DETERMINATION OF ACTIVITY BASED SAFETY RISK HAZARD IN BUILDING CONSTRUCTION PROJECTS IN ABUJA, NIGERIA

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ABSTRACT

The dynamic nature of the construction projects exposes workers to multiple safety hazards and risks, resulting to high cases of fatal occupational accidents on sites. The study determined the most hazardous building construction activities and identified the most common hazards in building construction projects. The study sought opinion of construction professionals who managed and supervised construction projects in Abuja via questionnaires. 50 well-structured questionnaires were administered and 34 were returned representing a response rate of 68%. The data was analysed using descriptive statistics (frequencies and Mean Scores). The result revealed that the top hazardous work activities on building construction projects sites were steel structure construction, roof work, electrical works, mean score of 4.24, 4.21 and 3.93 respectively. Result also revealed that the most critical safety hazards are: struck by falling objects; fall from height and hazard due to machine and tools usage with mean score of 4.26, 4.21 and 3.93 respectively. It was concluded that the nature and type of activities determines the dimensions and magnitude of hazard in a building construction operation. It was recommended that hazard identification investigation should be carried out on construction site periodically. The study provides valuable information for site-based construction managers in mitigating the hazards associated with building construction projects.

Keywords: Activities, Building, Construction, Hazard Identification, Safety Risk.

INTRODUCTION

The construction industry is characterized by a high level of hazard to the health and safety of workers (Hola *et al*., 2018). The dynamic nature of the construction projects in the industry has exposed worker to multiple safety hazards and risks, resulting to high occupational incidents and injury and fatality rates on sites (Albert *et al.*, 2014). Many factors may place construction workers at higher risk for workplace injury due to multiple workers activities that may lead to injuries and fatalities on construction site including constructing, assembling, dismantling and repairing (Census of Fatal Occupational Injuries (CFOI), 2017). Construction segment involves high risks due to its production processes and labour-intensive characteristic in addition the industry is faced with huge financial loss due to occupational accidents (Yilmaz, 2014).

The construction industry is one of the most hazardous industries in many countries (Park *et al.*, 2020). Consistently the construction industry leads other industries as one of the top industries in the number of total workers death (Bureau of Labour Statistics (2018). The construction industry in the United States accounted for 19% of the total industrial deaths in the year 2016 and worldwide

the construction industry was found to have higher fatality rate than in other industries (Chan *et* al.,2018). According to the estimate of the International Labour Organization (ILO) over 60,000 fatal injuries occur worldwide on construction project sites and at a rate of one fatal accident every 10 minutes (ILO, 2012). Data from the Bureau of Labour Statistics (2018) reveals that in 2016 the construction industry recorded four cases of workplace injuries and illness per 100 full-time workers (BLS, 2018) and for years this rate has been constant, despite numerous improvements in the safety and health management area in the construction industry, still incidents occur on construction sites and injury rates and fatality have been higher than in other industries (Bureau of Labour Statistics, 2018). Goh and Chua (2009) reported that the high rates of injury are due to the inability of workers in the construction site to recognize and respond to hazards.
Ramaswamy and Mosher (2017) assert that a well-identified hazard may reduce the rate of fatality and improve the safety management of construction projects. They explained further that in construction projects hazard identification and safety analysis is a challenging issue. Yang *et al.* (2017) observed that many efforts in identifying the root causes of incidents and the completion of a comprehensive safety analysis in construction projects has been hindered due to lack of available data to specifically address construction injuries and fatalities. In evaluating safety performance of a construction site, the first step is to identify the hazards, evaluate their priorities and effect and take adequate measures to avoid such hazards (Gunduz, 2020).

Occupational Safety and Health Administration (OSHA), 2002) describe hazard as any real or potential condition for an activity or to produce a harmful effect such as illness, injury or fatality. Albert *et al.* (2014) ascertained that in an industrial setting safety management involves four elements: identification, communication, assessment and selection of appropriate safety measures. To maximize the potency of safety management and safety prevention programs, hazards in the workplace need to be properly recognized. Hazard identification is fundamental to construction safety management activity; unidentified hazards presents intolerable and unmanageable risks (Carter, 2006). Construction projects are highly hazardous but limited attention has been given on hazard identification within this area (Albert *et al.*, 2014). To identify the root causes of safety incidents, workplace hazards must therefore be identified and studied. The aim of the study is to examine the potential hazards in building construction activities. The study had the following objectives: to determine the most hazardous building construction activities and to identify the most common hazards in building construction projects in Abuja.

