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ASSESSMENT OF OCCUPATIONAL HEALTH AND SAFETY RISKS IN SELECTED CONSTRUCTION SITES IN OYO STATE, NIGERIA

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ABSTRACT

Construction sites are an important part of the economy in many countries including Nigeria and is often seen as a tool for economic growth. However, these sites face significant occupational health and safety (OHS) challenges, characterized by high accident rates and substantial health risks. This study assessed occupational health and safety practices in selected construction sites in Oyo State, Nigeria, focusing on Reynolds Construction Company and Arab Contractors as case studies. Through a mixed-method approach involving interviews, questionnaires, and site observations, the research investigated current OHS assessment practices, risk management protocols, and implementation challenges. The study revealed critical findings: risk management responsibilities are exclusively delegated to contractors and limited to the construction phase, with no systematic assessment methodology in place. Instead, risk evaluation relies heavily on individual judgment, guided by personal experience, educational background, and existing regulations. The research identified that risk communication primarily occurs through toolbox meetings and informal discussions, while risk control predominantly depends on Personal Protective Equipment (PPE). Key factors influencing OHS management include regulatory frameworks, individual competencies, and work environment conditions. Notable challenges hampering effective OHS implementation include site configuration, procurement systems, design complexity, and geographical location constraints. Analysis of hazard consequences revealed that working at heights and manual handling presented the highest risk factors, followed by exposure to chemicals, dust, and noise. The study also found that 71% of workers lacked formal health and safety training, potentially contributing to the 31.74% rate of major accidents reported during task performance. This research recommends a more integrated approach to OHS management, emphasizing the need for active involvement from key project stakeholders, including clients, design teams, consultants, and government agencies, to enhance safety standards in Nigerian construction sites. The findings contribute to the understanding of OHS practices in developing countries and provide a framework for improving construction site safety in Nigeria. Therefore, in Nigeria, the study suggests that there is a need for the key project stakeholders such as client, design team consultants and government to be involved in managing health and safety risk on construction sites.

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1. INTRODUCTION

The Construction industry in Oyo State, Nigeria is often seen as a driver of economic growth. Nigeria owing to its diversity and nature, the building construction industry provides opportunities for employment for Nigerians in Oyo State and Nigeria as a whole. Building construction shows that there are opportunities open to construction crews. In reference to building construction advancement or progress, the industry is facing different challenges during operations or execution. Worldwide construction sites have always been regarded as very risky environments where construction employees are exposed to accidents and health problems [1].

Many investors or stakeholders see road and construction as risky due to health and safety, especially when construction activities involve dangerous heights, underground, confined spaces or close proximity to falling objects or materials, handling loads manually, handling hazardous substances, noises, specks of dust using plank and equipment, fire and exposure life cables [2]. In addition, the road and building construction industry is considered risky due to its frequent and high accident rates including OHS problems to workers, professionals, practitioners and users or occupants.

In spite of the risk involved, the construction industry is still considered to be the driver of economic growth in Nigeria. It contributed almost 10% of Nigeria's GNP in 2013 and 11% in 2014 compared to previous years 2008-2010. The building construction Industry has also employed 12% of the population of workforce in Nigeria. The construction industry is experiencing considerable growth in both economic and construction activities, especially in State Capitals and Capital Territory. The rate of growth in Abuja has heightened demand for infrastructural facilities to consumers. The demand for services has brought about an increase in the number of building and construction activities and employment opportunities for a wide range of skilled, semi-skilled and unskilled workers.

Regarding the contribution and development attained in building construction industries in Nigeria, Construction project sites can be considered as the second death trap after road traffic in Nigeria. This is because the number of deaths, permanent disabilities and severe injuries are on the increase for building construction employees. Poor working conditions and lack of control are the monumental threat to construction employee's safety.

As a result, the overall performance of the building construction industry is diminishing and is affecting the labour force and economy of the country. In reference to the building construction industry the challenges confronting Nigeria as a country is how to mitigate the accidents and health problems that are commonly occurring at construction sites in Nigeria. This has been a challenge for the reports, practice, policy, risk, accidents, and ill-health problems on construction sites [3, 4].

According to [5], work practice analysis, risk analysis, communication and control analysis can be managed or minimized if risk assessment analysis to determine the level of employees' exposure to health and safety hazards at work are taken on board. This may help to establish the instrument necessary to control the risk and protect health on site. Similarly, through assessment communication and control, project participants are informed and educated about the risks, and warned about disasters and how to manage emergencies [6]. In Nigeria particularly, the Occupational Health and Safety 1990, the Contractors Act 1990, Factories Act 1990, Workmen Compensation Act 1987, effective communication in safety management First Aid, Occupational Diseases and Fire Safety are not implemented accordingly [7].

However, little is known regarding the industry response and in particular the practice employed against health and safety risk assessment and communication. It is not well known or understood how Nigerians deal with hazards, how information is processed and evaluated, and how the information received affects perception of risk evaluation; behaviour change and which parties are involved. The lack of such information and experiences has limited the intervention process of improving health and ensuring a safe work environment on construction site in Nigeria.

