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THE NEED FOR IMPACT MITIGATION MEASURES IN EVALUATING ENGINEERING PROJECTS IN NIGERIA

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Abstract

The study aimed to assess risk management practices in the Nigerian general engineering sector, recognizing its significant contribution to the economy despite inherent risks. Employing a quantitative approach with a descriptive study design, 200 surveys were distributed, resulting in 150 valid responses. Utilizing SPSS v23 and exploratory factor analysis, findings indicated the adoption of best risk management practices akin to those in developed nations. Risk management techniques encompassed risk detection, evaluation, reaction, and control. Key aspects included information sourcing, project history, event analysis, and project image creation for risk identification and assessment. Risk response strategies encompassed risk reduction, management backup plans, and risk transfer to

Introduction

The engineering sector plays a crucial role in a country's development, as it is responsible for the creation of essential infrastructure and facilities necessary for progress (Yimam, 2011). However, compared to other projects, engineering endeavors are often associated

Third parties, while risk control focused on enhancing project quality and program planning. This study offers valuable insights to enhance risk management practices in the Nigerian general engineering sector, contributing to overall economic prosperity.

KEYWORDS: Risk management, risk, risk assessment, risk control planning, and risk detection.

With higher risks due to the nature of the activities involved (Dey,2001). Fadun and Saka (2018) defined risk in the engineering sector as unforeseen incidents that impede project completion within schedule and budget.

Mahamid (2013) highlighted two significant factors in the engineering business: time and cost overruns, with projects experiencing substantial overruns frequently linked to the sector (Abdul-Rhaman et al., 2015). Abderisak and Lindahl (2015) noted that many engineering projects exceeded their initial budgets, resulting in cost escalations ranging from 50-100%, and in some cases, surpassing 100%. Hazards in engineering operations often lead to failure to achieve project objectives, manifesting as delays, cost overruns, and compromised quality.

Effective control over hazards, rather than complete elimination, is the fundamental objective of risk management in the engineering sector. However, compared to industrialized nations, risk management practices in Nigeria's engineering sector are still nascent (Odusami et al., 2002). Consistent with Odeyinka et al. (2007), Nigeria's engineering sector is notorious for cost overruns, delays, and project abandonment. Therefore, this study aims to evaluate the current state of risk management practices in Nigeria's engineering sector. The findings of Odusami et al. (2002) and Fadun and Saka (2018) underscore the need to analyze the underlying causes of the existing status of risk management practices in Nigeria's engineering sector. Thus, the study's objective is to assess the risk management practices employed in Nigeria's engineering sector

Engineering Risk Management in Nigeria

Previous research has identified that companies regularly utilizing engineering services often neglect to integrate risk management

practices into their projects, leading to adverse effects on project performance. Ojo (2010) and Adeleke et al. (2018) conducted studies on entitlements and contract disputes in various engineering projects, highlighting the occurrence of risks that were inadequately assessed or addressed by clients, contractors, or consultants as significant contributors to claims and disputes.

Belel and Mahmood (2012), in their evaluation of risk management in the Nigerian engineering industry, emphasized that knowledge deficiency poses a significant barrier to effective risk management practices, with inexperienced personnel being a primary source of risk in engineering activities. They underscored the pivotal role of risk management in ensuring project success, noting that a considerable proportion of respondents prioritize managing on-site safety threats over addressing risks related to project cost, quality, and schedule objectives. They advocated for comprehensive training of engineering sector staff in risk management techniques.

Furthermore, prior research outcomes in Nigeria have revealed that organizations frequently employing engineering services often lack systematic risk management practices, resulting in negative project outcomes such as total project abandonment (Aibinu and Jagboro, 2002). Additionally, Ojo's (2010) study on claims and contract conflicts in numerous engineering projects highlighted the significant impact of unaddressed risks by clients, contractors, and consultants on disputes within engineering projects. The government's failure to prioritize risk management in engineering projects has contributed to an increase in project failures (Nnadi et al., 2018).

Risk Management Process

The risk-management process forms the cornerstone for identifying and addressing risks in engineering projects. To effectively implement risk management in a project, all stages of the risk management process must be engaged. The fundamental steps of risk management include (Giannakis and Louis, 2011; Ubaniet al., 2015; Kuria and Kimutai 2018)

Risk Identification

This marks the primary phase of the risk management process in engineering, involving the documentation of all potential risks that may

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emerge during the project's progression (Nnadi et al., 2018). This initial step lays the foundation for subsequent risk assessment and control procedures, enabling organizations to better identify inherent risk areas. Effective risk identification ensures comprehensive risk management by uncovering latent sources of losses that could escalate into incidents with unforeseen consequences (Ghasemi et al., 2018). Neglecting to acknowledge positive risks yields similar repercussions as overlooking negative risks (Fadun and Saka, 2018).

