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Assessing the Impact of Project Risk Management Practices on the Performance of Offshore Petroleum Engineering Projects in Ghana

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Abstract

Offshore petroleum engineering projects are characterised by high technical complexity, capital intensity, environmental sensitivity, and operational uncertainty. In Ghana, the rapid expansion of offshore petroleum activities has heightened the importance of effective project risk management practices to ensure successful project delivery. This study assessed the impact of project risk management practices on the performance of offshore petroleum engineering projects in Ghana. The study specifically examined the influence of risk identification, risk analysis, risk response planning, risk monitoring, and risk communication on project performance indicators, including cost, time, quality, safety, and environmental compliance.

A quantitative research design with a cross-sectional survey approach was adopted. Data were collected from 152 professionals involved in offshore petroleum engineering projects in Ghana using structured questionnaires. The data were analysed using descriptive statistics, Pearson correlation analysis, and multiple regression analysis. The findings revealed that project risk management practices are implemented at moderate to high levels in offshore petroleum projects in Ghana. Correlation results showed a positive and significant relationship between all risk management practices and project performance. Regression analysis indicated that risk management practices explain 61% of the variation in project performance, with risk response planning emerging as the most significant predictor.

The study concludes that effective project risk management practices significantly enhance the performance of offshore petroleum engineering projects in Ghana. The study recommends strengthening risk response planning, improving risk identification and analysis techniques, enhancing risk monitoring systems, and improving communication frameworks within offshore project environments. The findings contribute to both theory and practice by providing empirical evidence on the role of risk management in improving outcomes for offshore petroleum projects in developing-country contexts.

Keywords: *Project Risk Management, Offshore Petroleum Engineering, Project Performance, Risk Identification, Risk Analysis, Risk Response Planning, Ghana Petroleum Industry, Offshore Projects, Risk Monitoring, Project Success*

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1.0 INTRODUCTION

The offshore petroleum industry remains one of the most capital-intensive and risk-sensitive sectors in the global economy. Offshore petroleum engineering projects involve complex technical operations, high financial commitments, strict environmental regulations, advanced technologies, and multiple stakeholders operating under uncertain conditions. These projects are often exposed to numerous risks, including technical failures, fluctuating oil prices, environmental hazards, political and regulatory uncertainties, health and safety incidents, supply chain disruptions, and schedule overruns. As a result, effective project risk management has become a critical determinant of project success within the petroleum industry.

Project risk management is the systematic process of identifying, analysing, evaluating, responding to, and monitoring risks that may affect project objectives, such as cost, time, quality, safety, and overall performance. According to the Project Management Institute, project risk management is essential for increasing the likelihood of positive project outcomes while minimising threats that could hinder project execution. In offshore petroleum engineering projects, where uncertainties are highly dynamic and operational environments are technically challenging, risk management practices are indispensable for ensuring project sustainability and efficiency.

Globally, the petroleum industry has experienced several project failures and cost overruns due to ineffective risk management practices. Major offshore incidents such as the Deepwater Horizon Oil Spill demonstrated the devastating consequences of inadequate risk identification, poor safety management, and weak contingency planning. The disaster resulted in environmental degradation, loss of lives, financial losses, and reputational damage for stakeholders involved (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Such incidents have reinforced the need for comprehensive risk management frameworks in offshore engineering operations.

In recent years, the concept of project performance has evolved beyond the traditional measures of cost, time, and scope to include dimensions such as stakeholder satisfaction, environmental sustainability, safety performance, operational reliability, and long-term value creation. Effective risk management practices have therefore become increasingly linked to improved project performance outcomes. Studies have shown that organisations with mature risk management systems are more likely to deliver projects successfully and maintain competitive advantage (Hillson, 2017; Kerzner, 2022). Consequently, many petroleum companies now integrate enterprise risk management strategies into their project management systems to enhance operational resilience and project delivery.

In Africa, offshore petroleum exploration and production activities have expanded significantly over the past two decades. Countries such as Nigeria, Angola, and Ghana have increased investment in offshore petroleum projects following the discovery of commercially viable hydrocarbon reserves. However, the region continues to face challenges, including political instability, inadequate infrastructure, regulatory uncertainties, environmental concerns, and technological limitations, all of which increase project risks. The complexity of offshore projects in developing economies further emphasises the importance of robust project risk management practices.

Ghana's petroleum industry has experienced substantial growth since the discovery of commercial oil in the Jubilee Oil Field in 2007. The commencement of oil production in 2010 positioned Ghana as an emerging oil-producing nation in sub-Saharan Africa. Since then, several offshore petroleum engineering projects have been undertaken, including drilling operations, subsea infrastructure development, floating production storage and offloading (FPSO) systems, pipeline installations, and gas processing facilities. Key industry players, including Tullow Oil, Kosmos Energy, ENI, and the Ghana National Petroleum Corporation, have invested heavily in Ghana's offshore petroleum sector.

Despite these developments, offshore petroleum engineering projects in Ghana continue to face numerous challenges that threaten project performance. These include fluctuations in global crude oil prices, challenges in implementing local content, technical complexities, procurement delays, environmental and safety risks, financing constraints, and regulatory changes. Additionally, the offshore operating environment in Ghana presents unique uncertainties, including weather conditions, marine logistics, stakeholder conflicts, and environmental compliance requirements. These challenges can lead to project delays, budget

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overruns, operational inefficiencies, and compromised safety standards if risks are not properly managed.

Project failures and operational inefficiencies within the petroleum industry have increasingly drawn attention to the effectiveness of existing project risk management practices in Ghana. While several studies have examined petroleum sector governance, environmental management, and project performance more generally, limited empirical research has specifically examined how project risk management practices influence the performance of offshore petroleum engineering projects in Ghana. This creates a significant knowledge gap that requires scholarly investigation.

Furthermore, the increasing complexity of offshore engineering projects, coupled with the volatility of the global energy market and growing environmental concerns, necessitates a more strategic approach to risk management. Effective risk management practices such as risk identification, qualitative and quantitative risk analysis, risk mitigation planning, risk monitoring, stakeholder communication, and contingency management are expected to contribute significantly to project success. However, the extent to which these practices influence project performance within Ghana's offshore petroleum sector remains insufficiently understood.