In Nigeria as a developing nation, data on health and safety risk assessment, communication and control in construction management is inadequate. Deaths, permanent disability, severe injuries are common among construction employees due to major accidents and poor working environments at road construction sites are the influencing factors. Literatures around the world have identified several leading occupational health and safety risk assessment methods and models [8, 9, 10, 11, 12].

This unfortunate scenario has been a monumental threat to the overall performance of building construction projects which indirectly affects Nigeria economy. The first challenge facing Nigerian Engineers is how to reduce the accidents, and health problems and improve working conditions at construction sites in Nigeria. It is not well known how the industry deals with hazard and risk information and how it is processed and evaluated in Nigeria's construction industry. However, all of these studies have been carried out in developed countries. None among the existing studies have been done to suit Nigeria's needs [13].

The construction industry leaves occupational health and safety in the hand of the main contractor. Few studies have been conducted to include Occupational health and safety during design and procurement

phase. The construction industry is diminishing and is affecting the labour force and economy of the country [14].

The issue of workplace occupation health and safety is extremely relevant, failing to adhere to its principles; it affects moral, legal proceeding; financially; even both social, psychological and economics in the society. Workers on construction sites are exposed to extremely high risks as working conditions are constantly changing. Various construction equipment mechanisms are used, and workers of various professions/professional levels are involved. Furthermore, improving occupation health and safety risk management of construction projects has repeatedly been shown to have saved lives, time and money, also increases business goodwill and good reputations [15]. At the same time, the right to safety, healthy and safe site working conditions have been a central issue globally.

Campaign for saver and healthier working conditions makes an important contribution to poverty alleviation and sustainable development. This study seems to be in line with Nigeria development strategies, which recognizes that the construction industry is central to the economic development of the country. It has not been genuinely visualized during preparation of the tender documents and the tender evaluation process, whether the issue of health and safety has been strictly given its significance importance or has made enough provisions for health and safety management.

2. RESEARCH METHOD

2.1 Research Approach

This study used mixed method approach, interviewing, administering questionnaires to sample of research respondents, measures the reactions of individuals, thus facilitating comparison and statistically aggregation of the data so that the results can be generalized. Three different investigations were conducted using people who are exposed to hazard; duration and severity of harm and the flow of workday activities were considered. The investigation also considered the knowledge of regulations and Safety Standards under which Construction Operation Operates. It is believed that regulation procedures have provided guidelines on how risks should be assessed at construction sites. The qualitative estimate uses descriptive terms to define the likelihood and consequences of risk events. This process relies on an individual collective judgment in assessing the magnitude of the risks involved. In this study, it is classified into low, medium and high risks. The matrix method is used in this study to compare risk levels for different events and set priorities in taking action. The greater the efforts made to control it, the greater the urgency to control the risk and take action. Table 1 shows the matrix for estimating qualitative occupational health and safety risk.

Table 1: Health and Safety Matrix table for qualitative approach and risk Rating

Likelihood		CONSEQUENCES				
		1 Negligible Injuries	2 Minor Injury	3 Moderate	4 Major Injury	5 Fatality
A	Very likely	A1	A2	A3	A4	A5
B	Likely	B1	B2	B3	B4	B5
C	Possible	C1	C2	C3	C4	C5
D	Unlikely	D1	D2	D3	D4	D5
E	Rare	E1	E2	E3	E4	E5

Risk Rating follow the Colour as shown	EXTREME	HIGH	MODERATE	LOW

Table 1 shows the simple ranking mechanism of matrix, indicating different levels of risks, such as negligible injury as level 1, minor injury as level 2, moderate injury as level 3, major injury as level 4 and fatality as level 5. Similarly, likelihood can be determined as very likely – level A. likely – level B, possibly – C, unlikely –

level D or Rare – level E, the table also indicates that there are 25 potential risk combinations and the risk outcomes have been divided into risk – levels (Ratings) such as, Extreme, High, Moderate and Low. For this rating, the extreme situation indicates there are fatal consequences which should be resolved first while low rating indicates negligible injury which requires only first Aid.

Quantitative Risk Assessment Estimation (QRAS) uses numerical values to express both consequences and likelihood at a given event. This approach involves the use of intensive mathematical equations and modeling to rank risk into low, medium and high ranks which describe the frequency of injury or death.

Matrix Risk assessment technique where six levels risk Matrix are identified shows that as both severity and probability increase, the risk is higher. It also shows the risk rating where the numbers indicate higher risk; the situation is unacceptable (20-40) in Nigeria. Undesirable both severity and probability increase can be controlled or reduced but both management and workers are careless or care free believing that nothing would happen (10-16). Acceptable situation the risk situation is highly controlled. QRAS is generally considered to be most useful for quantifying off-site risk, for example, Transportation of Construction Materials and industrial Production Materials. In this context, QRAS is very useful in assessing, on-site risk, if sufficient details and understanding of the reality of peoples' responses to accidents.

2.1.1 Mixed Research Approach

This is a combination of qualitative and quantitative research approach for collection of data, the analysis of the data and other phases of the research approach or process. Mixed research approach also involves collecting both numeric and text information either simultaneously or sequentially, so as to understand research problems and establish final data base representing both quantitative and qualitative information. To certain extent, the survey method enabled the researcher to collect information based on the perceptions of the site managers, supervisors, Professionals, clients and workers. Also, it help the researcher to categorize occupational health and safety risks into the following: Very safe, Safe, moderately safe, Not safe and Never safe. In this context, the research design is designed to focus on the practice of occupational health and safety risk assessment and communication on construction sites.

