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EVALUATION OF SAFETY AND QUALITY MANAGEMENT IN CONSTRUCTION PROJECTS- A STUDY OF IBOM TROPICANA CONSTRUCTION PROJECTS

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ABSTRACT
The nature of the construction industry necessities dangerous activities and the proper implementation of safety and quality management is essential to control hazards and wastes, and also to improve project success. This paper aims at adopting failure mode, effect and criticality analysis on an on-going project to investigate on how to improve safety and quality management in construction projects. In order to achieve this, the study evaluates the most critical factors influencing safety and quality management. Normative and empirical approaches are used for data collection. The possible failure mode of structural components and accident occurrence rate are analysed using the failure mode, effect and critically analysis sheets. Research findings reveal the possible causes and effects of failures and accidents. From the decision rule, the risk priority number is less than decision index number, which implies that risks/ hazards can be accepted and mitigated through the safety and quality policy designed to resolve the identified possible causes. The most critical safety and quality factors are identified as parameters for policy implementation.

Keywords: Safety factors, Quality factors, Failure mode effect and criticality analysis, Project implementation, Nigeria.

1. INTRODUCTION

The advance in technology has given rise to diverse construction procedures and improved systems in project implementation (Ogwueleka, 2010). Regardless of the improved technology, the work-related accident and injury cases have also prevailed (Aksom and Hadikusumo, 2008). The statistics reveal that the twenty percent of both industrial accidents and fatalists are reported on construction sites (FMWHD, 2007). Globally, construction employees have three times more chances of dying and two times of getting injured than any worker of other economic activity (Sousa and Teixeira, 2004). The construction industry employs a greater proportion of workforce when compared to other industrial sectors (ETA/ Business Relations Group Report, 2004). This implies that a high population of construction workforce is prone to occupational injuries and fatalities.

Major causes of these accidents on a construction site are identified as collapse of construction parts or elements, unsafe working areas, human behavior, and misuse of machineries (Abdelhamid and Everett, 2000). Stanley (2010) reports that majority of construction accident cases are simply related to poor decision making, which might be prevented using adequate safety culture. Harmoniously, Construction Engineering and Infrastructure Management (2010) reports on the study conducted by Dr Dung investigating on reasons for construction accidents in Vietnam. Poor quality and un-safety of different temporary structure systems are identified as the major causes of construction accidents. The adoption of health and safety culture is without doubt one of the most important functions within and throughout the construction process, which can influence operating environment to achieve project objectives (Abdul-Raouf, 2004; Husin et al., 2008; Ogwueleka, 2011).

Researchers and project participants have adopted different management practices for project execution targeted towards reducing occupational injuries and fatalities. The positive drivers adopted for these management practices, in other industrial sectors are centered on quality management philosophies. In the construction sector, the recent development has shifted clients' objectives towards improved service quality, faster buildings and innovations in technology, and also the quality management practices are designed to meet clients' views of quality, as well as, complying with specifications. Husin et al. (2008) advocate that the integration of safety management into quality assurance and control will show a more comprehensive approach for safety assurance practices, as well as, improve the realisation of project objectives. Most researchers emphasise that safety is parallel to quality in a one-way relationship, where safety management can be improved through quality management processes, not the other way round (Krause, 1994; Cooper & Phillips, 1995). Contrary, recent studies have proved that safety leads to quality, and also working safe can enhance performance, likewise quality can support safety by reducing losses of assets (Husin et al. 2008; Stewart & Townsend, 1999).

An integration of safety and quality management will encourage the support and synergistic of each other, thereby maximise their mutual effectiveness. Numerous safety and quality management tools have been developed for improving efficiency and effectiveness of construction processes by eliminating waste and increase profit. For example, Construction Safety and Health Monitoring (CSHM) web based system, Occupational Safety and Health Administration Voluntary Protection Programs (OSHA VPP), Occupational Safety Health Administration (OSHA) construction E-tool, Occupational Health Safety Management system (OHSA 18001), and International Organisation of Standardisation (ISO 9001). Despite several efforts to prevent occupational injuries and fatalities, construction workers still remain casualties. Chan and Tam (2000) attribute these problems to poor safety and quality measures, which can be prevented through proper management of design complexities.

