Material Science and Engineering International Research Journal
ISSN: 2997-6685|
Volume 13 Issue 1, January-March, 2025
Journal Homepage: https://ethanpublication.com/articles/index.php/E30
Official Journal of Ethan Publication

OPERATIONAL RISK MANAGEMENT AND ITS INFLUENCE ON PRODUCTIVITY IN THE OIL AND GAS SECTOR

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DOI: https://doi.org/10.5281/zenodo.17192203

Abstract
This study examined the concept of operational risk practices and their impact on productivity within the framework of the oil and gas sector. Operational risk practices encompass strategies and measures aimed at identifying, assessing, and mitigating risks associated with day-to-day operations in the industry. Implementing comprehensive risk assessment processes is crucial for identifying potential risks such as equipment failures, supply chain disruptions, and safety hazards. By conducting thorough risk assessments, companies can proactively address vulnerabilities and reduce the likelihood of operational disruptions. Robust risk mitigation strategies, including investing in technology, adopting best safety practices, and improving emergency response procedures, are essential for enhancing resilience to potential threats and minimizing disruptions. Effective communication and collaboration among stakeholders, including employees, contractors, regulators, and communities, are vital for successful risk management. By fostering a culture of transparency and accountability, companies can proactively detect and address operational risks, leading to improved productivity and performance. Prioritizing operational risk management enables companies to enhance competitiveness, safeguard their reputation, and achieve long-term success in the dynamic oil and gas industry.

Keywords: *Risk Assessments, Equipment Failures, Supply Chain Disruptions, And Safety Hazards*

1. Introduction

The oil and gas industry are known for its complex operations, high-risk environment, and constant pressure to improve productivity and efficiency. Within this industry, managing operational risk is crucial to ensuring safety, security, and compliance with regulations. Operational risk refers to the risk of loss resulting from inadequate or failed internal processes, systems, people, or external events, Moosa, (2007). Mapping the operational risk practices within the framework of productivity are essential for oil and gas companies to identify areas of improvement, mitigate potential risks, and enhance overall operational performance for sustainable growth.

Dey, (2010) developed an integrated framework for managing project risks by analyzing risk across project, work package and activity levels, and developing responses using combined analytic hierarchy process (AHP) and risk map for managing project risks.

Griffin et al (2014) outlines a systemic study to understanding and assessing safety capability in the offshore oil and gas industry. A conceptual framework and assessment guide for understanding fitness-to-

operate (FTO) that builds a more comprehensive picture of safety capability for regulators and operators of offshore facilities was presented.

Singh and Hong (2020) examine how, in circumstances of supply chain network risk, firms develop effective risk management practices. Conducting a survey research of managers from global firms and a literature review; a research model was presented, and empirically test the hypothesized relationships. The study shows that under conditions of uncertainty, management decision-making was more likely to be cautious until visible forms of risks emerge, and prudent response mechanisms were put in place.

Shou et al. (2021) developed a systematic lean management framework based on value stream mapping and structured analysis, evaluation, and validation, specific to the Turnaround maintenance, TAM operation efficiency in Oil and Gas industry. Finally, the proposed framework is verified through a case study by using 4D building information modelling taken from a real-life environment. The framework provides structured guidance and empirical evidence for using lean for integrating improvement and evaluation in TAM project management.

Abatan et al. (2024) investigates the indispensable role of EHS practices within the automotive manufacturing sector, highlighting their significance in mitigating environmental impact, ensuring workplace safety, and complying with regulatory standards. Effective EHS practices were found to be the integral of managing environmental sustainability within automotive manufacturing. Bakare et al. (2024). proposes a comprehensive governance and risk management framework that tailored specifically to the unique needs of oil and gas projects. The framework integrates governance structures that define clear roles, responsibilities, and decision-making processes, ensuring that projects align with corporate objectives and compliance standards. Central to this framework is a risk management model that identifies, assesses, and mitigates potential project risks. The model emphasizes continuous risk monitoring, utilizing advanced technologies such as predictive analytics, AI, and digital twins to forecast risks and optimize decision-making Akash et al. (2024) elaborates the risk analysis and assessment procedure that uses a set of common financial analysis tools and determines the major financial coefficients. Liquidity ratios, solvency ratios, profitability ratios, and the risk exposure metrics were the major areas that the study was based on. Correlating the financial indicators from a rich dataset from Yahoo's Stock market data, regression analysis was used to determine these relationships between these indicators and risk management factors.