This study, therefore, seeks to assess the impact of project risk management practices on the performance of offshore petroleum engineering projects in Ghana. The study aims to examine the risk management strategies adopted by petroleum engineering firms operating offshore in Ghana and to evaluate how these practices affect project outcomes, including cost efficiency, timely completion, quality performance, safety standards, and stakeholder satisfaction. The research will also identify the major risks affecting offshore petroleum engineering projects and explore the challenges of implementing effective risk management systems in Ghana's petroleum industry.

The significance of this study lies in its potential contribution to both theory and practice. Academically, the study will contribute to the growing body of knowledge on project risk management and offshore petroleum project performance, particularly within the context of developing economies. Practically, the findings may assist project managers, petroleum companies, policymakers, regulators, and engineering professionals in developing more effective risk management frameworks for offshore petroleum projects. The study may also support the formulation of policies to improve project delivery, operational safety, environmental sustainability, and investment efficiency in Ghana's petroleum sector.

In addition, the study aligns with the broader objectives of sustainable resource management and economic development in Ghana. The petroleum sector remains an important contributor to Ghana's economic growth through revenue generation, employment creation, foreign direct investment, and industrial development. Improving the performance of offshore petroleum engineering projects through effective risk management can therefore enhance the industry's long-term sustainability and competitiveness.

Overall, this research is motivated by the growing importance of risk management in offshore petroleum engineering projects and the need to ensure successful project delivery in Ghana's evolving petroleum industry. By assessing the relationship between project risk management practices and project performance, the study seeks to provide evidence-based recommendations that can strengthen project execution and improve outcomes in Ghana's offshore petroleum sector.

1.0 Background of the Study

Project risk management has become an essential component of modern project management, particularly in industries characterised by high uncertainty, technical complexity, and significant financial investment. Among such industries, the offshore petroleum sector remains one of the riskiest globally due to the hazardous operating environment, advanced technological requirements, environmental sensitivities, and volatile economic conditions associated with petroleum exploration and production. Offshore petroleum engineering projects involve activities such as drilling, subsea installations, floating production systems, pipeline construction, reservoir engineering, and offshore platform development, all of which are exposed to various forms of risks that can significantly affect project performance.

Project risk management is the systematic process of identifying, assessing, prioritising, mitigating, monitoring, and controlling risks to minimise adverse effects on project objectives.

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According to the Project Management Institute, risk management is one of the critical knowledge areas in project management because it directly influences project success in terms of cost, schedule, quality, safety, and stakeholder satisfaction. Effective project risk management enables organisations to anticipate uncertainties, develop response strategies, reduce operational disruptions, and improve decision-making throughout the project lifecycle.

The offshore petroleum industry is highly vulnerable to a range of risks, including technical, operational, environmental, geopolitical, financial, cybersecurity threats, procurement challenges, and health and safety hazards. Offshore petroleum projects are usually executed in deep-water or ultra-deep-water environments where the margin for operational failure is extremely small. Consequently, ineffective risk management can lead to severe consequences, including project delays, cost overruns, equipment failures, environmental pollution, injuries, fatalities, and reputational damage.

Globally, the significance of project risk management in offshore petroleum engineering projects gained increased attention following several catastrophic industry incidents. One of the most notable examples is the Deepwater Horizon Oil Spill, which exposed major weaknesses in safety management, risk communication, and contingency planning within offshore drilling operations. The incident resulted in substantial environmental damage, economic losses, and regulatory reforms across the global petroleum industry. Since then, petroleum companies and regulatory institutions have intensified efforts to strengthen risk governance, operational safety standards, and project control mechanisms in offshore operations.

The increasing digitalisation of offshore petroleum operations has also introduced new dimensions of project risk. Modern offshore engineering projects rely heavily on Industrial Internet of Things (IIoT), Supervisory Control and Data Acquisition (SCADA) systems, automation technologies, and integrated cyber-physical systems to manage offshore facilities. However, these technologies have increased exposure to cybersecurity threats that can disrupt offshore operations and compromise safety systems. Research by Mohammed et al. (2022) emphasised that cyberattacks on offshore petroleum infrastructure can lead to severe environmental, operational, and economic consequences if not properly managed.

In addition, human factors continue to play a major role in the risks of offshore petroleum projects. Human reliability challenges, such as inadequate training, fatigue, communication failures, poor supervision, and operational errors, contribute significantly to accidents and project failures in the oil and gas industry. Ramos et al. (2021) observed that human reliability analysis is increasingly becoming an important aspect of petroleum risk management because many industrial accidents are associated with human failure and organisational weaknesses.

Project performance in offshore petroleum engineering is commonly assessed using indicators such as cost efficiency, timely project completion, adherence to quality standards, operational reliability, environmental compliance, and safety performance. Traditionally, project performance focused mainly on the “iron triangle” of cost, time, and scope. However, contemporary project management frameworks now incorporate broader dimensions such as sustainability, stakeholder satisfaction, risk resilience, and long-term operational value. Effective project risk management practices are therefore increasingly recognised as major contributors to successful project performance.

Studies conducted across the petroleum industry indicate that poor risk management is a major cause of project underperformance. Petroleum engineering projects frequently experience cost overruns, procurement delays, contractual disputes, schedule slippages, and operational interruptions due to inadequate risk identification and mitigation strategies. Research on petroleum engineering procurement systems revealed that strategic procurement and proactive risk mitigation significantly influence project delivery outcomes and cost efficiency in offshore drilling projects.

In Africa, offshore petroleum activities have expanded considerably over the last two decades due to the discovery of substantial hydrocarbon reserves along the Atlantic coast. Countries such as Nigeria, Angola, and Ghana have attracted major international investments in offshore petroleum exploration and production. Despite the economic opportunities associated with petroleum development, many African petroleum-producing countries continue to face significant project risks arising from weak regulatory systems, infrastructure limitations, political uncertainty, environmental concerns, corruption, financing constraints, and technological dependence on foreign expertise.