Achieving project success requires cooperative efforts of contracting parties, but this may be difficult to attain due to different priorities amongst the parties. This might resulted in design complexities with frequent changes to design details. Extreme changes in project design can bring about risk to project quality. Risk is evitable in safety and quality management, there is need for effective practices with underlying procedures for achieving safety in environment, during job execution, and amongst project participants, and also for achieving quality in clients' expectations and specifications. Most of these approaches focus on symptoms and have failed to identify the possible causes and the impact of occupational injuries and fatalities on project sites.

Failure mode, effects, and critically analysis is a technique used to identify, to prioritize, and to eliminate potential failures from the system, design or process before they reach the customer. This paper adopts the failure mode, effects, and critically analysis to assess the potential failure mode of the structural components of Ibom Tropicana construction projects and possible accident causes. In order to achieve this, the following objectives are considered: a) identification of critical factors influencing safety and quality management b) assessment of possible causes and effects of failure and occupational accidents.

2. REVIEW OF SAFETY AND QUALITY FACTORS

Quality management has become a focal point in the construction sector, most stakeholders are concerned with the quality of their projects, while contractors are more concerned with safety of their workers (Ogwueleka, 2011). Although, adequate quality management can facilitate project success and organisational sustainability, but negligence of safety management has increasingly resulted in occupational accidents and injuries to construction workers. Occupational injuries and fatalities can affect the manpower output of workers and project success. Husin et al. (2008) emphasise that safety leads to quality. For example, it is difficult for a mason to lay brick on a straight line, if one hand is needed to hang onto the scaffold. Hoonakker et al. (2003) advocates for an integration of safety and quality management system, in order to reduce variability in the construction process, for example, failure of building elements, workers inefficiencies, and injuries. Several researchers have proved that the integration of both safety and quality management can improve productivity and occupational safety/ health and also minimize cost overruns (Mckim and Kiani, 1995; Schriener et al., 1995; Kuprenas and Kenney, 1998). The functions of safety and quality management are similar in several aspects such as: scope, critically to success and goal, detection, obstacles and problem causes, response, effect of failure, and difficult in optimizing the program (Husin et al., 2008).

The similarities between safety and quality functions and their abilities to co-exist in the same environment can prove that they can be easily integrated to produce positive effect. The literature scan reviews specific factors that are significantly important towards successful implementation of safety and quality programs to achieve desired outcomes. Tam et al. (2004) reveals elements of poor construction safety management in China as: lack of training, poor safety awareness of project managers, reluctance of input resources to safety, and reckless operation. Client requirement, insurance company requirement and employee requirement are identified as criteria for safety management system implementation (Law et al., 2006). Smallwood (2000) highlights the most common barriers to safety implementation as: lack of skilled workers, poor management commitment, workers altitude, and type and nature of construction. Coble and Kibert (1994) stipulate that construction accidents mostly occur on site, due to inappropriate knowledge or training, errors in judgment or carelessness and poor machineries. These causes can be eliminated or reduced by adoption of safety performance indicators such as: management commitment/ review, cost effectiveness/ time, communication, audits/ observations, strong safety culture/ climate, emphases on short-term objectives, and employee involvement/ empowerment (Hoonakkar et al., 2003).

European process safety center (1994) specifies the core safety management elements as: safety policy/ arrangement, organization, management practices and procedures, monitoring and auditing and management review. Husin et al. (2008) list the threats to safety implementation as: tight project schedule, low management competency, unsuitable planning, excessive approval procedures, variations, lack of coordination between project participants, and unavailability of skilled labor. Customer requirement, insurance company requirement, employee requirement and cost effectiveness are regarded as safety management criteria (Ashmore, 1995; Sakvik and Nytro, 1996; Harms-Ringdahl et al., 2000; Pun and Hui, 2002). Table 1 represents the summary of factors influencing safety management in construction projects.

Husin and Adnan (2008) highlight the threats to quality management implementation as: tight project schedule, inadequate scheduling, unsuitable construction planning, incomplete or inaccurate cost estimate, low management competency, variations, lack of coordination between project participants, unavailability of sufficient skilled labour. Supervision, relationship between project participants, bid selection process, training, quality policy and performance of quality tools are identified as quality factors (Arditi and Gunaydin, 1998). Chan and Tam (2000) state the major factors influencing quality performance in construction projects as: planning process, design/ project complexities, nature uniqueness, availability of resources and project environment. The most common barriers to a successful quality management are lack of management/ leadership skills, poor understanding of customer/ client expectation, lack of worker empowerment/ incentive and nature of job or construction industry (Loushine and Hoonakker, 2002).