2.1.2. Data Collection Techniques

The study used various methods considered complementary and beneficial to the investigation such as interviews, observation, documentaries and questionnaires. The study adopts Random Sampling where the population is given equal opportunity to be selected to participate in the study. Participants were grouped and selected according to their exposures to occupation health and safety risk hazard. Selected individual was contacted before the interview and the mailing of questionnaires.

In this study, the objective of the interview is to find out about how many of those participants understand the importance of occupational health and safety risks at construction sites and how they are handled. The nature of interview is unstructured as to obtain ideas of interviewees on the nature of the occupational health and safety risks existing at construction sites in Oyo State. All the interviews were conducted by the Researchers.

2.1.4 Questionnaire Survey

The questionnaire survey was part of the research design. This is aimed at determining the perception of the key participants to identify critical risks kept under the red carpet. The questionnaires were distributed to participants and they were used to rank the probability of occurrence of the critical risks identified.

Other parts of the questionnaires were designed to obtain the profile of the respondents in terms of their level of involvement in construction, their gender, employment status, level of education, construction-related qualification and experience, exposure to injury and illness, exposure to occupational health and safety training and information.

2.2 Measurement of Variables

In this study, variables were measured on the basis of Five Point Likely Scale with responses ranging from 1-5 as indicated above. The five-point scale is an order one – one-dimensional scale (only measured in a single trait) from which respondents were used to choose one option that best aligns with their views. Each level is

one option that best aligns with their views. Each level on the scale is assigned a numeric value, usually starting at land incremented by one at each level. The Five Point Likely scale was converted to the Relative Importance Index (R.I.I), Kometal (1994).

2.2.1 Method of Analysis

The study uses Relative Important Index (R.I.I) to analyze and rank the data information collected from the respondents or participants. Descriptive statistics is expressed in terms of the Relative Important Index (R.I.I) formulated using the following statistic expressions (Equations 1 and 2).

$$\text{Relative Important Index (R.I.I)} = \frac{\sum W}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N} \quad (1)$$

$0 \leq \text{RII} \leq 1$

Where W is the weight given to each factor by the respondents (ranging from 1 – 5)

N is the Total number of respondents n is Total number of respondents

A is the Highest weight (in this case is 5)

n_5 is the Number of respondents for very likely to occur

n_4 is the Number of respondents for likely to occur

n_3 is the Number of respondents with moderate of occurrence

n_2 is the Number of respondents not likely to occur

n_1 is the Number of respondents never likely to occur.

3. RESULTS AND DISCUSSIONS (10 PT)

3.1 Interview Results

As indicated in the research method, Interview was held with five experienced site managers on the nature and source of occupational health and safety hazard at selected construction sites. The results are indicated in Table 2.

Table 2: Summary of areas of occupational health and safety hazards and its consequences at selected construction sites

S/N	Type of health and safety hazard	Hazard Consequences	Possible source of occupational health and safety hazard consequences
1	Working at a height	Falling from height	i. Carelessness of workers. ii. Reluctant to use safety belts iii. Improperly fixed scaffolding iv. Not using PPE v. Supplied but workers not wearing it vi. Unprotected edge vii. Ignorance of worker in regards risk weather spends too much time in the sun
2	Falling object, poor housing keeping	Hit by falling object Trip and fall	i. Overcrowded sites ii. Confined sites iii. Unprotected feet (safety shoes) iv. Culture and ignorance (most workers have low education level) v. Unreliable income (willing to risk no matter what) vi. Lighting might be a problem, sometimes car lights have been used to light up the construction sites
3	Manual handling	Muscles pain, back pain.	i. Working for long time, twisting, bending ii. Crowded sites for movement/ equipment

			iii.	Carrying heavy loads
4	Equipment/Plant/Tools	Crushed/hit/cut by object such as equipment, car working tools and plants	i.	Wrong operating attitude of the users, improper maintenance.
5	Chemicals	Health problem such as headaches, eye irritation, dizziness, faintness, sleepiness and affect judgment and coordination.	i. ii. iii. iv.	Materials specification Cement and Paints Fumigation pesticide Timber treatment chemicals
6	Dust	Health problem respiratory disease	i. ii.	Present on sites where demolition, excavation, concrete mixing takes place Earthworks operation
7	Noises	Health problem hearing loss	i. ii. iii. iv. v. vi. vii. viii.	Equipment noise Activity noise Excavation Drilling Welding Piling Roofing Workers working on concreting
8	Bending and twisting	Masculo – skeleto disorder.	i. ii.	Bending and twisting for long time Too much manual handling
9	Fire	Injuries due to fire	Poor house keeping	
10	Construction stress	Health problems due to stress and construction	i. ii. iii. iv.	Stress works Management Working time Pressure from the work

Table 3a &b. present the most common occupational health and safety hazard and their resources at construction sites the results showed that these types and safety hazards include working at a height, manual handling, machinery and equipment, fire noise and dust and bullying. The findings are not totally different from Muriel, (2007) and Irizarry and Abraham, (2006). Tables 3a & b show how site managers have ranked hazard consequences according to individual occurrence.