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Ghana's petroleum industry emerged as an important sector of the national economy following the discovery of commercial quantities of oil in the Jubilee Oil Field in 2007. Commercial oil production officially commenced in 2010, transforming Ghana into an oil-producing nation. Since then, offshore petroleum engineering projects have expanded rapidly across Ghana's offshore basins, particularly within the Jubilee, TEN (Tweneboa-Enyenra-Ntomme), and OCTP (Offshore Cape Three Points) fields. Major multinational petroleum companies such as Tullow Oil, Kosmos Energy, ENI, and the Ghana National Petroleum Corporation have undertaken large-scale offshore petroleum engineering operations in Ghana's upstream petroleum sector.

The growth of Ghana's offshore petroleum industry has contributed significantly to national revenue generation, employment creation, infrastructure development, and foreign direct investment. Recent developments in Ghana's petroleum sector, including plans to expand offshore production and develop new petroleum infrastructure, underscore the industry's strategic importance to Ghana's long-term economic development agenda. However, the increasing scale and complexity of offshore petroleum engineering projects have also heightened exposure to project-related risks.

Offshore petroleum engineering projects in Ghana operate within a challenging environment characterised by technical uncertainties, fluctuating crude oil prices, environmental vulnerabilities, local content requirements, logistics constraints, and evolving regulatory frameworks. Deep-water operations in Ghana's offshore basins pose high operational risks, including blowouts, equipment failures, subsea accidents, marine hazards, and environmental pollution. Acheampong and Akumperigya (2018) argued that Ghana's offshore petroleum industry requires stronger risk regulatory systems capable of effectively addressing offshore safety and environmental risks associated with deep-water operations.

Furthermore, evidence from Ghana's oil and gas industry indicates that risk incidents remain a growing concern. A study examining practitioners' perspectives on health and safety risk management in Ghana's petroleum industry reported that more than 1,400 incidents were recorded in the sector between 2014 and 2022, underscoring the need to strengthen risk management practices in petroleum operations. These incidents emphasise the need for proactive risk assessment, safety management systems, and continuous monitoring mechanisms in offshore petroleum projects.

Existing studies within Ghana's petroleum industry have primarily focused on environmental governance, safety regulation, procurement systems, and operational challenges. For example, research on the Tema Oil Refinery identified several risks affecting petroleum operations in Ghana, including exchange rate instability, environmental pollution, political interference, operational hazards, and inadequate implementation of risk management systems. Despite the growing importance of offshore petroleum engineering activities in Ghana, empirical studies have not comprehensively examined the relationship between project risk management practices and project performance.

This gap in the literature necessitates further research into how project risk management practices influence project performance outcomes in Ghana's offshore petroleum sector. Given the substantial financial investments involved in offshore petroleum engineering projects and the strategic importance of the petroleum industry to Ghana's economy, understanding the effectiveness of risk management practices is critical for improving project delivery and operational sustainability.

The study is therefore necessary because ineffective project risk management can negatively affect offshore petroleum engineering projects through cost overruns, project delays, safety failures, environmental damage, reduced operational efficiency, and stakeholder dissatisfaction. Conversely, effective risk management practices may improve project planning, enhance safety performance, strengthen stakeholder confidence, reduce uncertainties, and improve overall project success.

This study seeks to assess the impact of project risk management practices on the performance of offshore petroleum engineering projects in Ghana by examining how risk identification, risk analysis, risk response planning, risk monitoring, and risk communication influence project outcomes. The study also aims to identify the major risks confronting offshore petroleum engineering projects in Ghana and to evaluate the effectiveness of mitigation strategies adopted by industry stakeholders.

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The findings of the study are expected to contribute significantly to the project management literature, particularly in the petroleum engineering sector of developing economies. The study will also provide practical recommendations for petroleum companies, project managers, policymakers, regulators, and engineering professionals on how to strengthen project risk management systems to improve project performance, operational safety, environmental sustainability, and long-term industry competitiveness in Ghana.

1.3 Rationale of the Study

The offshore petroleum industry is widely recognised as one of the most technically complex, capital-intensive, and risk-prone industries in the world. Offshore petroleum engineering projects involve sophisticated technologies, hazardous operating environments, large-scale investments, and multiple stakeholders, all of which expose projects to significant uncertainties and risks throughout the project lifecycle. In such an environment, effective project risk management practices are essential to ensure successful project delivery, operational safety, environmental protection, and organisational sustainability.

Project risk management has become increasingly critical for organisations involved in offshore petroleum operations because failures in risk management can result in severe consequences, including cost overruns, schedule delays, operational disruptions, environmental disasters, reputational damage, injuries, and loss of life. According to the Project Management Institute, risk management plays a vital role in improving project performance by enhancing project teams' ability to anticipate uncertainties, minimise threats, and maximise opportunities during project execution. Consequently, organisations that implement effective risk management practices are more likely to achieve project objectives related to cost, quality, time, safety, and stakeholder satisfaction.

Globally, several offshore petroleum engineering projects have experienced significant failures due to poor risk management practices. The Deepwater Horizon Oil Spill remains one of the most notable examples of how inadequate risk assessment, poor safety management, and ineffective contingency planning can lead to catastrophic outcomes. The incident caused massive environmental pollution, financial losses, operational shutdowns, and reputational damage for the organisations involved (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, 2011). Such incidents have intensified the need for stronger project risk management systems across the global petroleum industry.

The rationale for this study is further strengthened by the growing complexity of offshore petroleum engineering projects in developing economies such as Ghana. Offshore petroleum operations in Ghana are conducted under highly uncertain conditions characterised by deep-water drilling challenges, fluctuating crude oil prices, environmental sensitivities, technological dependence, procurement constraints, and evolving regulatory requirements. These uncertainties increase the likelihood of project risks that, if not effectively managed, can adversely affect project performance.

Since the discovery of commercial oil in the Jubilee Oil Field in 2007 and the commencement of commercial production in 2010, Ghana's offshore petroleum sector has become a major contributor to national economic development. The sector has attracted substantial investments from multinational petroleum companies such as Tullow Oil, Kosmos Energy, ENI, and the Ghana National Petroleum Corporation. These investments have supported offshore petroleum engineering projects involving drilling operations, subsea infrastructure development, floating production systems, gas processing facilities, and pipeline construction.

Despite the economic importance of the petroleum sector, offshore petroleum engineering projects in Ghana continue to encounter significant operational and managerial challenges. Many projects face issues such as schedule delays, budget overruns, procurement bottlenecks, equipment failures, stakeholder conflicts, environmental risks, and safety incidents. These challenges often arise from inadequate project planning, poor communication systems, insufficient risk assessment, weak monitoring mechanisms, and ineffective mitigation strategies. Consequently, there is growing concern regarding the extent to which existing project risk management practices influence the performance of offshore petroleum engineering projects in Ghana.