LITERATURE REVIEW

hazards in building construction activities

Various studies have identified health and safety hazards on construction sites, the most recognized have been fall from height, struck by falling objects; fall from height; hazard due to machine and tools usage; Equipment accidents, working in confined spaces, Manual handling of machine/tool hazards, working underground, fire exposure, noises exposure and poor housekeeping (Memarian and Mitropoulos, 2013; Choi, 2015; Gurcanli *et al.*, 2015; Okoye, 2018, Ghousi *et al.*, 2018). Some studies have associated certain building trades/ activities with high fatality or injury risks while some others are associated with low risks. Baradan and Usmen (2006) study occupational injury and fatality risk analysis was performed on 16 building trades and revealed that ironworkers and

roofers were the riskiest building trades. Memarian and Mitropoulos (2013) studied accidents in masonry construction and identified the most frequent incident events to be overexertion, struck by object and contact with objects.

Choi (2015) studied aging workers and trade-related injuries in the US construction workers and identified Laboure's, carpenters, iron workers and operators as the four trade groups with the highest injury rates in addition the causes of accident were struck against an object, caught in between object and falls from higher level. Gurcanli *et al.* (2015) determined activity-based risk assessment and safety cost estimation for residential building construction projects on five construction activities and 12 accident types. Finding revealed that reinforced concrete work and roof work and were the most hazardous activities and fall from height, struck by flying/falling object and building structure collapse were the highest causes of accident in construction activities. Okoye (2018) found that masonry, carpentry including formwork and roofing and iron bending are the common building trades associated with high risks and fall from height, manual handling activities and climbing step and walking platforms were the most impactful health and safety risk factors in building trades. Ghousi *et al.* (2018) who design a flexible method of building construction safety risk assessment and investigated the financial aspects of safety program and identified structural steel, excavation and building facade were the riskiest building trades and Struck by falling objects and Fall to lower level as the most critical hazard in building construction projects. Literature review have shown that the fundamental requirement to improving safety which is the identification of hazard has received little attention especially in the literature researched. Limited studies have use activity based to determine safety risk hazard in building construction projects. This is the premise of the study.

RESEARCH METHODOLOGY

The study sought the opinion of construction professionals such as Project Managers, Quantity surveyors, Site Engineer, Health and safety manager, who managed and supervised construction projects in Abuja. A well-structured questionnaire was developed and distributed to respondents to assess their perceptions in determining the most hazardous building construction activities and to identify the most common safety hazards in construction projects. Non-probability convenience sampling technique was used in identifying the study respondents. Collins *et al.* (2007) described convenience sampling technique as a sampling method that involves choosing from a sample that is not only accessible but also the respondents are willing to participate in the study. The study was such that the respondents were asked questions based on the projects they were found handling during the self-administration of the questionnaires. This may explain why the responses obtained were limited to 34 and invariably 34 construction projects were examined. The unit of analysis was construction project handled by each respondent. The data collected were analysed using the mean score value method and percentile.

METHOD OF DATA COLLECTION

The questionnaire was designed to identify the potential hazards in building construction projects in Abuja, Nigeria**.** It was also designed to determine the most hazardous activities in building construction projects. The questionnaire comprised of two sections. The first section captured information about the respondent 's background which includes: Gender, Academic qualification,

Professional qualification and year of experience. The second part of the questionnaire focused on 17 selected common work activities for building construction projects and 17 safety risk hazards in building construction projects. Respondents were asked to tick from their wealth of experience the riskiest safety hazards in building construction projects. The other aspect of the questionnaire was based on a Likert's scale of 5 ordinal measures from 1 to 5. For the identification of the riskiest hazardous activities in building construction projects; Where: 1-Not Very risky, 2- Not risky, 3-Low risk, 4-High Risk, 5-Very High risk.

METHOD OF DATA ANALYSIS

The data was analysed using descriptive statistics which involved the use of frequencies and Mean Scores (MS). The Mean Scores (MS) was use to rank the response items according to the central tendency of responses, as represented in equation (1)

$$MS = \frac{1n_1+2n_2+3n_3+4n_4+5n_5}{n_0+n_1+n_2+n_3+n_4+n_5} \quad \text{eq (1)}$$

RESULTS AND DISCUSSIONS

RESPONSE RATE TO QUESTIONNAIRE

In this study 50 questionnaires were administered and 34 were returned representing a response rate of 68%.