Table 3a: Occupational health and safety hazard consequences as ranked by site managers

S/N	Type of Hazard	N1	N2	N3	N4	N5	R.I.I	Rank	Sum Total Respond
1	Bending twisting while laying asphalt	13	17	23	20	10	0.592	1	83
2	Noise (from construction equipment.	10	21	33	17	5	0.567	2	86
3	Dust (sand, cement debris)	15	17	24	21	6	0.559	3	83
4	Manual handling carrying or lifting/cement bag	17	15	26	17	6	0.550	4	81
5	Overcrowded site	12	21	32	15	3	0.542	5	83
6	Working at height	23	20	30	12	4	0.513	6	86
7	Manual handling	23	24	25	10	4	0.479	7	86

Q 12: In your experiences how probable do you think the following risk will occur when you are performing construction activity?

Table 3b: Occupational health and safety hazard consequences as ranked by site managers

S/N	Type of Hazard	N1	N2	N3	N4	N5	R.I.I	Rank	Sum Total Respond
8	Muscular skeleton disorder, back pain due to bending, twisting while laying block/bricks	12	14	18	16	19	0.640	1	79
9	Inhalation of dust from cement causing and affecting respiratory system	13	19	12	16	18	0.617	2	78
10	Manual handling carrying or lifting (cement bags, brick/blocks) necks back or arm injury	10	17	20	25	7	0.605	3	79
11	Noise (using block/bricks cutting, molding) cause hearing loss	15	15	24	22	8	0.583	4	84
12	Falling objects (blocks, bricks, debris, tools)	11	20	17	19	8	0.581	5	75
13	Handling heavy load	11	18	16	12	9	0.569	6	66
14	Employee crushed or knockdown by moving vehicles, fork lift, tractors etc	21	15	20	19	9	0.552	7	84
15	Falling from working at height (serious injury)	18	11	28	17	5	0.549	8	79

Table 3c: Occupational health and safety hazard consequences as ranked by site managers

	Type of health and safety hazard consequences	Ranking
1	Bending, twisting, laying bricks	8
2	Back pain, muscular pain, due to manual handling	8
3	Health problem caused by noise	7
4	Hit by falling object, trips and fail	7
5	Crushed moving equipment, cuts by equipment and hand – led tools	7
6	Health problem caused by chemical	5
7	Health problem caused by too long bending and twisting	4
8	5 Health problem caused by dust	4
9	Injury from fire and other disaster	3
10	Covered by earthwork during excavation of basement and trenches	2
11	Bullying and stress	1

Table 3c shows that the probability of falling from height was ranked as the most important hazard consequence as it scored the highest on the table while bulling and stress scored the lowest. This indicates that there is a probability of falling from height due to the fact that most of workers are exposed much to height, especially on high-rise buildings. Based on observation and discussion with managers, supervisors and workers at the construction site the questionnaire survey was developed. Table 4.2c ranking was done before the mathematical application of R.I.I.

3.2 Results from Questionnaire Survey

The questionnaire survey was distributed to the selected site managers, gang supervisors and crews. The results are discussed below.

a. Demographic characteristics of Respondents, 150 questionnaires were distributed to respondents who are actually involved and exposed to occupation health and safety risk problems. Respondents ages range from 20 to 55 years and above, with the majority (50%) ranging between 20 – 35 years old, followed 36 – 45 respondents by (32%). There were few respondents between 46 to over 55 years (13%) and 5%. This study shows that most of the construction activities on construction sites in Oyo State are done manually. One needs to be physically fit and strong, this is to say that there are some activities that cannot actually be handled by elderly men. These activities actually require someone with high energy and extremely strong.

The result shows the number of participants or respondents to be 86 and they are all exposed to occupational health and safety risks at construction sites. Out of these participants, 71 percent are full-time Employees, 17% are Part-Time while 7% and 5% are both contract and Temporary employees. The majority (71%) were full-time employees only 17% were part-time employees and the rest 13% are contract employees or casual employees or self-employees. The study found that the majority of workers at the time of this study were full–time. The result shows that about 42% of the employees are employed by the main contractors, 26%, client 28% while manufacturers and self-employed 1% and 3%.

3.2.1 Defined Job Title

The nature of work in which an individual was employed for has risen to be one of the challenges to implementing occupational health and safety standards at construction sites. It shows that they were fully engaged and exposed to occupational health and safety hazards at construction sites.

3.2.2 Level of Education

The result indicates that about 31 of the respondents had B. Eng followed by HND 20 while the lowest percentage of the Respondents 1% had PhD. It was identified that almost all respondents or participants in the exercise had Degrees about 63% while 20% had HND certificates only 3% percent had Technical Education, National Diplomas certificates, and primary school certificates. The results revealed that the majority of Employee participants have university degrees. This makes it easier to communicate and also the way participants perceive occupational health and safety risks. The results show that although the majority of workers had higher education, but their level of experience varied.