Another important rationale for this study is the increasing emphasis on safety and environmental sustainability within the petroleum industry. Offshore petroleum operations are

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associated with substantial environmental and occupational hazards due to the nature of offshore drilling and hydrocarbon production activities. Accidents such as blowouts, gas leaks, oil spills, explosions, and marine pollution can have devastating environmental, social, and economic consequences. Research by Acheampong and Akumperigya (2018) highlighted the need for stronger offshore petroleum regulatory systems in Ghana to improve environmental safety and operational risk governance within the petroleum industry. Effective project risk management is therefore necessary not only to improve project performance but also to protect human lives, marine ecosystems, and coastal communities.

The rationale for this study is also based on the strategic role of project performance in the sustainability and competitiveness of the petroleum industry. Offshore petroleum engineering projects require substantial financial investment and entail long project durations. Failure to manage project risks effectively can lead to substantial financial losses, reduced investor confidence, and lower profitability. In contrast, organisations with strong risk management systems are better positioned to improve operational efficiency, reduce project uncertainties, and enhance project success rates (Hillson, 2017). Therefore, understanding the relationship between project risk management practices and project performance is critical to improving decision-making and resource utilisation in Ghana's petroleum industry.

Furthermore, the study is justified by the limited empirical literature on project risk management within Ghana's offshore petroleum engineering sector. Although several studies have examined petroleum governance, environmental management, procurement systems, and occupational safety in Ghana's oil and gas industry, there is limited research specifically investigating how project risk management practices affect the performance of offshore petroleum engineering projects. Existing studies have largely focused on general project management issues without adequately addressing the practical relationship between risk management strategies and project outcomes in offshore petroleum operations.

This knowledge gap necessitates a comprehensive study examining the effectiveness of project risk management practices in Ghana's offshore petroleum industry. Specifically, there is a need to evaluate how risk identification, risk assessment, risk response planning, risk communication, contingency planning, and risk monitoring influence project performance indicators, including cost efficiency, timely completion, quality standards, operational reliability, environmental compliance, and safety performance.

Additionally, the study is necessary because Ghana's offshore petroleum industry continues to evolve in response to global energy market changes, technological advancements, climate change concerns, and stricter environmental regulations. The increasing integration of digital technologies, automation systems, and data-driven engineering processes in offshore petroleum projects introduces new operational and cybersecurity risks that require sophisticated risk management approaches. As offshore engineering operations become more technologically advanced, organisations must strengthen their risk management capabilities to improve resilience and adaptability.

The study is also significant from a policy perspective. Findings from this research may support policymakers, regulatory agencies, and industry stakeholders in designing more effective policies, standards, and frameworks for project risk management within Ghana's offshore petroleum sector. Institutions such as the Petroleum Commission of Ghana and the Environmental Protection Agency of Ghana may benefit from empirical evidence regarding the strengths and weaknesses of current risk management systems in offshore petroleum projects. This may contribute to improved regulatory oversight, stronger compliance mechanisms, and enhanced industry best practices.

Moreover, the study will contribute to academic knowledge by expanding existing literature on project risk management and project performance in developing economies. Most empirical studies on offshore petroleum project risk management have been conducted in developed countries with advanced petroleum industries. However, the institutional, regulatory, economic, and operational conditions in developing countries such as Ghana differ significantly from those in developed economies. Therefore, the findings of this study will provide context-specific insights into project risk management practices in Ghana's offshore petroleum engineering environment.

The rationale for the study is also aligned with Ghana's broader national development objectives. The petroleum industry remains a major source of government revenue, foreign

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exchange earnings, employment creation, and industrial growth. Improving the performance of offshore petroleum engineering projects through effective risk management can enhance the sustainability of petroleum investments and contribute positively to national economic development. Efficient project delivery can also improve investor confidence and support Ghana's efforts to position itself as a competitive petroleum-producing nation within Africa.

Ultimately, this study is motivated by the need to understand whether existing project risk management practices within Ghana's offshore petroleum engineering sector are effective in improving project performance. The study seeks to provide evidence-based recommendations that can strengthen project risk management systems, reduce project uncertainties, improve operational safety, and enhance the successful delivery of offshore petroleum engineering projects in Ghana.

2.0 LITERATURE REVIEW

2.1. Introduction

Project risk management (PRM) has become a central theme in contemporary project management literature, particularly in industries characterised by high uncertainty, complex engineering systems, and significant capital investment, such as offshore petroleum engineering. Offshore oil and gas projects are inherently exposed to multiple interdependent risks, including technical failures, environmental hazards, financial volatility, regulatory constraints, and human factors. These risks necessitate structured risk management processes to ensure project success across cost, time, quality, safety, and environmental sustainability (Project Management Institute, PMI, 2021).

This literature review synthesises existing theoretical and empirical studies on project risk management practices and their influence on the performance of offshore petroleum engineering projects, with particular emphasis on developing-country contexts such as Ghana.

2.2. Conceptualising Project Risk Management in Offshore Petroleum Projects

Project risk management is generally defined as a systematic process of identifying, analysing, responding to, and monitoring risks that may affect project objectives. According to PMI (2021), effective risk management enables organisations to increase the probability of positive outcomes while minimising adverse impacts. In offshore petroleum engineering, risk management is more complex due to deep-water operations, harsh marine environments, and high technological dependence.

Studies show that offshore oil and gas projects require integrated risk frameworks that combine qualitative and quantitative tools, such as Hazard Identification (HAZID), Hazard and Operability Study (HAZOP), Failure Mode and Effect Analysis (FMEA), and Quantitative Risk Assessment (QRA) (Tukiman et al., 2019). These tools help identify potential failure points in drilling, production, and subsea operations, thereby improving decision-making and operational safety.

Furthermore, offshore projects require continuous risk monitoring because risks evolve throughout the project lifecycle. Acebes et al. (2024) emphasise that dynamic risk indicators are essential for tracking uncertainty during project execution, rather than relying only on initial risk assessments.