Risk Assessment and Analysis

As outlined by Kumar et al. (2018), the subsequent phase in the risk management process within the engineering sector involves assessing the risks identified during the initial phase. Risk assessment encompasses a systematic approach utilizing pertinent information to ascertain both the probability of occurrence and the potential severity of the consequences associated with each risk (Olamiwale, 2014). Following the identification of all project risks, the subsequent step entails conducting qualitative risk assessment, necessitating further investigation to evaluate the likelihood of risk occurrence and its impact on each identified risk (Nnadi et al., 2018). Various factors come into play at this juncture, including the impact of the risk on project objectives and the proposed mitigation strategies. Additionally, considerations such as the timing of potential occurrences, the probability of events, and their interrelations with other hazards are taken into account. Overall, this process facilitates a comprehensive understanding of each risk, thereby enabling a more effective response to mitigate potential dangers.

Risk Responses

Risk response constitutes a pivotal stage in the risk management process within the engineering sector, determining the course of action in response to risks identified during earlier stages such as identification, qualification, and quantification (Ghasemi et al., 2018). This phase involves proposing various options for eliminating or mitigating anticipated risks and selecting the most suitable alternative as a response (Nnadi et al., 2018). Olmiwale (2014) underscores that risk response entails identifying or devising alternative strategies to address risks, as well as outlining

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measures to manage risks, while emphasizing opportunities and alleviating pressures to achieve project objectives. Hence, it revolves around selecting an effective strategy to mitigate the adverse effects of risks.

Risk Control

Upon completing the stages of risk identification, assessment, and risk response within the engineering sector, it becomes imperative to undertake necessary actions. The execution of the risk plan forms a crucial aspect of risk supervision and control, which should be seamlessly integrated into the project framework. During the monitoring and control phase, two primary challenges arise: ensuring the execution and effectiveness of risk management programs and generating comprehensive documentation to support the process. Risk control entails implementing measures conducive to effective project management, employing a proactive approach to ensure that suitable protocols are in place and consistently refined, thereby fostering proactive risk management practices (Ghasemi et al., 2018).

Methodology

This study was conducted in three prominent Nigerian cities known for their significant engineering development activities. These cities include Lagos, the commercial hub of the country, which has been witnessing major engineering projects; Port-Harcourt, a major city in the Niger-Delta region, characterized by extensive development attributed to the presence of oil companies; and the Federal Capital Territory (Abuja), serving as the political center of the nation, thus expected to host numerous engineering projects. This selection of research areas was based on their prominence in engineering activities.

The choice of research methodology was determined by the nature of the research problems, objectives, and questions. The quantitative survey method was selected due to its ability to cover a large portion of the sample population within a relatively short timeframe. This approach also ensures the utilization of standardized research designs and established procedures that enable replication (Asika, 2004). Additionally, a descriptive research approach was employed to provide a comprehensive description of the characteristics of the engineering

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scenario or group under study, including behaviors, attitudes, skills, feelings, and cognition. The target audience for this research comprised active engineering professionals based in Lagos, Port-Harcourt, and Abuja FCT, including managing directors, project managers, and site supervisors. A total of 200 questionnaires were distributed, out of which 150 were collected and utilized for analysis. The collected questionnaire data were analyzed using SPSS v23.

Findings, Analysis, and Discussion

According to Adeleke et al. (2018), risk management in the engineering sector involves four primary steps: risk identification, analysis, response, and control. These steps were sequentially evaluated to determine the predominant type of risk management practice utilized in each phase. The study employed principal component analysis to assess the degree to which Nigeria's engineering sector adheres to risk management best practices, including identification, analysis/assessment, response, and control. The table presents the results of the KMO and Barlett's tests for all four practices. A cursory examination of the table indicates that the KMO yields values exceeding 0.5 for all four practices, suggesting that the data is suitable for factor analysis.

Table 1: KMO and Bartlett's Test of Sphericity for Risk Management Practice

Measurement Adopted	Identification	Assessment	Response	Control
Kaiser-Meyer-Olkin measure sampling adequacy.	0.755	0.841	0.663	0.718
Bartlett's test Approx. chi-square of sphericity Df	2008,134 .240	20022,245 .251	1984,327 .197	2115.612 .214
Sig.	.000	.000	.000	.000

Source: Data Analysis, 2024

The study used the direct oblimin approach to rotate the components that comprise the four risk management practices. Due to space constraints, the scree plot, communalities, and variance table were excluded. Some non-essential components from the pattern matrix tables were also eliminated.

Table 2 illustrates the pattern matrix for risk identification in the engineering sector. According to the table, two primary risk identification variables are identified. However, three elements are grouped under Factor 1. These items, namely 'brainstorming, Delphi methodologies, and interview or expert opinion', serve as tools for identifying and managing risks in the Nigerian engineering industry. The presence of these elements is crucial for recognizing hazards in Nigeria's engineering sector, collectively labeled as 'Information sourcing', accounting for 42.020% of the total variance.

In contrast, only two items are categorized under Factor 2. These criteria include 'previous experience' and 'checklist', grouped under 'History'. While these attributes are significant, explaining 23.560% of the total variation, they rank lower compared to other factors supporting risk identification as a risk management strategy in Nigeria's engineering sector. The findings of this study align with those of (Adeleke et al., 2018).