3.2.3 Employee Experience

Regarding their experiences (1 – 5) years of experience were estimated to be 47% (6 -10) years, 25% (11 – 15) years is 25%, while (16 -20) years and (21 – 25) years were estimated to be 2% and 1% each while (26 – 30) had 0%

3.2.4 Knowledge of health and safety risks on construction sites

Construction crews or participants were asked about their knowledge of health and safety risks on the construction site and the results are indicated in Table 4.

Table 4: knowledge on occupational health and safety risk.

S/N	Workers	Number of Respondents	Frequency of Respondents Yes	No
1	Have you ever received any training relating to health and safety on construction sites?	86	25 (29%)	61 (71%)
2	Have you ever been involved in a major accident while you are performing your task?	86	31 (25.74%)	63 (73.26%)
3	Have you ever been injured (minor) while performing your tasks?	86	31 (36%)	55 (64%)
4	Do you think that wearing personal protective equipment PPE affects productivity?	86	10%	86 (100%)
B	Site manager/supervisors			
1	Have you ever received any training relating to health and safety on construction sites	10	2 (20%)	8 (80%)

2	Have you ever seen one of your workers being involved in a major accident while performing his or her task	10	5 (50%)	5 (50%)
3	Have you ever seen one of yours being injured while performing his/her tasks	10	4 (40%)	6 (60%)
4	Do you think that wearing personal protective equipment (PPE) affects productivity?	10	0(0%)	10 (70%)

Table 4 shows that the majority of workers (61%) did not receive any formal health and safety training, possibly causing (31.74%) major accidents while performing their tasks and 36% have been injured. This finding indicates that the majority of workers have not had any formal occupational health and safety training and to some extent that they have been subjected to either major accidents or minor injuries. It is believed that being involved in an accident or being injured has shaped their perceptions of occupational health and safety risks. This may be the reason why workers believe if they wear their PPE it would not affect their productivity. On the other hand, despite, the background of employees only 20% of site managers/supervisors received occupational health and safety training and have witnessed their workers being involved in accidents and sustaining injuries, 0% of the supervisors believe that wearing PPE would negatively affect worker's productivity. This is to say that everybody at the construction site should be protected.

3.3 Risk Perceptions

Site managers, supervisors and workers were asked to indicate qualitatively the probability of occupational health and safety problems occurring when working in a hazardous environment. The Likert scale was used where 1= Not likely to occur at all (never) 2 = not likely to occur, 3 = moderate, 4 = likely to occur 5 = very likely to occur. The results are indicated in the Figure 1.

3.3.1 Risk Perception of the Workers

It is indicated in Figures 1 and 2 that both groups (workers and supervisors) indicate that the probability of falling from a height is the most likely to occur at construction sites, following arm pain, back pain and muscle pain due to manual handling meanwhile both workers and supervisors indicate that hearing loss and respiratory illness from dust occur moderately. The findings indicate that there is a high chance of falling from a height if there is no control measure meanwhile the nature of construction activities exposes workers to more manual handling, therefore, the chance for workers to have back and muscles is high.

3.3.1 Risk Perceptions

How safe are you when you are performing a task?

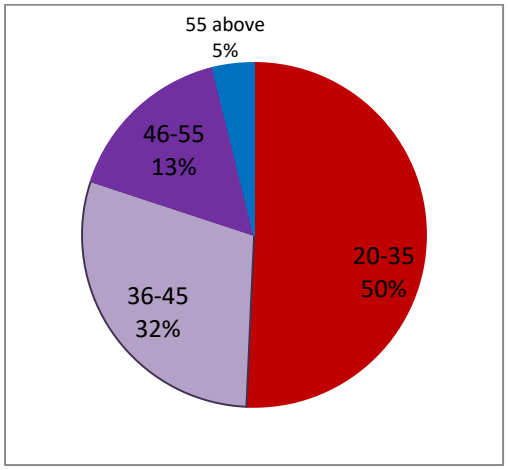

Figure 1: Participants' Risk perceptions

Knowledge on Occupational Health Safety Risk Information
Do you have any information about health and safety in your workplace?

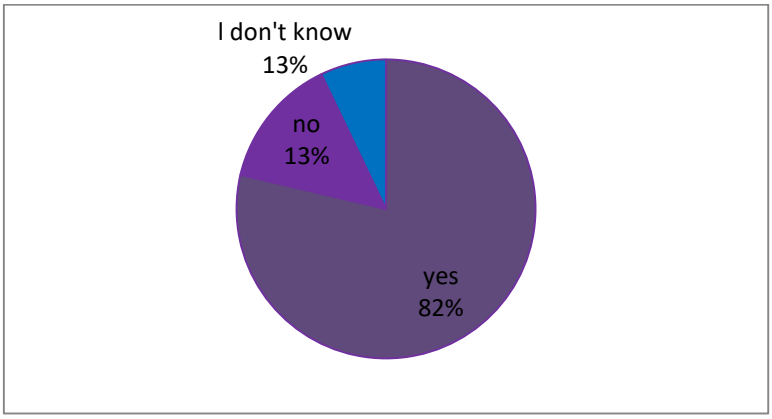

Figure 2: Risk Information

3.3.2 Hazard Consequences Categorization

Hard categorization is performed so as to determine which hazard consequence is perceived as higher by both groups of supervisors and workers. In hazard categorization, hazard consequences were calculated according to the number of respondents who indicated the probability of occurrence, very likely to occur, and likely to occur. The results are grouped into categories: Category A indicates hazard consequences highlighted by 79 respondents Category B indicates hazard consequences highlighted by 50 – 75 respondents. Category C indicates hazard consequences mentioned 40 – 74 respondents. Category D contains hazard mentioned by 73 respondents. The results are shown in Table 5.