This study aims to examine various aspects of operational risk management within the oil and gas industry and its relationship to productivity. It identifies common operational risk practices, such as monitoring, assessment, mitigation, and reporting, and their importance in driving productivity within organizations

2. Materials and Methods

The study utilizes the qualitative research method to systematically examine the concept of operational risk practices and their impact on productivity within the framework of the oil and gas sector.

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After conducting a survey research of senior staff from the oil and gas firms in Rivers State of Nigeria, and also consulting relevant research literature to examine some of the most applicable keywords, Googlescholar and ScienceDirect databases were searched using the following keywords "Operational risk assessment" and "Impact of operational risk on productivity within the framework of the oil and gas sector". Analytical measures for mapping operational risk practices within the framework of productivity in the oil and gas industry was computed to identify areas of improvement mitigate the potential risks.
The results were analyzed in line with the operational risk of loss resulting from inadequate or failed internal processes, systems, human errors, and external events as stated in Figure 1.

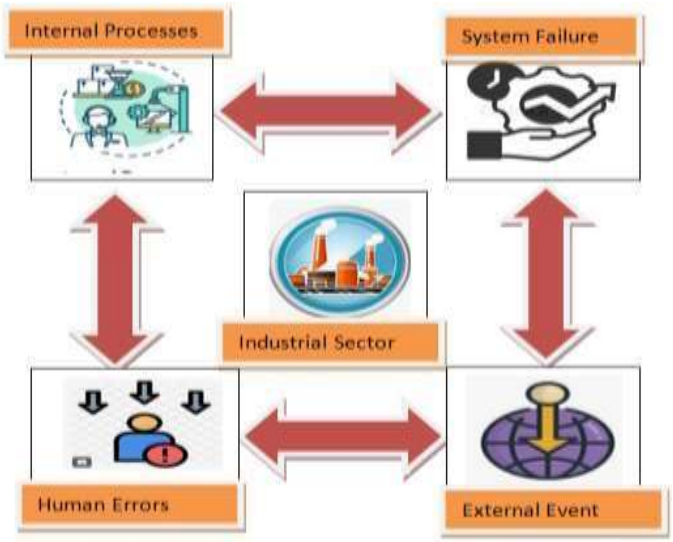

Figure 1: Basic Framework on the Impact of Productivity within the Oil and Gas Sector.

i. Failed Internal Processes

Failed internal processes are deficiencies or breakdowns in the way an organization conducts its activities. These failures can occur due to design flaws, implementation issues, or a lack of adherence to established processes. Examples include errors in transaction processing, inadequate documentation, and poor communication between departments. The operational risk of loss resulting from failed internal processes is a significant challenge for organizations. By understanding the causes, identifying vulnerabilities, and implementing robust mitigation measures, businesses can minimize the likelihood of process failures and their potential impact. Ensuring continuous improvement in internal processes is major to long-term operational resilience, Chernobai et al. (2007).

ii. Failed Systems

Operational risk from failed systems in the oil and gas sector refers to the potential losses that arise when technical systems or equipment critical to operations malfunction, fail, or become obsolete. This is a significant concern in the sector due to the complexity, scale, and hazardous nature of oil and gas activities, which heavily depend on reliable systems for safety, efficiency, and environmental protection.

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Damage to the burner end of a heater treater, as illustrated in Figure 2, can interfere with the separation of oil, water, and gas. Potential causes include corrosion, overheating, flame impingement, or mechanical stress. Indicators of such damage may involve abnormal flame behavior or reduced thermal efficiency. Prompt inspection is crucial. While minor issues might be addressed through cleaning or component replacement, extensive damage could necessitate full burner replacement. Verifying burner controls and fuel systems post-repair is vital. Routine maintenance and proper tuning help prevent recurrence and maintain efficient operation, Xie et al. (2019).