Analysis of Respondents' Profile

This section offers basic information regarding the background of the respondents. The profile of respondents is given in Table 1.

Table 1. Background information of respondents

Gender of Respondents	Frequency	Percent
Male	26	76.47
Female	8	23.53
Total	34	100
Age of Respondents		
20-29	2	5.88
30-39	5	14.71
40-49	11	32.35
Above 50	16	47.06
Total	34	100
Academic Qualification		
HND	6	17.65
Bachelor Degree	14	41.18
Post graduate	2	5.88
Master degree holders	11	32.35
PhD.	1	2.94
Total	34	100
Professional Qualification		
QS	10	29.41
Arch	8	23.53
Builder	6	17.65
Engineer	6	17.65
Others	4	11.77
Total	34	100
Year of experience of respondent		

5-10	10	29.41
11-14	8	23.53
15-20	4	11.77
21 years above	12	35.29
Total	34	100

Table 1 illustrates the gender of respondents, 26 of the population sampled were male representing 76.47% and 8 were female representing 23.53%. The age of the respondents, result indicates that the highest number of respondents 47.06% were those above 50yrs of age. About 32.35% respondents were 40yrs – 49yrs of age, while 14.71% respondents were within the age of 30yrs – 39yrs and 5.88% number of respondents were between 20-29yrs of age.
The academic qualification of respondents as shown in Table 1, the largest groups of respondents were 14 (41.18%) those who possessed Bachelor Degree. Next is Master degree holders with 11(13.6%), following are respondents with Higher National diploma 6(17.65%) next are Post graduate with 2(5.88%) and the last in the list is PhD with 1(2.94). This is an indication that the respondents were competent based on their various levels of qualification attained. The various Professional qualification of the respondents as shown in Table 2; 29.41% belonged to Quantity surveying profession. 23.53% were in Architecture, 17.65% were in Building and Civil Engineering profession. While 11.77% belonged to Other professions not listed.

Table 1 illustrates the years of experience of respondents which to a large extent shows the competency regarding construction tasks and responsibilities are shown in Table 1. The highest number of respondents were those with the working experience of 21yrs and above 35.29%. 29.41% of the respondents have 5yrs – 10yrs working experience, while 23.53% of respondents having above 11yrs – 14yrs working experience and 11.77% of respondents having above 15yrs – 20yrs working experience. The result can be concluded that their responses could be considered to be trustworthy.

Analysis of Hazardous Work Activities in Building Projects

This section presents the result of the top hazardous work activities in building construction projects sites in Abuja. This is illustrated in Table 2.

Table 2 Summary of the top five Hazardous Work Activities in Building Construction Projects.

S/N	Work items in building projects.	Mean	Rank
1	Structural steel	4.24	1
2	Roof work	4.21	2
3	Electrical works	3.93	3
4	Lift installation	3.83	4
5	Concrete work	3.52	5
6	Cladding work	3.52	5
7	Mechanical works	3.33	7
8	Rebar & other metal work	3.33	7

Table 2 shows the summary of the top five hazardous work activities in building construction projects: Construction structural steel, roof work, electrical works, lift installation and cladding work with mean score of 4.26, 4.21, 3.93, 3.83 and 3.75 respectively.

Identification of Critical Safety Risk Hazards in Building Construction

This section presents the result of the Critical Safety Risk Hazards in Building Construction projects sites in Abuja. The results are presented in Table 3.

Table 3 Identification of Critical Safety Hazards in Building Construction

S/N	Safety Hazards in Building Construction Projects	Mean Score	Rank
1	Struck by falling objects	4.26	1
2	Fall from height	4.21	2
3	Hazard due to machine & tools usage	3.93	3
4	Equipment accidents	3.83	4
5	Manual handling of machine/tool hazards	3.75	5
6	Contact with electricity	3.74	6
7	Fall to the same level / Slips' trips and falls	3.74	6
8	Fall to lower level	3.61	8
9	Caught in-between Objects or Materials	3.42	9
10	Cave- ins /trench collapses	2.78	10
11	Exposure to noise	2.76	11
12	Exposure to harmful substance	2.55	12
13	Collapse of underground cavities / pits	2.43	13
14	Building/structure collapse	2.41	14
15	Struck by moving vehicles	2.33	15
16	Contact with underground lines	1.42	16
17	Traffic accident	1.88	17

Table 3 revealed that the five most critical safety hazards in building construction projects were struck by falling objects; fall from height; hazard due to machine and tools usage; Equipment accidents and Manual handling of machine/tool hazards with mean score of 4.26, 4.21, 3.93, 3.83 and 3.75 respectively and the least was Traffic accident with MS of 1.88.