Table 5 indicates that the probability of occurrence of falling from a height and back and muscle pain to manual handling hazards was perceived by few respondents, which fall under category A, meanwhile, the probability of getting health problems due to noise by falling objects and crushed by moving equipment and working tools were in the B category. Health problems due to bending and twisting fall under category C while health problems due to dust fall under category D.

This indicates that no hazard consequences should be ignored however, priority should always be given to reducing the risks B categories. As can be seen in the analysis, workers and supervisors were asked to indicate if the identified hazards were based on the probability of occurrence of hazard consequences. Among the hazards consequences, falling from height and muscle and back pains due to manual handling were perceived to be likely to occur while crushed by a moving object, bending and twisting are equally considered on different categories (likely and less likely).

Table 5: Hazard Consequences Categories as perceived by workers and supervisors

S/N	Hazards consequences	Respondents	Category
1	Falling from height	79	A
2	Muscle pain, back pain and injury manual handling	79	A
3	Health problems due to bending & twisting	75	B
4	Health problems due to noise	75	B
5	Hit by a falling object	75	B
6	Health problems due to dust	74	C
7	Crushed by moving equipment and cuts by working tools	73	D

Key to hazard consequence categories

A. Highest hazard consequences category
B. Second hazard consequences category
C. Third hazard consequences category

D. Fourth hazard consequences category

3.3.3 Findings from Oyo Construction Sites

This section presents the results of the data collected from construction sites in Oyo. The study focused on the process of occupational health and safety risk assessment and communication at selected construction sites in Oyo State and how legal factors, Organizational factors, individual factors, and the work environment influence the process.

3.3.4 Description of the Projects

The projects are located in Ibadan and Ogbomoso in Oyo state. The scope of work is the construction of a four-lane highway which consists of 7.30m wide 2-lane roadway in each direction (i.e. northbound and southbound) which was separated by a 26m wide median originally. They are now separated by a 16.8m wide median on design review. The outer shoulders are 2.75m wide while the inner shoulders are 1.80m wide.
The contract as originally packaged provided for: two (2) dual and five (5) single bridges, ten (10) underpasses under the dual carriageway highway for pedestrian and vehicular crossings, drainage structures of reinforced concrete box culverts, reinforced concrete pipe culverts, concrete-lined drains, kerbs, stone pitching, kilometre posts, concrete median barriers, road signs, road marking and two trumpet interchanges, one at Oyo close to the beginning of the project and the second at kilometre 88+850. The project employed 1200 hundred workers whereby 700 were unskilled and 500 were skilled. The project period is 30 months. The contract cost was not disclosed.

3.4 Actors Involved in the Project

The project has different actors, including the client, highway Engineer, Quantity Surveyor, Contractor and sub-contractors. All sub-contractors have a contractual relationship with the contractor.
The project level was headed by the client who employs the design team involving highway engineers and Quantity surveyor. The client also employs a contractor to offer construction services. Similarly, the contractor employs sub-contractors who have been approved by the client. At contractors; sites, the site management organization chat shows that the site is headed by the site Project Manager assisted by the engineers.

3.4.1: Legal Aspect of Risk Management at Oyo Construction Site.

During the time of this research, so far no fatal accidents reported.

3.4.2: Organizational System of Risk Management at the Construction Site (Oyo)

A semi-structured interview held with the project managers took half an hour, was taped, recorded and later transcribed. It was supplemented by some questions during the explanation.

3.4.3 Company Policy and Responsibility for Occupational Health and Safety at Construction Site

The project managers of each site were asked whether the company has an occupational health and safety policy. They indicated that the companies have safety officer coordinators who are permanently employed and work with site project managers at sites to foresee any health and safety issues. They made the researcher to understand that all necessary occupational health and safety welfare facilities and PPE are provided by the head office.

3.4.4 Risk Assessment and Communication Process

The researcher noted that there was no specific method or software for risk assessment and communication but the site project manager and safety officer are responsible for this. Any challenges concerning occupational health and safety issues must be reported to the head office immediately. The result indicates that the factors enhance and hinder risk assessment, communication and control on construction sites.

3.5 Interviews with Individuals at Construction Sites

An interview was conducted with individuals on the construction site in two groups as shown in Table 6. The first part of the questions focuses on the participant in the area of identification, evaluation, estimation, and communication. To open up their minds, questions were frequently formulated and familiarity questions were also asked.

The project managers of various sites are very knowledgeable about occupational health and safety risk management and they have worked in different construction sites. They have also witnessed a number of accidents on different construction sites. Safety officers attended formal training organized by OSHA management; the training exposed them to different areas of occupational health and safety hazards.

