of regulatory non-compliance and its repercussions across different organisational levels. Each interview session was recorded to ensure the accuracy of data collection. Respondents were chosen based on their direct involvement in project and operational roles across various O&G organisations.

To ensure diverse insights, participants were selected based on specific criteria, including service tenures ranging from seven to thirteen years. This range was chosen to capture a wide spectrum of experiences and perspectives within the industry. This method aligns with the approach used by similar studies to ensure a comprehensive understanding of the subject matter. For instance, Marshall et al. (2013) emphasised the importance of selecting participants with varied service tenures to gather a diverse range of insights and experiences. Furthermore, the interview process continued until data saturation was achieved, which occurred after interviewing 17 respondents. This approach is consistent with Guest, Bunce, and Johnson's (2006) findings, which indicate that data saturation often occurs within the first 12 interviews, with additional interviews reinforcing the obtained themes.

Data saturation was employed to guarantee the comprehensiveness and representativeness of the findings (Saunders et al., 2018). The credibility and dependability of the qualitative findings were established through data saturation, ensuring that the collected data were thorough (Creswell & Creswell, 2018; Saunders et al., 2018; Saunders et al., 2016). This approach bolstered the credibility and dependability of the qualitative findings.

Qualitative data analysis was performed using the software tool ATLAS.ti. The analysis involved several steps to ensure a rigorous examination of the data (Creswell & Creswell, 2018):

i. Transcription: All interviews were transcribed to capture the complete and accurate content of the discussions. The recordings were subsequently transcribed to facilitate a thorough analysis.
ii. Coding: The transcripts were then systematically coded using ATLAS.ti. Initial codes were generated by identifying significant phrases, terms, and concepts within the data.
iii. Theme Development: The codes were then grouped into categories and through iterative analysis. These themes represented the core issues and insights related to regulatory compliance and risk management in the O&G sector.
iv. Review and Refinement: The identified themes were reviewed and refined to ensure they accurately represented the data and were relevant to the study's aims. This process involved cross-checking the raw data to validate the findings.

The final output of the data analysis revealed five main themes that highlighted the key recommendations regarding regulatory compliance in minimising risk impacts. These themes provided a detailed understanding of the factors influencing effective compliance and risk mitigation in this context.

4.0 RESULTS AND DISCUSSIONS

To systematically address this study's findings, themes generated from the analysis were grouped according to the emerging themes. The initial coding process resulted in five main code groups, which were identified as the primary themes generated from the analysis: (i) The organisation and its business, (ii) The natural environment, (iii) The safety and health, (iv) The operational activities and work progress, and (v) The local society. These themes provided a structured framework for understanding the diverse risks associated with regulatory non-compliance in operational activities within the O&G industry.

These identified themes were used to address the specific risks of non-compliance with regulations in operational activities. By examining each theme in detail, this thematic analysis provided a thorough approach to improving regulatory compliance, thus recommending the improvement aspects of regulatory implementation toward risk minimisation. Ultimately, proactive risk management practices may enable project managers to navigate challenges effectively, ensuring project success amidst the complexities of the Malaysian O&G industry (Arun et al., 2023; Krauss, 2013).

4.1. Risks Minimisation Through Regulatory Implementation

This section of the interview was significant in shaping the insights into the most preferred themes among respondents, as indicated by the highest frequency of codes shown during analysis. These themes represented the significant elements that organisations had implemented as part of their efforts for continuous improvement in regulatory policies influencing risk minimisation. The data collected revealed patterns and trends, as illustrated in Figure 1 below, providing valuable insights into the opportunities associated with regulatory compliance in the O&G industry.