Hoonakker (2006) identifies quality indicators as teamwork, continuous improvement, management commitment, communication, customer or client focus, employment involvement/ empowerment.

Joaquin et al. (2008) spell out quality problems as: low quality continuous improvement, lack of quality policy and poor availability of resources. Wong and Fung (1999) point out project supervision and subcontractor responsibility as critical factors influencing quality performance. Reduced subcontractor responsibility, inappropriate bid selection method, lack of auditing system, low quality continuous improvement and lack of motivation are listed as quality problems (Pheng and Wei, 1996). Marosszeky et al. (2002) identify quality setbacks as poor organization structure, lack of motivation, poor management commitment and poor teamwork. Other previous studies have identified quality factors as coordination between project participants, expertise knowledge/ training, design complexity, subcontractor responsibility, planning process, auditing system, management commitment, availability of resources, incentives and nature uniqueness (Jha and Iyer, 2006; Tang et al., 2009; Leonard, 2008; Moody, 2005; Saraph et al., 1989; Samuels, 1994; Hiyassat, 2000; Yung and Yip, 2010; Mohammed and Abdullah, 2006; Serpell, 1999; Kanji and Wong, 1998).Table 2 denotes the summary of factors influencing quality management in construction projects.

3. THE APPLICATION OF FAILURE MODE, EFFECTS AND CRITICALLY ANALYSIS

Failure mode, effects and criticality analysis (FMECA) was one of the first systematic techniques used in US Military for failure analysis, which was guided by Military procedure MIL-P-1629 (Rausand and Hoyland, 2004). This technique is usually adopted as the early stage of system to identify errors and failures, where the mitigation measures of failure mode will be cost-effective. It has been previously adopted by different researchers to identify technical risks, potential failure and construction errors. Barlett and Cliff (1999) adopt FMECA in Building Research Establishment to analyse supply chain of buildings during whole system lifecycle. This technique was used to identify critical failures of the supply chain, and also in decision making on the correction actions and modifications applied. Wyatt (2005) employs FMECA and fault tree method to assess building performance, the study reveals possible errors in the design phase. In the study conducted by Pollo (2003), FMECA was adopted as a part of the technique used in analysing the system lifecycle of building components during design phase in the University of Turin. Results of the analysis reveal degradation rates for each component, and this also assisted in improving maintenance and optimizing the global cost. In window and cladding technology, Layzell and Ledbetter (1998) apply FMECA to study cladding failures of both elemental and building process levels. The findings of the research are considered relevant to improve cladding quality during design phase, to facilitate inspection, and to survey actions during installation phase.

Table 1: Summary of factors influencing safety management in construction projects

SAFETY FACTORS	1	2	3	4	5	6	7	8	9	10	11
Management Commitment		x				x					x
Employee involvement/ altitude		x			x	x			x		x
Errors in judgement or carelessness	x		x								
Expertise knowledge or training	x		x			x				x	
Poor machineries	x										
Communication		x									x
Audits/ observations		x		x							x
Safety culture/ climate		x									x
Safety awareness of top management/ top managers			x							x	
Reluctance of input resources to safety			x								
Safety policy/ arrangement				x							
Type/ nature of construction						x					
Safety management/ practices/ procedures/ review				x						x	
Client involvement					x		x				
Insurance company requirement					x			x			
Cost-effective/ time											x
Tight project schedule										x	
Improper construction planning/ programs										x	
Variations											
Lack of coordination between project participants										x	
Employee empowerment											x
Emphases on short-term objectives											x

(1) Coble and Kibert (1994), (2) Loushine and Hoonakker (2002), (3) Tam et al (2004), (4) European process safety centre (1994), (5) Law et al (2006), (6) Smallwood (2000), (7) Pun and Hui (2002), (8) Harm-Ringdahl (2000), (9) Saksvik and Nytro (1996), (10) Husin et al (2008), (11) Hoonakker (2002).