Table 6: Individuals who participated in the interviewed

SN	Individuals	Number	Methods
1	Site management team and supervisor and safety officer	1 Site manager + 2 supervisors and a safety officer	Interview
2	Workers	5 steel reinforcement + 10 concrete workers	Interview
3	Site project manager	B.Eng Civil Engineer with 10 years experience	Interview
4	Supervisors	HND,5-10 years experience	Interview
5	Safety officer	HND with formal Health and Safety training (OSHA)	interview

3.5.1 Occupational Health and Safety Organization at the Construction Sites.

It was revealed to the researcher that site managers carried out hazard identification in their schedule of work. In some sites, it was noted that before the closing of the site each day, the site manager, safety officer and supervisors discuss the potential hazard areas, and progress made so far. The supervisors usually meet with the workers every day before daily activities start or begin. However, supervisors make sure that all workers are provided with PPE.

3.5.2. Interview with Workers

The groups selected for the interview from different sites showed that they were still directly exposed to falling from heights, dust, poisonous chemicals and manual handling problems. The interview was conducted while they were at work. They indicated that the company did not provide them with enough PPE needed for the work. Supervisors are the main players of communication risk to the workers assisted by site managers because communication is embedded on the construction production process. From the researcher's observation, it was observed that construction crews were subjected to more manual handling with few mechanical aids.

3.6 Cross – Cases Analysis

There are similarities and differences between site A (case 1) and site B (case 2). The essence of this cross–case analysis is to identify the main differences to substantiate whether the preposition that legal, organizational factors, individual factors and the work environment have an impact on occupational health and safety risk management at construction sites. The variations that exist between the two construction sites provide new insight into how occupational health and safety risks are managed at different sites. Table 7 compares the research variable in matrix format to make the explanation more meaningful.

Table 7: Research variable in matrix format

S/N	Variables	Site A (Elete)	Site B (Iroko)
1	Nature of the project	Construction of new four–lane divided highway. It employs 1,200 workers.	Rehabilitation of Dual Carriageway Road. It employs 550 workers.
2	Risk assessment process	Done by site project manager through the safety committee used individual judgment based on experience, educational	Done by site project manager through the safety committee used individual judgment based on experience, educational background, and

		background, knowledge of health and safety risks and regulations	knowledge of health and safety risks and regulations.
3	Risk communication	Verbally for all workers through toolbox meetings written through posters and signs	Verbally, informally in individual groups (gangs)
4	Risk control process	Use of PPE, engineering control system	The use of PPE
5	Legal system registration control mechanism	Registered OSHA, No special inspection fine and penalty not specific 2 fatal accidents	Registered OSHA, no inspection, no fine no fatal accidents
6	Organization system health and safety policy	Existence of formal health and safety policy. Health and safety coordinators were employed.	Existence of formal policy. Health and safety officers were employed.
	Management styles	Coordination through • Site manager • Safety coordinations • Safety Committee	Coordination through • Site managers • Safety officer • Supervisors
	Resource allocation	Provide all PPE and facilities. motivation • Fund • Procurement system • Market forces • Design complexity	Provide few PPE and facilities. • Fund • Site location and configuration • Project variations • Procurement system • Market pressure
	Challenges on implementing health and safety management		
7	Individuals Education background	Site manager, foreman, supervisor, safety committee, sub-contractor's operatives High level of education of site management (e.g. site manager), medium level of education e.g. supervisors safety committee team. Low level for operative	Site manager, Safety officer, supervisors and operatives High level of education of site manager, medium level of education (e.g supervisors low level foremen and operatives
	Experience	Much Experience	Much experience
8	Work environment		
	Site organization	Well organized with little welfare facilities	Little provision of welfare facilities
	Working methods	Mechanical tools were used for concrete transportation.	Concreting and reinforcement activities were done both mechanically and manually. Transportation of concrete was both mechanically and manually.
	Work team	Site manager safety committee and supervisor	Site manager and supervisors
	Physical space	Enough working space	Enough working space

Having analyzed the two case studies Site A and Site B, two salient points surfaced. It seems that the companies surveyed or investigated are trying to manage or adapt to their own method to manage occupational Health and safety risks in their own way. Actually, there is no big difference sincerely, it is a matter of how individuals prioritize individual systems or communication systems. Individual judgment based on experiment and regulation on assessment was found to be common in the two construction sites. The nature of their construction site is not different but only in terms of size, location and site configuration, number of workers or employees and stage of the project. See above Table 7.

3.6 Discussion of the Finding

The nature of occupation health and safety risks management practice at the selected construction sites in Oyo State, the findings did not show any difference except the management style. The identified hazards include: working at a height, falling objects, poor housekeeping, manual handling, chemicals, dust, noise, and stress. Based on the perception of site managers, supervisors, and crews, hazard consequences, as revealed, falling from a height, back pain, and arm and muscle pain due to manual handling are among those noted as critical hazards. These findings support Chan [16]. In addition, manual handling always results in muscular disorder, back injury, and muscle pains. The rankings of these hazards are always very high in the world. They kill more workers on construction sites than in other accidents. The causes of accidents can be attributed to ignorance, attitudes and carelessness. These are the main causes of accidents and ill-health problems at construction sites. The same methods and techniques are being used for managing occupation health and safety risk communication and risk control assessment at selected construction sites.