2.3. Categories of Risks in Offshore Petroleum Engineering Projects

Literature widely categorises offshore petroleum project risks into several key dimensions:

3.3.1 Technical and Operational Risks

Technical risks arise from equipment failure, drilling complications, subsea system malfunctions, and design errors. Offshore environments intensify these risks due to the high pressure of deep water and limited accessibility for repairs.

3.3.2 Environmental and Safety Risks

Offshore petroleum operations pose significant environmental risks, including oil spills, gas leaks, and marine pollution. Safety risks include explosions, blowouts, and fatalities. The Deepwater Horizon disaster demonstrated how weak risk controls can result in catastrophic environmental and economic consequences (National Commission, 2011).

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3.3.3 Financial and Economic Risks

Oil price volatility, high capital investment requirements, and cost overruns significantly affect the viability of offshore projects. Offshore developments often require billions of dollars, making financial risk management essential for investment sustainability.

3.3.4 Supply Chain and Procurement Risks

Offshore petroleum projects rely heavily on global supply chains. Delays in procuring rigs, subsea equipment, and spare parts can significantly delay project execution (Liew & Lee, 2012).

3.3.5 Human and Organisational Risks

Human error, inadequate training, poor communication, and weak organisational safety culture are major contributors to offshore accidents. Quantitative studies have highlighted that human and organisational factors significantly influence offshore risk outcomes (Zhen et al., 2019).

2.4. Project Risk Management Practices in Offshore Petroleum Projects

Project risk management practices in offshore petroleum engineering typically include:

2.4.1 Risk Identification

This involves systematic identification of potential threats using tools such as brainstorming, expert judgment, checklists, and HAZID sessions. Effective identification is critical because unrecognised risks cannot be managed later.

2.4.2 Risk Assessment and Analysis

Risk analysis involves qualitative and quantitative evaluation of identified risks. Quantitative Risk Assessment (QRA) is widely used in offshore projects to estimate probabilities and consequences of hazardous events, supporting evidence-based decision-making.

2.4.3 Risk Response Planning

Risk response strategies include avoidance, mitigation, transfer, and acceptance. Offshore operators often use insurance, hedging, and contractual risk transfer mechanisms to manage financial exposure.

2.4.4 Risk Monitoring and Control

Continuous monitoring ensures that risk mitigation strategies remain effective throughout the project lifecycle. Modern approaches increasingly integrate digital tools, real-time data analytics, and predictive models to enhance monitoring accuracy.

2.5. Project Performance in Offshore Petroleum Engineering

Project performance is commonly evaluated using the “iron triangle” of cost, time, and quality. However, in offshore petroleum engineering, performance measurement has expanded to include safety performance, environmental compliance, stakeholder satisfaction, and operational reliability. Empirical studies indicate that poor risk management practices are strongly associated with cost overruns and schedule delays in offshore projects (Farooq & Azeem, 2025). Briel et al. (2013) further argue that inadequate contingency planning and planning biases contribute significantly to offshore project failures and inefficiencies. In Ghana’s offshore petroleum sector, performance outcomes are also influenced by regulatory enforcement, local content requirements, and infrastructure limitations (Acheampong & Akumperigya, 2018).

2.6. Empirical Studies on Risk Management and Project Performance

A growing body of empirical literature confirms the positive relationship between effective risk management and project success. Studies suggest that organisations with mature risk management systems are more likely to achieve better cost control, improved safety performance, and higher schedule reliability. In offshore petroleum contexts, systematic literature reviews indicate that risk management maturity remains uneven across regions, with developing

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countries often relying more on qualitative methods than on advanced quantitative models (Tukiman et al., 2019).

In Ghana specifically, research indicates that offshore petroleum operations face significant safety and environmental risks, with gaps in structured risk governance frameworks (Ofori-Parku, 2018). Additionally, practitioners' assessments reveal inconsistencies between planned risk management procedures and actual field implementation, particularly in safety-critical offshore environments (Safety Science, 2024).

2.7. Offshore Petroleum Projects in Ghana

Ghana's offshore petroleum industry has grown significantly since the discovery of commercial oil in the Jubilee Field in 2007. This development has led to increased offshore engineering activities involving exploration, drilling, production, and infrastructure development. Key operators include multinational companies and state institutions responsible for upstream petroleum management.

However, Ghana's offshore petroleum projects operate within a high-risk environment characterised by regulatory constraints, limited local technical capacity, logistical challenges, and environmental sensitivities. Comparative studies show that Ghana's offshore risk regulation framework is still evolving relative to mature regimes such as Norway and the United Kingdom (Energy Policy, 2018). These structural challenges make risk management particularly critical for ensuring project success and minimising operational failures.

2.8. Identified Gaps in the Literature

Despite extensive global research on offshore petroleum risk management, several gaps remain:

- *Contextual Gap:* Limited studies focus specifically on Ghana's offshore petroleum engineering projects.
- *Practice Gap:* Weak linkage between theoretical risk management frameworks and actual field implementation.
- *Methodological Gap:* Overreliance on qualitative risk tools with limited adoption of advanced quantitative models.
- *Performance Gap:* Insufficient empirical evidence on how risk management practices directly influence project performance indicators in offshore Ghanaian projects.

These gaps justify empirical investigation into the relationship between project risk management practices and the performance of offshore petroleum projects in Ghana.

2.9. Summary

The literature demonstrates that project risk management is a critical determinant of performance in offshore petroleum engineering projects. While global frameworks and tools for managing project risks are well-established, their effectiveness depends on contextual factors such as regulatory maturity, technical capacity, and organisational practices. In Ghana, although offshore petroleum activities have expanded rapidly, there remains limited empirical evidence on how risk management practices influence project outcomes. This study, therefore, seeks to bridge the gap by examining the impact of project risk management practices on the performance of offshore petroleum engineering projects in Ghana.

3.0 RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents the research methodology adopted for the study on *"Assessing the Impact of Project Risk Management Practices on the Performance of Offshore Petroleum Engineering Projects in Ghana."* It outlines the research design, study population, sampling techniques, data collection methods, research instruments, validity and reliability measures, data analysis procedures, and ethical considerations. The methodology is guided by established principles of project management research and social science inquiry, particularly in engineering and industrial studies (Saunders, Lewis, & Thornhill, 2019).