Table 2: Summary of factors influencing quality management in construction projects

QUALITY FACTORS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Management/ leadership skills	x																			
Interpretations of client/customer expectations	x																			
Worker empowerment/incentive	x			x								x					x	x		
Organization structure																	x			
Nature of construction	x																			
Continuous improvement							x					x								
Management commitment		x	x	x										x			x			
Communication		x																		
Client/customer focus		x																		
Employee involvement/ altitude		x		x																
Tight project schedule			x																	
Inaccurate or incomplete estimate			x																	
Variations			x																	
Planning/ scheduling process			x		x								x			x				
Coordination between project participants		x	x			x			x	x							x			
Expertise knowledge or training system			x	x		x												x	x	
Tendering and bidding climate				x		x			x			x								
Emphases on short-term objectives				x																
Cost and time implementation				x																
Design complexity					x					x										
Quality policy						x	x													
Project supervision						x		x												
Auditing system												x		x						
Subcontractor's responsibility								x				x								
Nature uniqueness					x															x
Availability of resources					x		x								x					
Project environment					x															

(1) Loushine and Hoonakker (2002), (2) Hoonakker (2006), (3) Husin and Adnan (2008), (4) Hoonakker et al, (2003), (5) Chan and Tam (2000), (6) Arditi and Gunayalin (1998), (7) Joaquin et al (2008), (8) Wong and Fung (1999), (9) Jha and Iyer (2006), (10) Tang et al (2009), (11) Leonard (2008), (12) Pheng and Wei (1996), (13)Moody (2005), (15) Saraph et al (1989), (16) Samuels (1994), (17) Hiyassat (2000), (18) Marosszeky et al (2002), (19) Yung and Yip (2010), (20) Mohammed and Abudullah (1999), (21) kanji and Wong (1998).

4. RESEARCH METHODOLOGY

4.1 Questionnaire Design

This paper is designed to analyse safety and quality management using failure mode, effects and criticality analysis (FMECA) in an ongoing Ibom Tropicana and Tourism project. The study adopted normative and empirical approach to ensure unbiased judgment. The normative approach involves the collection of data from existing safety and quality management records of both contractors and subcontractors.

The empirical approach involves the administration of structured questionnaire to consultants, consultants and subcontractors participating in the project. The questionnaire is designed to determine the importance index for both safety and quality factors. In order to achieve this, the respondents are expected to rank each factor using two scales. The first scale ranges from 0 for never occurred to 4 for Always and the second scale ranges from 0 for never severe to 4 for extremely severe. Pilot studies were carried out to ensure clarity and relevance of the drafted questionnaire. The drafted questionnaire was reviewed by four professionals in the research field. The two professionals are university professors, while the other two are researchers in the related field. Amendments are made on the drafted questionnaire based on the suggestions made by reviewers. The questionnaire was administered to respondents using face to face method to ensure validity of their responses.

4.2 Characteristics of Respondents

The project site is located at Akwa Ibom State in Nigeria. In recent times, Akwa Ibom state has been recognised by both local and international bodies for rapid development, which has earned the present administration several awards for gigantic efforts. The signing of Nigeria's National Building Code (NBC) into law in 2007 has increased the demand of adequate safety, health, and quality in construction. However, unofficial statistics reveal an increase in safety related incidents and collapse of buildings year to year since 2007. The struggle to enforce the law has led to the demand for possible solutions to work-related accidents and injuries on construction sites. The study project is owned by Akwa Ibom government covering an area of about 84 hectares of land, with about seven different construction projects including Convention Centre, seven-star hotel, mega cinema, ground hall, children's park, and others. The structure consists of 235 numbers of piles with diameter varying from 600 – 1000mm. This study targeted 220 construction professionals working on the project site. For varied reasons, 40 did not respond which reduced the population size to 180 professionals. Figures 1, 2 and 3 reveal the demographic data of respondents with 50% of subcontractors, 42% of contractors and 8% of consultants. This reveals that majority of respondents as actively involved in project implementation as subcontractors (see figure1). Figure 2 reveals the working experience of respondents below 5 years (30 percent), between 5 to 9 years (13 percent), between 10 to 15 years (51 percent) and above 15 years (6 percent) while figure 3 shows 56 percent of the respondents are experienced in both building/ industrial projects, 32 percent in bridge/ road projects, and 12 percent in both.