Figure 2: A damage to the burner end of a heater treater

iii. Human Errors

Operational risk arising from human errors in the oil and gas sector refers to the potential losses caused by mistakes or lapses in judgment, decision-making, or actions by personnel. Human errors are an unavoidable aspect of any operation, but their risks can be significantly reduced in the oil and gas sector through proactive measures. By fostering a culture of safety, investing in training, leveraging technology, and implementing strong controls, organizations can minimize the frequency and impact of these errors. Continuous improvement, learning from past mistakes, and prioritizing safety are critical for long-term resilience and operational efficiency. iv. **External Events**

Operational risk resulting from external events in the oil and gas sector refers to potential losses caused by factors outside the organization's direct control. These external events can disrupt operations, damage infrastructure, harm the environment, or pose safety risks. Due to the global and high-stakes nature of the oil and gas industry, external events can have significant financial, operational, and reputational impacts.

3. RESULTS AND FINDING

3.1 Failed internal processes in operational risk practices within the oil and gas industry

Failed internal processes in operational risk practices within the oil and gas industry have a direct and significant impact on productivity. Poor risk management, ineffective maintenance, inadequate employee training, and inefficient communication systems all contribute to increased downtime, higher costs, safety incidents, and legal challenges. Addressing these failures through enhanced risk management, better

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communication, and proactive safety measures is crucial for ensuring high productivity levels, minimizing costs, and maintaining a strong reputation in the highly competitive and hazardous oil and gas industry.

Table 1: Failed Internal Processes in Operational Risk Practices Affecting Productivity in the Oil and Gas Industry and the Mitigation Strategies

Failed Internal Processes	**Causes in Percentage %**	**Percentage Impact on Productivity %**	**Mitigation Strategies**
Maintenance management	Aging equipment and Inadequate Maintenance Schedules 14%	Frequent breakdowns and costly repairs 22%	Implement predictive maintenance and upgrade equipment
Safety Protocols	Non compliance and inadequate safety training 18%	Increased incidents and regulatory penalties 25%	Regular safety audits and improvement of safety culture and training
Supply Chain and Inventory	Poor vendor management and transportation delays 16%	Production halts and material shortages 18%	Diversify suppliers, improvement in logistics and inventory tracking
Decision Making and Governance	Lack of clear policies and poor leadership 10%	Delayed in projects and misaligned priorities 15%	Improve governance frame works and stream line decision making processes
Training and Competency	Insufficient training and lack of expertise 12%	Low employee performance and high turnover rates 10%	Focus on continuous employee training and development
Inspection and Quality Assurance	Lack of inspection checks and inadequate quality control 8%	Reduced product quality and operational inefficiencies 8%	Implement regular inspections and improve quality assurance processes

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Information Flow and Communication	Poor information and communication channels 10%	Delays, miscommunication and poor coordination 10%	Implement efficient communication systems and regular updates
Incident Management and Crisis	Inadequate resources and unclear crisis response plans 12%	Slow recovery and prolonged downtime 12%	Develop clear crisis management protocols and conduct simulations

3.1.1 Model Equation on Operational Risk Impact on Productivity

To model the impact of failed internal processes on operational risk practices based on the given data, we can use a weighted formula. This formula will help quantify how much each failed internal process contributes to overall productivity loss based on both the cause percentage and the percentage impact on productivity. The impact of failed internal processes on productivity is model as a weighted sum of each cause's contribution. The formula is given as:

$$C = \sum_{i-1}^{n} \left(\frac{i}{} . P_i \right) I_{total} \ 100 \qquad (1)$$

Where:

I_{total} is the total impact on productivity due to all the failed internal processes.

C_i is the percentage causes of the internal process i (as a percentage of total causes). P_i is the percentage impact on productivity due to internal process failure i.