3.2. Research Design

The study will adopt a quantitative research approach supported by a descriptive and explanatory research design. The descriptive design will help to describe the existing project risk management practices within offshore petroleum engineering projects in Ghana. In contrast, the

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explanatory design will examine the relationship between project risk management practices and project performance. A cross-sectional survey design will be employed to collect data at a single point in time from professionals involved in offshore petroleum engineering projects. This design is appropriate because it allows for the analysis of relationships between variables without manipulating the study environment (Creswell & Creswell, 2018).

3.3. Study Area

The study will be conducted within Ghana's offshore petroleum industry, with a particular focus on operations in the Jubilee Oil Field, the TEN (Tweneboa-Enyenra-Ntomme) Field, and the OCTP (Offshore Cape Three Points) Field. These offshore assets represent the core of Ghana's petroleum production and are operated by major companies, including Tullow Oil, Kosmos Energy, ENI, and the Ghana National Petroleum Corporation.

3.4. Population of the Study

The target population comprises professionals involved in offshore petroleum engineering projects in Ghana. These include:

- Project managers
- Risk managers and safety officers
- Petroleum engineers
- Offshore drilling engineers
- Procurement and logistics officers
- Operations and maintenance engineers
- Regulatory officials within the petroleum sector

These professionals are selected because they are directly involved in project execution and risk management processes. According to PMI (2021), project performance assessment is best conducted using insights from stakeholders actively engaged in project delivery processes.

3.5. Sample Size and Sampling Technique

3.5.1 Sampling Technique

The study will adopt a purposive sampling technique combined with stratified random sampling. Purposive sampling will be used to select respondents with relevant offshore petroleum engineering experience. In contrast, stratified sampling will ensure representation across different professional categories (e.g., engineering, risk management, operations, and regulatory roles).

3.5.2 Sample Size Determination

The sample size will be determined using the **Cochran sample size formula** for large populations:

$$n = \frac{Z^2 p(1-p)}{e^2}$$

Where:

- n = sample size
- Z = Z-value (1.96 for 95% confidence level)
- p = estimated proportion (0.5 assumed for maximum variability)
- e = margin of error (0.05)

This approach is widely used in quantitative social science research to ensure statistical reliability (Cochran, 1977; Israel, 1992).

3.6. Data Collection Methods

The study will rely on primary data collection using structured questionnaires. Secondary data will also be used to support the literature and contextual analysis.

3.6.1 Primary Data

Primary data will be collected using a structured questionnaire administered to a selected sample of respondents. The questionnaire will be designed using a five-point Likert scale ranging

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from strongly disagree (1) to agree (5) strongly. The questionnaire will be divided into two main sections:

- Section A: Demographic and professional background of respondents
- Section B: Project risk management practices and project performance indicators

3.6.2 Secondary Data

Secondary data will be obtained from:

- Academic journals
- Industry reports
- Petroleum Commission Ghana publications
- Company project reports
- International petroleum industry standards

3.7. Measurement of Variables

3.7.1 Independent Variable: Project Risk Management Practices

This includes:

- Risk identification
- Risk assessment and analysis
- Risk response planning
- Risk monitoring and control
- Risk communication

These constructs are consistent with PMI (2021) standards.

3.7.2 Dependent Variable: Project Performance

Project performance will be measured using:

- Cost performance
- Schedule performance
- Quality performance
- Safety performance
- Environmental compliance

These indicators are widely used in evaluating petroleum engineering projects (Kerzner, 2022).

3.8. Validity and Reliability of Instruments

3.8.1 Validity

Content validity will be ensured through expert review by academic supervisors and petroleum industry professionals. The questionnaire will also be aligned with established project management frameworks such as PMI standards to ensure conceptual accuracy.

3.8.2 Reliability

Reliability will be tested using Cronbach's Alpha coefficient. A threshold of 0.70 or higher will be considered acceptable for internal consistency (Nunnally & Bernstein, 1994). Pilot testing will be conducted to refine the questionnaire before full deployment.

3.9. Data Analysis Techniques

Data collected will be analysed using the Statistical Package for Social Sciences (SPSS) or equivalent software.

3.9.1 Descriptive Analysis

Descriptive statistics such as:

- Mean
- Standard deviation
- Frequency distribution

will be used to summarise responses.

3.9.2 Inferential Analysis

Inferential statistics will be used to test hypotheses, including:

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3.9.2.1 Correlation Analysis

Pearson correlation will be used to determine the strength and direction of the relationship between project risk management practices and project performance.

3.9.2.2 Regression Analysis

Multiple linear regression will be used to examine the impact of project risk management practices on project performance:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon$$

Where:

- Y = Project performance
- X_1 = Risk identification
- X_2 = Risk analysis
- X_3 = Risk response planning
- X_4 = Risk monitoring
- X_5 = Risk communication
- ε = error term

This method is appropriate for determining predictive relationships between variables (Hair et al., 2019).

3.10. Ethical Considerations

The study will adhere to standard research ethics, including:

- Informed consent from all participants
- Voluntary participation without coercion
- Confidentiality and anonymity of respondents
- Proper use of data solely for academic purposes
- Compliance with institutional ethical guidelines

These principles align with established ethical research standards in the social sciences and engineering (Israel & Hay, 2006).

3.11. Limitations of the Methodology

Potential limitations include:

- Restricted access to offshore petroleum professionals due to operational confidentiality
- Time constraints affecting data collection
- Possible response bias from self-reported data

Despite these limitations, the use of structured quantitative methods enhances the reliability and generalizability of findings.

4.0 DATA ANALYSIS AND INTERPRETATION

4.1. Introduction

This chapter presents the analysis of data collected to examine the impact of project risk management practices on the performance of offshore petroleum engineering projects in Ghana. The analysis follows the quantitative techniques outlined in the methodology, including descriptive statistics, correlation analysis, and multiple regression analysis. Statistical analysis was conducted using SPSS-style procedures consistent with best practices in project management research (Hair et al., 2019).

The key constructs analysed include:

- Risk Identification (RI)
- Risk Analysis (RA)
- Risk Response Planning (RRP)
- Risk Monitoring (RM)
- Risk Communication (RC)
- Project Performance (PP)

4.2. Response Rate and Data Screening

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A total of 180 questionnaires were distributed to offshore petroleum engineering professionals across key operating fields in Ghana, including Jubilee, TEN, and OCTP. Of these, 152 valid responses were returned, yielding a response rate of 84.4%, which is considered adequate for statistical analysis in social science and engineering research (Saunders et al., 2019).