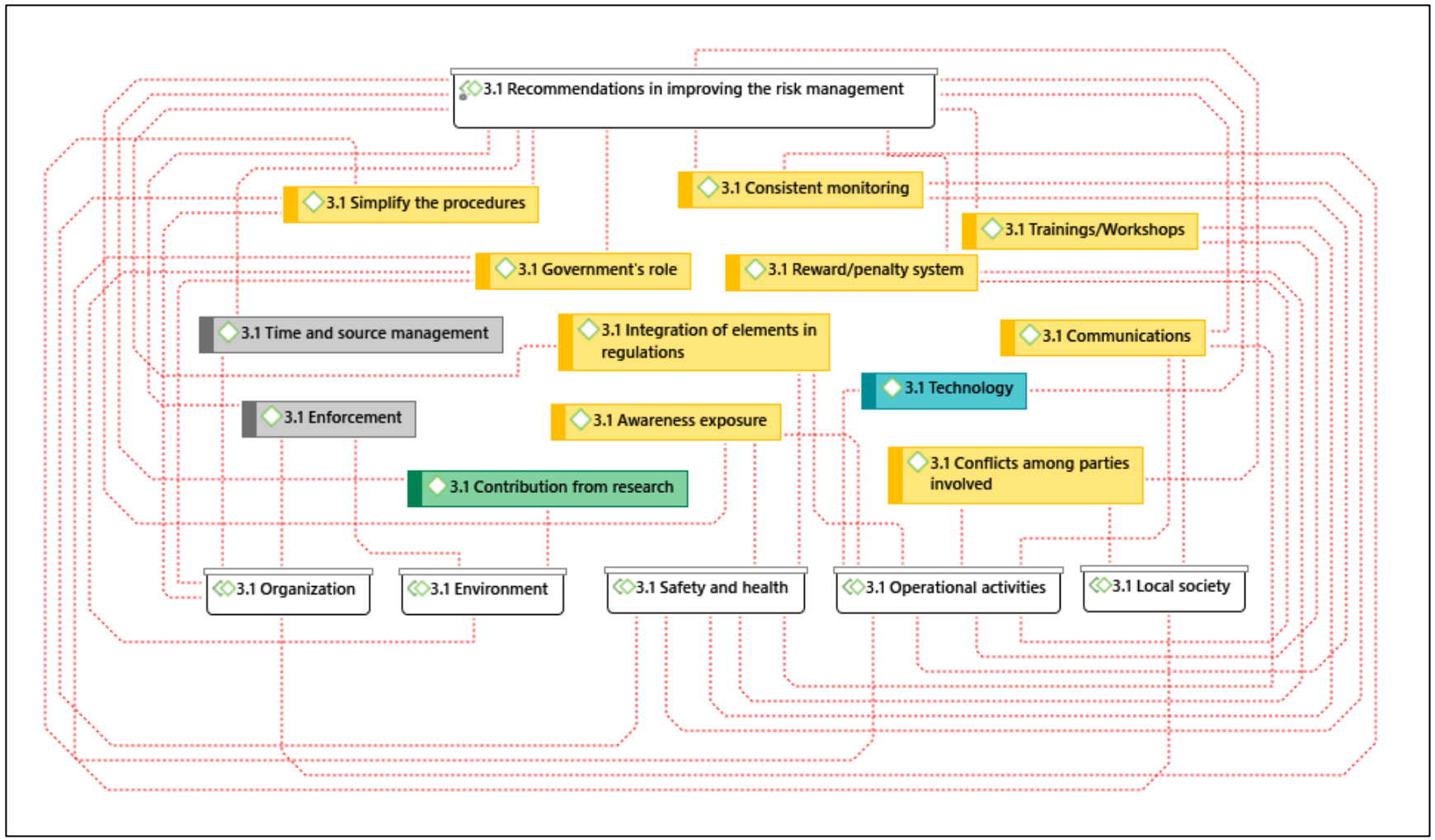

Figure 1. The Respondents' Answers Pattern

The respondents demonstrated weaknesses in the existing systems that were being practised. This part of the research interview aimed to prompt respondents' opinions on the provided questions and relate them to their respective working environments. Table 1 below highlights key aspects identified by respondents that may have significantly contributed to the improvement of future practices.

Table 1. Recommendation for Improvement Towards Risk Minimisation

No.	Themes	Contributing Factors
i.	The organisation and its business	Enforcement
ii.		Time and source management
iii.	The natural environment	Contribution from research
iv.	The safety and health of personnel	Awareness exposure
v.		Communications
vi.		Conflicts among parties involved
vii.		Consistent monitoring
viii.		Government's role
ix.		Integration of elements in regulations
x.		Reward/penalty system
xi.		Simplify the procedures
xii.		Trainings/Workshops
xiii.	The operational activities and work progress	Technology

The final output of this study elaborated on the concept of optimising operational execution through compliance with regulations while simultaneously minimising risks. It facilitated a deeper exploration of ideas and a better understanding of strategies to respond to risks and uncertainties emerging from changes in the working environment and updated policies. These findings were instrumental in constructing a framework that established a clear link between assessed risks and the improvisation of policy compliances, offering a comprehensive approach to addressing challenges and enhancing the effectiveness of regulatory policies in operational execution (Hunt, 2018; Stella Emeka-Okoli et al., 2024).

Participants in the study demonstrated a general awareness of the regulatory policies or programs set by their organisations, underscoring their significance in every project. Participants emphasised various aspects deemed significant for improvement in future practices, including stronger enforcement, efficient time management, research contributions, enhanced awareness exposure, improved communication, conflict resolution, consistent monitoring, government role definition, regulation integration, establishment of reward/penalty systems, procedure simplification, provision of training/workshops, and incorporation of technology. These insights were useful as they laid the groundwork for developing strategies to enhance policy compliance and risk mitigation (Arun et al., 2023; Jalaei et al., 2023).

Based on the interpretations drawn from the study findings, several recommendations emerged for improving regulatory implementation and minimising risks in Malaysian O&G operations. Especially, enhancing safety measures were necessary to reduce risks in O&G operations. The study underscored the importance of comprehensive safety protocols, particularly in hands-on tasks, to prevent accidents and ensure workplace safety. Investing in safety initiatives and providing adequate personnel training could significantly mitigate the occurrence of workplace incidents, promoting a safer working environment overall (Mrozowska, 2021).