3.7 Risk Assessment

The findings in this study showed that risk assessment on construction sites is coordinated by site managers through the safety committee or supervisors. It showed that hazards are incorporated into work schedule programme. It was observed that brainstorming exercise was based on experience and educational background to judge the level of risk. This indicates that risks are assessed through individual judgment guided by regulations without using numerical judgment or any other tools or techniques. Moreover, there is no clear demarcation between risk estimation and risk evaluation. It was identified that the theoretical risk assessment was not done in practice; quality individual judgment was based on experience on risk management guided by regulations. It was also identified that risk assessment and communication occur during the construction phase. All the responsibilities on risk management were assigned to the contractor as risks' assessments were not considered during the design or procurement.

This finding does not support Rahim [17] who indicated that clients, designers, contractors and sub-contractors considered occupation health and safety stage–by stage from the outset of the project. These types of findings indicate that each phase of construction projects contributes to occupational health and safety hazards. These revealed that the root causes of accidents in construction sites, Oyo were attributed to the design and procurement.

Following the argument of the PMs of the two companies compared, both claimed that the complexity of the design; site configuration and competitive procurement market are their major challenges in managing occupational health and safety. It means these companies are afraid to include the cost of managing occupation health and safety during tendering. They believe addressing construction safety during the design and procurement phases would reduce injuries and the cost associated with safety delays in the project; however, incorporating these factors might work against them is securing the contract.

3.8 Risk Communication Methods

The findings indicate that there is no difference between the two sites, verbal formal communication such as toolbox meetings and formal discussions, and written communication, such as posters, images, signs and letters were used for communication of occupational health and safety risk in both construction sites. However, the researcher noted the difference between the supervisor and safety committee, the difference can be attributed to the division of power or responsibilities involving sending information, receiving and interpreting information. Power relations and conflict were observed to bring challenges to managing occupational health

and safety risks. However, the findings showed that active participation of site workers in occupational health and safety induction meetings reduces power tussles or challenges.

3.9 Risk Control Methods

The finding showed that personal protective equipment PPE such as a safety harness hard hat and safety boots were used as part measures for or as control aids at both construction sites. In addition, hazard identified as holes and edges of walls were barricaded with handrails or safety mash. Toolbox meetings were used to change workers behavior/attitudes toward the health and safety management system. Some penalties, such as a warning letter and dismissal may be issued to workers to make sure they adhere to safety rules.

Furthermore, manual handling was controlled by using mechanical aids such as a power wheelbarrow, pipe to transport concrete (pumping concrete) compacting machine and lifts. Another surprising finding was that several of those who were given set of PPE were not wearing them because they were not comfortable with them due to weather and for some other reasons. It may be necessary for the employer to consider PPE suitable for climate conditions in Nigeria.

3.10 Findings Summary

The summary shows that few of the practitioners at construction sites, supervisors, and safety committee members, use a checklist and brainstorming to assess risk. They use different methods to communicate risk including formal verbal toolbox meetings, site meetings informal verbal, poster and sign/image communication. To control risk, PPE and isolated hazards were used. However, the study considers the importance of individual and contributions in managing occupational health and safety. The individual judgment helps in determining the results of the risk management system, based on experience, the regulatory system and educational background.

4. CONCLUSION

The study revealed that the responsibility at construction site occupational health and safety lies with the main contractor, resulting in many designers, consultants and clients absolving themselves from their responsibilities, in case accidents occur at the construction site. The active participation of clients and design teams in the built environment in occupational health and safety matters in Nigeria is yet to be realized.

It also revealed that risk was assessed by brainstorming, checklists and safety regulations judgment of risk was based on individual judgment based on experience, educational background and knowledge of occupational health and safety regulations.

Working at height and manual handling (bending, twisting, chemicals, dust & carrying head pan on their heads) were identified to be the most critical hazards at the construction sites.

Based on methods used to communicate risk at construction sites, toolbox meetings, site meetings, posters and formal and informal verbal communication are used. Moreover, safety committees and supervisors play a major role in communicating occupational health and safety risks, and power relations, also conflicts were observed when there is a clear separation between occupational health and safety communication quality and productivity, the study identified that PPE is the main item use for risk control. Every now and then PPE available on sites is not enough due to weather conditions and pressure workers are not comfortable wearing them.

Relating to influencing risk management factors, the legal system plays a major role in risk assessment communication and control. Regular inspections, penalties and compliance with the certificate issued by regulatory institutions also influence risk management.

Moreover, individual characteristics such as experience of those working at construction sites, their educational background and knowledge of occupation health and safety matter are seriously considered because they influence occupational health and safety risk management.

The study also identified factors hindering occupational health and safety risk management at construction sites. These factors include diminutive public awareness of regulations, lack of resources such as personnel, funds, coverage of regulations, and complexity of design, the procurement system, the low level of education, site configuration and location.

This shows that there is a need for a systematic approach and a wider perspective that includes individual judgment and at the same time a holistic approach that considers all project phases such as design, procurement and construction.

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