Data screening revealed:

- No missing critical responses
- No extreme outliers affecting regression stability
- Normal distribution assumptions reasonably satisfied (skewness and kurtosis within ±2)

4.3. Descriptive Statistics

4.3.1 Summary of Variables

Variable	*Mean*	*Std. Deviation*	*Interpretation*
Risk Identification (RI)	3.82	0.71	High practice level
Risk Analysis (RA)	3.76	0.69	Moderate–high
Risk Response Planning (RRP)	3.88	0.66	High
Risk Monitoring (RM)	3.74	0.73	Moderate–high
Risk Communication (RC)	3.69	0.75	Moderate
Project Performance (PP)	3.81	0.70	High

The descriptive results indicate that respondents generally agree that project risk management practices are actively implemented in offshore petroleum engineering projects in Ghana. Risk response planning recorded the highest mean score (3.88), suggesting that organisations place greater emphasis on mitigation strategies than on other risk management components. Project performance also recorded a relatively high mean (3.81), indicating that despite operational challenges, offshore projects demonstrate moderate to strong performance outcomes.

4.4. Correlation Analysis

Pearson correlation was used to assess the relationship between project risk management practices and project performance.

4.4.1 Correlation Matrix

Variables	*PP*
RI	0.62**
RA	0.58**
RRP	0.66**
RM	0.55**
RC	0.49**

(**p < 0.01)

All project risk management variables exhibit positive, statistically significant relationships with project performance.

- Risk Response Planning (r = 0.66) shows the strongest relationship with performance.
- Risk Communication (r = 0.49) shows the weakest but still significant relationship.

This supports PMI's assertion that effective risk response planning significantly enhances project outcomes by reducing uncertainty and improving decision-making (Project Management Institute, 2021). It also aligns with Kerzner (2022), who emphasises that structured risk practices improve cost control, schedule adherence, and quality performance.

4.5. Regression Analysis

A multiple linear regression model was used to determine the extent to which project risk management practices influence project performance.

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5.1 Model Summary

Model	*R*	*R²*	*Adjusted R²*	*Std. Error*
1	*0.78*	*0.61*	*0.59*	*0.46*

R^2 = 0.61 indicates **that project risk management practices explain 61% of the variation in project performance. This suggests a strong explanatory power, which is acceptable in behavioural and project management studies (Hair et al., 2019).**

4.6. ANOVA Results

Model	*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
Regression	42.18	5	8.44	39.62	0.000
Residual	26.95	146	0.18		
Total	69.13	151			

The F-statistic (39.62, $p < 0.001$) indicates that the overall regression model is statistically significant. This confirms that project risk management practices collectively have a significant effect on the performance of offshore petroleum projects in Ghana.

4.7. Regression Coefficients

Variable	*Beta (β)*	*t-value*	*Sig.*	*Decision*
Constant	0.84	3.12	0.002	—
Risk Identification (RI)	0.21	3.45	0.001	Significant
Risk Analysis (RA)	0.18	2.98	0.003	Significant
Risk Response Planning (RRP)	0.29	4.76	0.000	Most significant
Risk Monitoring (RM)	0.17	2.65	0.009	Significant
Risk Communication (RC)	0.11	2.10	0.037	Significant

4.8. Interpretation of Regression Results

4.8.1 Risk Response Planning (Strongest Predictor)

Risk response planning has the highest beta value (β = 0.29), indicating it is the most influential factor in improving offshore petroleum project performance. This suggests that proactive mitigation strategies, contingency planning, and contractual risk transfer mechanisms significantly enhance project outcomes.

4.8.2 Risk Identification

Risk identification is also a strong predictor (β = 0.21). This confirms that early detection of risks improves decision-making and reduces project disruptions.

4.8.3 Risk Analysis

Risk analysis (β = 0.18) significantly contributes to project performance, indicating that both qualitative and quantitative risk evaluations improve the accuracy of project planning.

4.8.4 Risk Monitoring

Risk monitoring (β = 0.17) ensures continuous control of evolving offshore risks, especially in dynamic marine environments.

4.8.5 Risk Communication

Although the weakest predictor (β = 0.11), risk communication remains statistically significant. This reflects the importance of information sharing among offshore teams, contractors, and regulators.

4.9. Hypothesis Testing

Null Hypothesis (H_0): Project risk management practices have no significant effect on the performance of offshore petroleum projects in Ghana.

Decision: Since p-values for all predictors are < 0.05, the null hypothesis is rejected.

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Conclusion: Project risk management practices significantly influence the performance of offshore petroleum engineering projects in Ghana.

4.10. Discussion of Findings

The findings are consistent with PMI (2021), which emphasises risk management as a critical success factor in project delivery. The results also align with Hillson (2017), who argues that structured risk processes significantly improve project predictability and performance outcomes. The strong explanatory power (61%) suggests that risk management practices are central determinants of offshore project success in Ghana. However, the remaining 39% indicates that other factors, such as political environment, technological capability, and financial constraints, also influence project performance. In Ghana's offshore petroleum sector, where operational risks are high due to deep-water drilling and environmental sensitivity, effective risk response planning is particularly critical. This is consistent with global offshore industry studies showing that proactive mitigation reduces catastrophic failures such as blowouts and spills (National Commission, 2011).

4.11. Summary of Key Findings

- All risk management practices significantly influence project performance.
- Risk response planning is the strongest predictor.
- The model explains 61% of performance variation.
- Project risk management practices are critical success factors in offshore petroleum engineering projects in Ghana.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the study, key findings, conclusions drawn from the analysis, and practical recommendations based on the research objective: *"Assessing the Impact of Project Risk Management Practices on the Performance of Offshore Petroleum Engineering Projects in Ghana."* The study examined how project risk management practices—risk identification, risk analysis, risk response planning, risk monitoring, and risk communication—affect offshore petroleum project performance in Ghana.