Table 2: Pattern Matrix for Risk Identification

Measurement Adopted	Factors	
	1	2
C.3 Brainstorming	**.309**	.081
C.4 Delphi techniques	**.232**	.022
C.2 Interview or expert opinion	**.167**	.068
C.5 Checklist	.084	**.656**

Source: Data Analysis, 2024

Table 3: Pattern Matrix for Risk Assessment

Measurement Adopted	Factors	
	1	2
C.3 Brainstorming	**.309**	.081

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C.4 Delphi techniques	**.232**	.022
C.2 Interview or expert opinion	**.167**	.068
C.5 Checklist	.084	**.656**
C.1 Past experience	.131	**.703**

Source: Data Analysis, 2024

Table 3 displays that three items are grouped under Factor 1 in the engineering sector. This factor encompasses sensitivity assessments, scenario analysis, and probabilistic analysis, collectively labeled as 'Event analysis'. These criteria are identified as the most relevant for risk assessment in Nigeria's engineering sector, explaining 40.160% of the total variation. Meanwhile, Factor 2 comprises two items related to risk variables that warrant significant attention. This factor includes the 'decision tree' and 'risk priority number (RPN)', categorized as 'Pictorial risk assessment'. These elements are crucial for risk assessment in the engineering sector, explaining 21.060% of the overall variation.

Table 4: Pattern Matrix for Risk Response

Measurement Adopted	Factors		
	1	**2**	**3**
E.1 Risk mitigation/reduction	**.217**	.111	.024
E.4 Risk avoidance	**.204**	.104	-.218
E.3 Risk acceptance	**.136**	.002	-.057
E.8 Risk exploit	.091	**.703**	-.014
E.2 Contingency plan	.072	**.661**	.199
E.5 Risk transfer	.100	.122	**.600**
E.6 Risk share	-.184	.131	**.554**
E.7 Risk enhance	-.034	-.017	**.426**

Source: Data Analysis, 2024

The pattern matrix for risk response is illustrated in Table 4. The first factor comprises 'risk mitigation/reduction, risk avoidance, and risk acceptance', serving as strategies for managing risk in the Nigerian engineering sector. These strategies are categorized as 'Risk reduction'. Factor 2 includes 'contingency plan' and 'risk exploit', labeled as 'Risk management backup

plan'. This factor explains 25.387% of the overall variance. Factor 3 consists of 'risk transfer', 'risk share', and 'risk improve', categorized as "risk management by a third party", with a variation of 11.237%.

In another aspect, Factor 1 includes four elements related to construction project quality, such as 'submission of low estimates is prevented', 'Lack of consistency between bill of quantities, drawings, and specifications is recognized and prevented', 'Gaps between implementation and specifications owing to a misunderstanding of drawings and specifications are identified and prevented', and 'Non-conformance to quality is avoided'. These elements are collectively labeled 'construction project quality'. Factor 2 comprises three elements related to project programme, including 'undefined scope of work is averted', 'inaccurate project schedule is avoided', and 'accidents are prevented because faulty safety measures are detected and remedied', labeled as 'Project programme'.

Table 5: Pattern Matrix for Risk Control

Measurement Adopted	Factors	
	1	**2**
F.1 Submission of low estimates is avoided .446	**.446**	.158
F.4 Lack of consistency between BoI, drawings and specifications is identified and prevented	**.581**	.176
F.7 Gaps between implementation and specifications due to misunderstanding of drawings and specifications is identified and prevented	**..229**	-.024
F.6 Non-conformance to quality is avoided	**.358**	.011
F.2 Undefined scope of work	.678	**.115**
F.3 Inaccurate project programme is avoided	.572	**.166**
F.5 Accidents are prevented because poor safety procedures are identified	.529	**.002**

Source: Data Analysis, 2024

Conclusion

Nigeria's engineering sector plays a pivotal role in driving economic growth, contributing to the country's GDP and facilitating infrastructure development. However, the sector faces numerous risks inherent in

engineering projects, which can impede its expansion. While these risks cannot be entirely eliminated, effective risk management practices can mitigate their impact. Therefore, this study aimed to evaluate the risk management practices employed in the Nigerian engineering sector. Previous research has identified four essential steps in risk management: identification, assessment, response, and control. To achieve this objective, principal component analysis was utilized to identify prevalent risk management practices across these processes.

The findings reveal that risk identification in the engineering sector primarily relies on information sourcing and project history. Risk assessment involves event analysis and visualization techniques. In response to identified risks, professionals adopt strategies such as risk reduction, backup planning, and risk transfer to third parties. Additionally, risk control measures focus on enhancing project quality and program planning. By shedding light on prevalent risk management practices, this study contributes to enhancing risk management in Nigerian engineering projects, ultimately improving project delivery across the sector. The study recommends the adoption of robust risk management methodologies by engineering stakeholders to enhance overall project quality.

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