Figure 1: Distribution of respondents by profession in projects

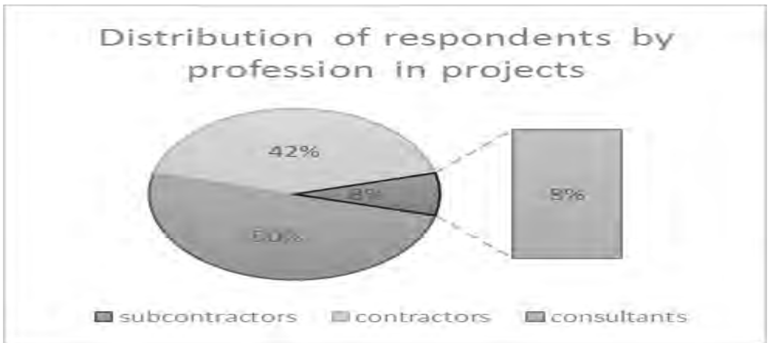
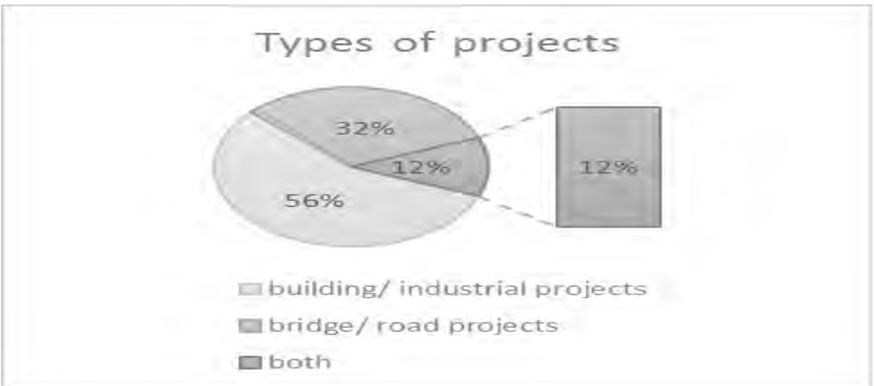


Figure 2: Distribution of respondents by years of working experience in the construction industry

Figure 3: Types of project involved by respondents



4.3 Method of Data Analysis

The data collected by normative approach are analysed using importance index in FMECA known as Risk Priority Number (RPN). The RPN is a measure of the risk of failures which can be expressed as:

RPN = O x S x D

Where O is the occurrence of failure showing the probability that the failure mode will occur as a result of specific case; S is the severity representing the measurement of the seriousness of the effect of the potential failure mode on the system; and D presents the rank of likelihood that a potential failure will be detected.

The formula for decision rule is stated as:

$$DIN = \frac{N \times 10^6}{10^N}$$

Where DIN represents Decision index number and N is the number of identified failure/ risk. For this study, the total number of potential failure/ accident mode identified is 4. Using the decision rule formula, it is calculated as:

$$DIN = \frac{4 \times 10^6}{10^4} = 400$$

The decision rule states that where RPN<DIN, the potential failure will be accepted and where RPN>DIN, the potential failure will be rejected. Evaluation of data collected through empirical approach was done using three types of indices namely frequency, severity and importance indices. The frequency and severity indices are calculated using both formulas:

$$F.I. = \frac{\sum_{0}^{4} a_i n_i}{4N}$$

and

$$S.I. = \frac{\sum_{0}^{4} a_i n_i}{4N}$$

Where a represents weight assigned; n is frequency of each response; and N is total number of responses. The importance index expresses the overview of the factors of both frequency and severity indices. It is calculated using the formula:

IMPORTANT INDEX = FREQUENCY INDEX x SEVERITY INDEX

5. FINDINGS AND DISCUSSIONS

The Pareto rule states that the highest ranked has the greatest influence, assumptions are made based on this rule. Table 3 and 4 reveal the frequency, severity and important indices of the factors influencing safety and quality management in construction projects. From table 3, the index rank reveals the three most important factors influencing safety management in construction projects as: poor machineries, errors in judgment or carelessness, and management commitment. The use of both manual and non-manual machineries is essential for execution of all types of building and construction projects. The analysis shows that poor machineries as factor, which has contributed immensely to the challenges associated with safety management in construction projects in Nigeria. Decision making is a crucial aspect in project implementation. Errors in judgment or carelessness is ranked second, it is generally accepted by respondents that decisions taken by project participants can greatly influence the management of safety in projects. The commitment of top management is concerned as a crucial requisite for safety policy implementation. A sincere commitment by management and consistency in enforcement of safety rules are foundations for effective safety program. The least important factor is concerned as audits and observations. Most respondents believed that audits and observations of work progress can only play little or no significant influence in safety procedure.