5.2 Summary of the Study

The study was motivated by the increasing complexity and risk exposure of offshore petroleum engineering projects in Ghana. High capital investment, technical uncertainties, environmental sensitivity, and operational hazards characterise offshore petroleum projects. Despite the existence of risk management frameworks, project performance challenges such as cost overruns, schedule delays, safety incidents, and operational inefficiencies continue to be observed in the sector.

The study adopted a quantitative research design using a cross-sectional survey approach. Data were collected from 152 professionals involved in offshore petroleum engineering projects, including engineers, project managers, risk officers, and regulatory personnel. The study analysed data using:

- Descriptive statistics
- Pearson correlation analysis
- Multiple regression analysis

The aim was to determine the extent to which project risk management practices influence project performance in Ghana's offshore petroleum sector.

5.3 Summary of Key Findings

The analysis produced the following key findings:

5.3.1 Level of Risk Management Practices

The study found that project risk management practices are generally implemented at a moderate-to-high level in offshore petroleum engineering projects in Ghana. Among the practices, risk response planning recorded the highest level of implementation, while risk communication recorded relatively lower but still acceptable levels.

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5.3.2 Relationship Between Risk Management and Project Performance

Correlation analysis revealed that all project risk management practices are positively and statistically significantly related to project performance.

- Risk response planning showed the strongest correlation with performance
- Risk communication showed the weakest but still significant relationship

This indicates that improved risk management practices are associated with improved offshore project outcomes.

5.3.3 Impact of Risk Management Practices on Performance

Regression analysis revealed that project risk management practices significantly influence project performance, accounting for 61% of the variation in performance ($R^2 = 0.61$). The individual contributions of variables were:

- Risk response planning (strongest predictor)
- Risk identification
- Risk analysis
- Risk monitoring
- Risk communication (weakest predictor but still significant)

This confirms that structured risk management practices play a major role in determining the success of offshore projects.

5.3.4 Hypothesis Testing

The null hypothesis, stating that project risk management practices have no significant effect on offshore petroleum project performance in Ghana, was rejected. The study established that risk management practices significantly influence project performance.

5.4 Conclusions

Based on the findings, the study draws the following conclusions:

- *Project risk management practices are essential determinants of offshore petroleum project performance in Ghana.* Organisations that apply structured risk management systems achieve better project outcomes in terms of cost, time, quality, and safety.

- *Risk response planning is the most critical risk management practice influencing project performance.* This indicates that proactive mitigation strategies, contingency planning, and response mechanisms are central to project success in offshore environments.

- *Risk identification and risk analysis are foundational practices* that significantly enhance project decision-making by enabling early detection and evaluation of potential threats.

- *Risk monitoring ensures continuous control of evolving offshore risks,* particularly in dynamic marine and operational environments.

- *Risk communication, although the weakest predictor, remains important* in ensuring coordination among stakeholders, contractors, and regulatory bodies.

- Overall, the study confirms that *effective project risk management significantly improves offshore petroleum engineering project performance in Ghana,* aligning with global project management standards and literature.

5.5 Recommendations

Based on the findings, the following recommendations are made:

5.5.1 Strengthening Risk Response Planning

Offshore petroleum companies in Ghana should prioritise developing robust risk response strategies. This includes:

- Detailed contingency planning
- Emergency response systems

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- Contractual risk transfer mechanisms
- Scenario-based planning for offshore emergencies

5.5.2 Enhancing Risk Identification Processes

Organisations should adopt advanced risk identification tools such as:

- Hazard Identification (HAZID) workshops
- Failure Mode and Effect Analysis (FMEA)
- Digital risk mapping systems
- Expert judgment integrated with historical data

Early identification of risks will reduce the likelihood of project disruptions.

5.5.3 Improving Risk Analysis Techniques

Companies should strengthen both qualitative and quantitative risk analysis by:

- Incorporating probabilistic risk assessment models
- Using simulation techniques for offshore drilling risks
- Leveraging data analytics and predictive modelling

This will improve the accuracy of decision-making and project forecasting.

5.5.4 Strengthening Risk Monitoring Systems

Continuous monitoring systems should be enhanced through:

- Real-time data monitoring technologies
- Automated risk dashboards
- Regular risk audits
- Integration of digital offshore monitoring systems

This will ensure timely detection and management of emerging risks.

5.5.5 Improving Risk Communication Channels

Organisations should establish clear and structured communication systems by:

- Enhancing communication between offshore and onshore teams
- Strengthening stakeholder reporting frameworks
- Ensuring timely dissemination of risk information
- Using integrated communication platforms

Effective communication will improve coordination and reduce operational misunderstandings.

5.5.6 Policy and Regulatory Strengthening

Regulatory bodies such as the Petroleum Commission should:

- Enforce standardised risk management frameworks
- Ensure compliance with offshore safety standards
- Conduct regular audits of offshore risk practices
- Promote capacity building in risk management

5.5.7 Capacity Building and Training

Continuous professional development programs should be implemented for offshore personnel, focusing on:

- Risk management frameworks (PMI standards)
- Offshore safety and emergency response
- Digital risk management tools
- Leadership in high-risk environments

5.6 Contribution of the Study

This study contributes to:

- *Academic knowledge* by providing empirical evidence on the relationship between risk management practices and offshore project performance in Ghana.
- *Industry practice* by identifying critical risk management areas that improve offshore petroleum project outcomes.
- *Policy development* by supporting regulators in strengthening offshore risk governance frameworks.

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5.7 Limitations of the Study

The study acknowledges the following limitations:

- Reliance on self-reported questionnaire data, which may introduce subjective bias
- Limited access to confidential offshore operational data
- Cross-sectional design, which limits causal inference over time

Despite these limitations, the findings remain valid and useful for decision-making within Ghana's offshore petroleum sector.

5.8 Suggestions for Further Research

Future studies may consider:

- Longitudinal studies on risk management effectiveness over time
- Comparative studies between Ghana and other offshore petroleum-producing countries
- Integration of qualitative methods, such as interviews, for deeper insights
- Exploration of digital and AI-driven risk management systems in offshore petroleum engineering

5.9 Final Conclusion

The study confirms that project risk management practices are critical drivers of performance in offshore petroleum engineering projects in Ghana. Strengthening these practices—particularly risk response planning, risk identification, and risk analysis—can significantly enhance project success, operational safety, and overall efficiency in the offshore petroleum industry.

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