Table 2: Computation of the Total Impact on Productivity due to Internal Process Failure

Failed Internal Processes	**Causes in Percentage %**	**Percentage Impact on Productivity %**	**Contribution to Total Impact** $C \left(\frac{i}{100} . P_i \right)$
Maintenance management	14	22	$\frac{14}{100}$ 18 . 22 = 3.08
Safety Protocols	18	25	____ . 25 = 4.5 100
Supply Chain and Inventory	16	18	$\frac{16}{100}$. 18 = 2.88
Decision Making and Governance	10	15	$\frac{10}{100}$. 15 = 1.5

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Training and Competency	12	10	$\frac{12}{100}$. 10 = 1.2
Inspection and Quality Assurance	8	8	$\frac{8}{100}$. 8 = 0.64
Information Flow and Communication	10	10	$\frac{10}{100}$. 10 = 1.0
Incident Management and Crisis	12	12	$\frac{12}{100}$. 12 = 1.44

The sum of individual contributions to compute the total impact on productivity due to internal process failure is given as:

I_{total} = 3.08 + 4.5 + 2.88 + 1.5 + 1.2 + 0.64 + 1.0 + 1.44 = 16.74

The total impact on productivity due to failed internal processes is **16.74%**. This indicate that, this internal process failures reduce the overall productivity of the organization by approximately 16.74%

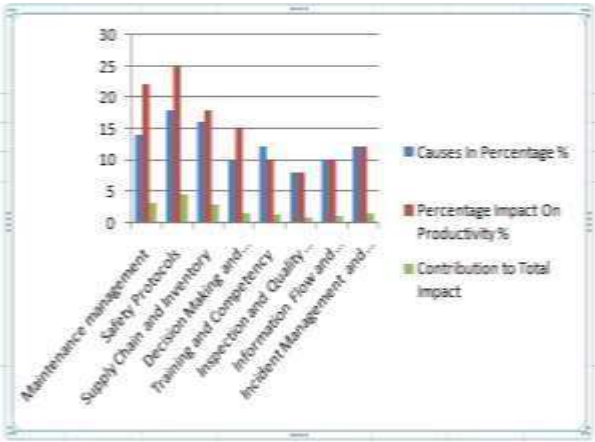

Figure 3: Total Impact on Productivity due to Failed Internal Processes

The graphical illustration in Figure 3 shows that the most significant contributors to productivity loss are Safety Protocols (25%), Maintenance Management (22%), and Supply Chain and Inventory (18%), highlighting areas that require focused attention to improve operational efficiency and reduce the negative impact on productivity in the oil and gas industry.

3.2 Systems Failure in operational risk practices within the oil and gas industry Operational risk practices in the oil and gas industry are critical to maintaining productivity, safety, and environmental sustainability. However, failed systems within these practices can severely impact productivity and have cascading effects on various operational aspects.

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Table 3: Systems failures Affecting Productivity within Operational Risk Practices in the Oil and Gas Industry

Systems Failure	Cause Percentage %	Impact on Productivity %	Impact Value
Equipment reliability	20%	25%	5.00
Control systems	18%	22%	3.96
Data management systems	15%	18%	2.70
Safety systems	12%	15%	1.80
Energy supply systems	10%	12%	1.20
Communication systems	8%	10%	0.80
Monitoring and Alarm systems	8%	5%	0.40
Emergency response systems	7%	8%	0.56

C^i

Contribution to Total Impact $(\underline{100}\ldots P_i) = \mathbf{16.42}$

The total impact on productivity as a result of Systems Failure Risk Affecting Productivity is 16.42%. This shows that, collectively, this Systems Failure reduce the aggregate result of productivity in the oil and gas industry by approximately 16.42%.