From table 4, the three important factors influencing quality management are considered as: inaccurate or incomplete cost estimate, employee involvement and altitude, and finally expertise knowledge or training. The most commonly adopted bidding process in Nigeria is the lowest bid selection process. Most bidders are mostly concerned with winning the bid by tendering the lowest bids , where they might submit inaccurate or incomplete cost estimates deliberately or accidently. If eventually they win, they try to cut corners in order to complete the projects which will affect the quality of their jobs. The analysis reveals inaccurate or incomplete cost estimate as the highest ranked factor influencing quality management in construction projects. The behavioral pattern of project employees has a major role to play in project productivity or output. The analysis ranks employee involvement and altitude to work as second highest factor influencing quality management. For complex and larger projects, a construction company may not have all the required expertise. In specialized areas, it is important to employ an expert in the related field to manage the work element. The study shows that the quality of a project can be enhanced through proper involvement of experts in the relevant areas; this is ranked as the third factor.

The table 5 discloses the possible failure mode of the component, where four possible failure modes are identified. These possible failure modes are breakage while driving in, un- monolithic curing of concrete, drilling without bailing underground water and inability of pile to reach the desired depth. The causes and effects of these possible failure modes are analysed, in order to assess the possible impacts. The assessment exposes the possible failure mode, causes and effects on components. The risk priority number (RPN) is calculated as 340 as against decision index number (DIN) of 400. Based on the decision rule, the RPN < DIN where this is possibility the component failure rate can occur, but can be accepted and prevented through proper mitigations. Table 6 shows the possible accident occurrence on project site where four possible accident modes are identified. These modes are driving hammer falling on worker, spattered pile falling on worker, suspended drilling hook dropping on worker and worker dropping into drilled holes. The analysis reveals the causes and effects of these possible accident modes. The risk priority number (RPN) for possible accident occurrence is calculated as 385 as against decision index number (DIN) of 400. Although, the RPN is close to DIN, but RPN< DIN, therefore the accident occurrence rate will be accepted and mitigated.

Table 3: Frequency, severity and importance indices of factors influencing safety management in construction projects

Safety factors	Frequency index	Severity index	Importance index	Index rank
Management commitment	0.928	0.824	0.765	3
Employee involvement/ altitude	0.527	0.425	0.224	19
Errors in judgment or carelessness	0.892	0.877	0.782	2
Expertise knowledge or training	0.884	0.535	0.473	9
Poor machineries	0.880	0.921	0.811	1
Communication	0.651	0.544	0.354	14
Audit/ observations	0.421	0.351	0.148	22
Safety culture/climate	0.782	0.447	0.350	15
Safety awareness of top management/ project managers	0.904	0.838	0.758	4
Reluctance of input resources to safety	0.724	0.652	0.472	10
Safety policy/ arrangement	0.681	0.521	0.355	13
Safety management practices/ procedure/ review	0.525	0.488	0.256	16
Type and nature of construction	0.482	0.323	0.156	21
Client involvement	0.854	0.712	0.608	5
Insurance company requirement	0.723	0.318	0.230	18
Cost effectiveness/ time	0.654	0.587	0.384	11
Tight project schedule	0.812	0.725	0.589	7
Improper construction planning/ procedure	0.743	0.656	0.487	8
Variations	0.654	0.921	0.604	6
Lack of coordination between project participants	0.548	0.685	0.375	12
Employee empowerment	0.482	0.512	0.248	17
Emphases on short objectives	0.526	0.321	0.169	20

Table 4: Frequency, severity and importance indices of factors influencing quality management in construction projects

Quality factors	Frequency index	Severity index	Importance index	Index rank
Management/ leadership skills	0.833	0.751	0.626	9
Interpretation of client/ customer expectation	0.759	0.521	0.395	19
Worker empowerment through incentive	0.778	0.431	0.335	23
Organization structure	0.658	0.523	0.344	22
Teamwork	0.806	0.648	0.522	15
Continuous improvement	0.788	0.858	0.676	5
Management commitment	0.724	0.725	0.525	14
Communication	0.812	0.631	0.512	17
Client/ customer focus	0.851	0.723	0.615	10
Employee involvement/ altitude	0.901	0.890	0.801	2
Tight project schedule	0.478	0.527	0.252	25
Inaccurate or incomplete cost estimate	0.854	0.950	0.811	1
Variations	0.724	0.823	0.596	12
Improper planning/ scheduling	0.644	0.545	0.351	20
Coordination between project participants	0.756	0.831	0.628	8
Expertise knowledge and training	0.890	0.884	0.787	3
Tendering/bidding climate	0.806	0.702	0.566	13
Emphases on short term objectives	0.792	0.653	0.517	16
Cost and time implementation	0.347	0.575	0.200	26
Design complexity	0.856	0.766	0.656	7
Quality policy	0.726	0.823	0.597	11
Project supervision	0.923	0.811	0.749	4
Auditing system	0.665	0.522	0.347	21
Subcontractors responsibility	0.754	0.892	0.673	6
Nature uniqueness	0.215	0.451	0.097	27
Availability of resources	0.670	0.758	0.508	18
Project environment	0.421	0.688	0.289	24