Furthermore, participants highlighted the importance of flexibility in the enforcement of regulations, particularly in the context of risk management within O&G projects. This flexibility was crucial due to the diverse nature of projects and works within the industry, necessitating a refined approach to regulatory compliance (Alkazimi & Grantham, 2015; Meyer-Gutbrod et al., 2019). Regular enhancement and review of

regulatory and policy frameworks, aligned with dynamic changes and technological advancements, were recommended to ensure adaptability and responsiveness to evolving landscapes (Stella Emeka-Okoli et al., 2024; Wei et al., 2020).

Additionally, respondents emphasised the importance of continuous improvement and review of regulations to keep pace with technological advancements and global best practices (Ancarani et al., 2020; Stella Emeka-Okoli et al., 2024). Also, benchmarking against global best practices offered valuable insights, minimising risks associated with regulatory changes and fostering resilience in the industry (Ortiz-Volcan et al., 2018; Yasseen et al., 2019). Also, staying abreast of industry technological advancements and regularly reviewing and updating regulatory frameworks were found significant to ensure relevance and responsiveness to evolving industry dynamics. These insights shed light on the challenges faced in regulatory compliance and highlight opportunities for improvement in future practices.

Ultimately, this study's findings highlighted that embracing a flexible regulatory approach, coupled with a commitment to technological advancements and global best practices, could empower O&G practitioners and organisations in Malaysia. It cultivated an environment of innovation, efficiency, and adaptability, positioning them for success in a competitive and dynamic industry (Sarwar et al., 2018). These values can lead to improved project outcomes, enhanced industry reputation, and sustained success amidst the evolving landscape of the Malaysian O&G sector.

By implementing these recommendations, Malaysian O&G companies would be able to enhance regulatory compliance, improve safety standards, foster cultural awareness and communication, establish robust monitoring and reporting systems, and adopt a proactive approach to risk management, ultimately ensuring the sustainable and responsible operation of O&G projects in Malaysia.

For instance, Santos-Reyes and Beard (2009) demonstrate that systematic safety management practices, when coupled with regulatory compliance, significantly improve the operational efficiency of hazardous industries. This aligns with the findings of Cagno et al. (2013), who found that robust safety management systems can lead to enhanced compliance and reduced risks in high-risk sectors such as O&G. Gunningham and Sinclair (2011) discuss the importance of strong communication channels and transparent reporting systems in ensuring compliance and improving safety outcomes, emphasising that effective communication is critical for the dissemination of safety protocols and regulatory updates, which supports compliance and operational efficiency.

Continuous improvement and regular review of regulatory frameworks are essential to ensure policies remain relevant and effective. Aven (2016) argues that the dynamic nature of risks in industries like O&G necessitates regular updates to regulatory frameworks, showing that continuous improvement processes help organisations stay ahead of emerging risks and adapt to new challenges. Hopkins (2011) supports this by demonstrating that organisations that regularly review and update their safety and regulatory practices are better positioned to mitigate risks and enhance compliance. Benchmarking against global best practices provides valuable insights for enhancing regulatory compliance and fostering resilience. Camp (1989) and Moriarty and Smallman (2009) discuss how benchmarking can lead to significant improvements in safety and regulatory compliance by providing organisations with a clear understanding of what constitutes excellence in their field.

5.0 CONCLUSION

The study sheds light on the risks associated with non-compliance with regulations in operational activities, emphasising the importance of thorough project risk identification to anticipate potential errors. Five prominent themes emerged in the Malaysian upstream sector, covering organisational, environmental, safety, health, operational, and societal factors. These encompassed risks such as reputational damage, environmental hazards, safety incidents, operational disruptions, and broader societal impacts. To strengthen project risk management, continuous monitoring and reporting systems, tailored risk assessments, and proactive responses to emerging risks are crucial in navigating challenges and ensuring project success in Malaysia's dynamic operational landscape.

Furthermore, the study's findings highlighted the significance of improving regulatory implementation to minimise risks in Malaysian O&G operations. Participants identified weaknesses in current systems and recommended enhancements in regulatory enforcement, staff competency, and technological integration. Recommendations included robust enforcement mechanisms, efficient resource management, enhanced awareness campaigns, streamlined procedures, and the incorporation of technology in operations. These measures aim to promote consistency, discipline, and quality throughout organisations, fostering better communication, compliance, and risk management.

Ultimately, this study contributes to the body of knowledge by providing empirical evidence on the effectiveness of these strategies in the Malaysian O&G industry. It underscores the importance of tailored approaches to regulatory compliance that consider the unique challenges of the local context. Adopting a flexible regulatory framework alongside technological advancements empowers practitioners and organisations, leading to improved project outcomes and sustained success in Malaysia's O&G sector. Additionally, by integrating findings from various studies, this research offers a comprehensive framework for enhancing regulatory compliance and safety standards in high-risk industries.

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