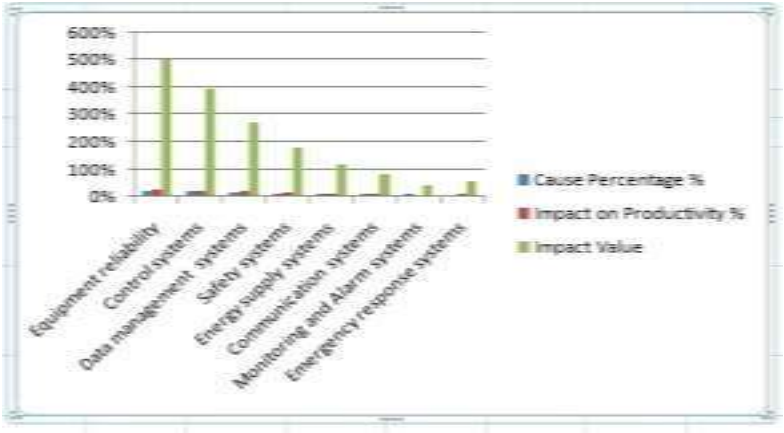

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Figure 4: The Impact on Productivity Resulting from Failed Systems

The graphical illustration in Figure indicate that not all systems contribute equally to the overall risk. The systems with the highest contributions are equipment reliability (5.00 units) with the highest impact, accounting for approximately 30.4% of the total risk, control systems (3.96 units) is the second most significant contributor, responsible for 24.1% of the total risk, while data management systems (2.70 units) contributing 16.4% to the total risk, can lead to poor decisionmaking and inefficiencies in operational workflows. Prioritizing predictive maintenance and invest in durable, high-quality equipment, conduct regular diagnostics on control systems, and ensure real-time data availability to mitigate the systems failure.

3.3 Failures Resulting from Human Errors in operational risk practices within the oil and gas industry

Human errors have a significant contributor to failures in operational risk practices within the oil and gas industry. Given the industry's high complexity, hazardous environments, and dependency on human interaction with advanced systems, the consequences of human errors can be severe as presented in Table 4.

Table 4: Effect on Productivity Resulting from Human Errors in Operational Risk Practices

Human Error Category	Percentage Cause of Failures %	Percentage Impact on Productivity %	Impact Value
Inadequate training	20%	25%	5.00
Poor decision making	18%	22%	3.96
Non-Adherence to procedures	16%	20%	3.20
Fatigue and Stress	12%	15%	1.80
Lack of Communication	10%	12%	1.20
Operator Errors	9%	10%	0.90
Maintenance Errors	8%	8%	0.64
Supervisory Failures	7%	8%	0.56

C^i

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Contribution to Total Impact $(\underline{100}\ldots P_i) = 17.26$

The total impact value of 17.26% indicates the aggregated risk to productivity resulting from human errors in operational risk practices within the oil and gas industry.

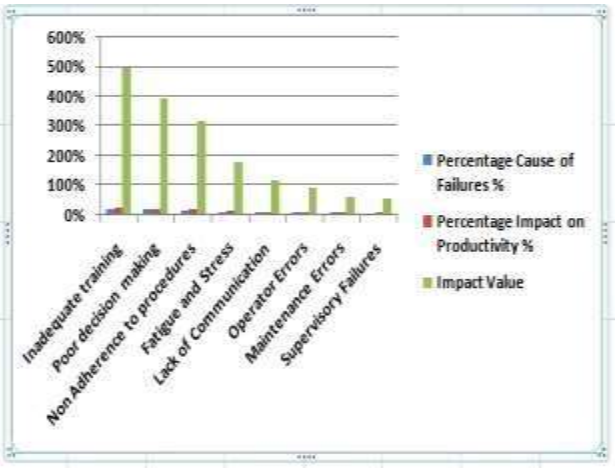

Figure 5: Impact on Productivity Resulting from Human Errors

The graphical illustration in Figure 5 shows that Inadequate Training of (5.00 units) and Poor Decision Making of (3.96 units) are the leading contributors, accounting for over 50% of the total impact. Non-Adherence to Procedures (3.20 units) and Fatigue and Stress (1.80 units) are significant but less impactful than the top two factors, while Lack of Communication with (1.20 units) and Operator Errors with (0.90 units) have lower individual contributions, yet they cumulatively add to the total risk

3.4 Failed External Events in Operational Risk Practices and Their Impact on Productivity in the Oil and Gas Industry

External events are unforeseen incidents or situations outside an organization's control that can disrupt operations, compromise safety, and significantly affect productivity. In the oil and gas industry, these events are particularly critical due to the industry's heavy dependence on external factors, such as geopolitical stability, natural conditions, and supply chain dynamics as stated in Table 5