Table 5: FMECA sheet of possible failure mode of structural component

Project: IBOM TROPICANA
Component Name: PILING
Component Location: STRUCTURAL/ CONVENTION CENTRE
Issue Number: 1

Part or system name	Function	Possible failure mode	Cause of failure mode	Effects of failure on component	O	S	D	RPN
1. Precast piles	Serves as substructure to high rise buildings	Breakage while driving in.	Excessive driving in load.	Foundation settlement.	8	5	1	40
2. Bored piles	Transmits building load to a good soil bearing capacity which cannot be easily reached	Un-monolithic curing of concrete.	Height of casting.	Undesired strength is achieved.	6	3	5	90
		Drilling without bailing underground water.	Lack of workers supervision .	Undesired chemicals react with concrete thereby reducing its strength.	5	3	2	30
		Pile not getting to the desired depth	Pile can reach a false firm stratum.	Settlement of the structure overtime	2	10	9	180
								340

Table 6: FMECA sheet of possible accident occurrence

Project: IBOM TROPICANA
Work Item: DRILLING HOLES FOR PILES
Work Location: STRUCTURAL/ CONVENTION CENTRE
Issue Number: 2

Part or system name	Function	Possible accident mode	Cause of accident mode	Effects of accident on work	O	S	D	RPN
1. Driving in precast piles	Serves as substructure to high rise buildings	Driving hammer head falling worker.	Unsecured hammer head.	Death of worker.	3	2	10	60
		Spattered piles falling on worker.	Improper fixing of absorber to pile head.	Reduced workforce.	7	5	3	105
2. Boring holes in piles	Transmits building load to a good soil bearing capacity which cannot be easily reached	Suspended drilling hook falling on worker.	No PPE use and safety signs.	Reduced workforce and efficiency.	4	5	1	20
		Worker falling into drilled hole.	No caution and safety signs.	Death of worker.	2	10	10	200
								385

6. CONCLUSION AND RECOMMENDATION

The research survey demonstrated that safety and quality management is a vital tool in improving performance, profitability and productivity during project implementation. In the literature scan, the study identified a total number of 22 safety factors and 27 quality factors which was evaluated. The result reveals three important safety factors as: poor machineries, errors in judgment or carelessness, and management commitment. The three most important quality factors are identified as: inaccurate or incomplete cost estimate, employee involvement, and altitude and finally expertise knowledge or training. The analysis reveals both manual and non-manual machineries are essential for all building and construction projects. Therefore, poor machineries are considered as most important factor influencing safety management. Challenges associated with bid evaluation process have resulted to contractors submitting inaccurate or incomplete cost estimates deliberately or accidently in order to achieve lowest bid prices. If eventually they are selected to execute the jobs, then they cut corners to complete their jobs within the quoted bid prices. The analysis also discloses inaccurate and incomplete cost estimate as the most important factor influencing quality management.

The application of failure mode, effects and critically analysis (FMECA) on the on-going project reveals the component failure rate as RPN<DIN, which implies that there is possibility of component failure occurrence on the project site, but it can be accepted and mitigated. The possible accident occurrence rate on project site is estimated as RPN<DIN, which still emphasises the possibility of accident and injury occurrence, but it can be accepted and mitigated. From the research findings, the on-going project is prone to risks associated to the identified failure and accident modes. In order to resolve these risks, safety and quality management programs must be efficient in addressing their issues. This study has created insight for the adoption of FMECA in safety and quality management from the perspective of Akwa Ibom state government projects in Nigeria. More so, it has also exposed the critical factors to be considered in managing both safety and quality issues. Similar studies are hereby recommended in both developing and developed countries for comparison.

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