Table 5: Effect on Productivity Resulting from External Events in Operational Risk Practices

External Events Category	Percentage Cause %	Percentage Impact on Productivity %	Impact Value
Natural disasters	15%	25%	3.75
Regulatory Changes	20%	18%	3.60
Market Fluctuations	18%	15%	2.70
Geopolitical Events	12%	14%	1.68
Supply Chain Disruptions	14%	12%	1.68

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Technological Failures	10%	10%	1.00
Social and Labor Unrest	7%	4%	0.28
Environmental incidents	4%	2%	0.08

C^i

Contribution to Total Impact $(\frac{100}{\_\_}. P_i) = 13.09$

The total impact of failed external events affecting productivity in the oil and gas industry is 13.09 units**.** This value represents the cumulative risk that external events pose to the productivity of operations in this sector, reflecting the combined effect of different risk factors such as natural disasters, regulatory changes, market fluctuations, and other disruptions.

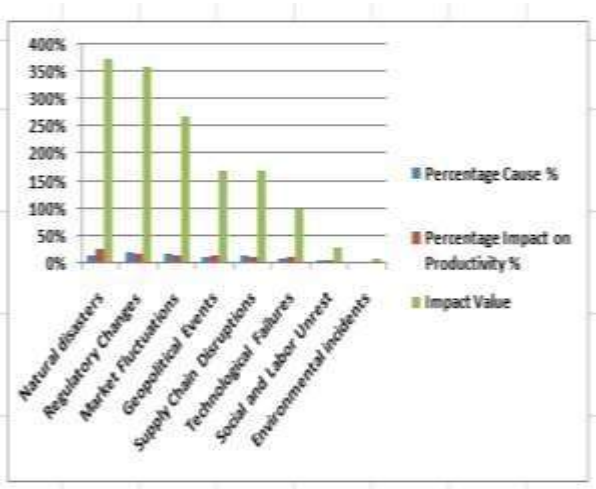

Figure 6: Value Impact Failed External Events in Operational Risk Practices

Natural Disasters of (3.75%) such as hurricanes, floods are the largest external event affecting productivity. These events can cause severe damage to physical infrastructure, such as drilling rigs, refineries, and pipelines, leading to significant downtimes and costly repairs. Regulatory Changes (3.60%) also have a significant impact on productivity. These changes may require sudden adjustments in operations, additional investments in compliance measures, or delays due to the time needed to meet new requirements

The industry needs to invest in more resilient infrastructure and develop more robust emergency response protocols to minimize the impact of these events.

4. Conclusion

The productivity in the oil and gas industry is significantly affected by four operational risk factors. Failed internal processes contribute 16.74% to productivity loss, emphasizing the need for improved procedures

(Table 2). System-related failures account for 16.42%, underscoring the importance of robust operational infrastructure (Table 3). Human errors have the highest impact at 17.26%, highlighting the critical need for enhanced training and adherence to safety protocols
(Table 4). Lastly, failed external events contribute 13.09%, showing the substantial influence of market, regulatory, and environmental disruptions (Table 5).

5. Recommendation

The following recommendations aim to mitigate the operational risks and enhance productivity in the oil and gas industry.

1. Improve safety procedures, maintenance management, and inventory control to reduce major internal process failures that collectively contribute over 40% to productivity loss.
2. Focus on equipment reliability, control systems, and real-time data management to reduce system failures, which account for 16.42% of total productivity impact.
3. Enhance workforce training, enforce procedural adherence, and reduce fatiguerelated errors to minimize human error, which contributes 17.26% to productivity decline in operations.
4. Strengthen infrastructure, prepare emergency protocols, and adapt quickly to regulatory and market shifts to mitigate the 13.09% productivity loss caused by external disruptions.

6. Acknowledgements

The authors express profound gratitude to Prof. Harold U. Nwosu and other lecturers in the
Faculty of Engineering, Mechanical Engineering Department, University of Port Harcourt, Nigeria

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