Safety Risk Analysis of most Hazardous Building Construction Activities

An activity-based analysis of the top five hazardous work activities in building construction projects was conducted for the 17 safety hazards identified from literature. (see Tables 4-8).

Table 4 Analysis of Safety Hazard in the Construction of Structural Steel

Activity	Safety hazard in construction	Percentile	Rank
STEEL STRUCTURAL	Struck by falling objects	100	1
	Hazard due to machine & tools usage	82.35	2
	Fall from height	76.47	3
	Equipment accidents	70.58	4
	Building/structure collapse	70.58	4

Table 4 revealed that the three most critical safety risk hazards in the construction of structural steel were struck by falling objects; fall from height and hazard due to machine and tools usage with 100%, 82.35% and 76.47% respectively.

Table 5 Analysis of safety hazard in roof work

Activity	Safety hazard in construction	Percentile (%)	Rank
ROOF WORK	Fall from height	100	1
	Struck by falling objects	88.2	2
	Equipment accidents	82.35	3
	Fall to the same level / Slips' trips and falls	76.47	4
	Hazard due to machine & tools usage	70.58	5

Table 5 revealed that the three most critical safety hazards in the of construction of roof work are: Fall from height; Struck by falling objects; Equipment accidents with 100%, 88.2% and 82.35% respectively.

Table 6 Analysis of Safety Hazard in the Installation of Electrical Work

Activity	Safety hazard in construction	Percentile (%)	Rank
ELECTRICAL	Contact with electricity	100	1
	Equipment accidents	70.59	2
	Contact with underground lines	58.82	3
	Hazard due to machine & tools usage	58.82	3
	Manual handling of machine/tool hazards	47.06	5

The result from Table 6 reveals that the three most critical safety hazards in the installation of electrical work are Contact with electricity, Equipment accidents, Contact with underground lines and Hazard due to machine & tools usage with 100%, 70.59% and 58.82% respectively.

Table 7 Analysis of Safety Hazard in the Installation of Lift

Activity	Safety hazard in construction	Percentile (%)	Rank
LIFT INSTALLATION	Struck by falling objects	76.47	1
	Hazard due to machine & tools usage	70.58	2
	Equipment accidents	52.94	3
	Fall from height	47.06	4
	Fall to the same level / Slips' trips and falls	46.7	5

The result from Table 7 reveals that the three most critical safety hazards in lift installation are struck by falling objects; hazard due to machine and tools usage and Equipment accidents with 76.47%, 70.58% and 52.94% respectively.

Table 8 Analysis of Safety Hazard in Cladding Work

Activity	Safety hazard in construction	Percentile (%)	Rank
CLADDING	Fall from height	88.24	1
	Fall to the same level / Slips' trips and falls	70.59	2
	Hazard due to machine & tools usage	70.59	2
	Struck by falling objects	64.71	4
	Fall to lower level	52.94	5
	Manual handling of machine/tool hazards	52.94	5

The result from Table 8 reveals that the three most critical safety hazards in the installation of electrical work are Fall from height; Fall to the same level / Slips trips and falls and Hazard due to machine & tools usage with 88.24%, and 70.59% respectively.

DISCUSSION OF FINDINGS

Seventeen main work activities were sampled and the result of the study indicates that Construction of steel structure was the riskiest common work activities in building construction projects, this is in line with Ghousi (2018) who revealed that the most critical hazard in building construction projects was structural steel work, this could be as a result of inexperience of workers in the activity being it is a specialist job. Roof work was ranked second with MS=4.21, this is in line with Kim *et al*. (2010); Choi (2015) & Okoye (2018) who revealed that roof work had the highest safety risk in comparison with other work activities. Third in position was Electrical works with MS= 3.93. Forth in position was Lift Installation with MS=3.63 while Landscaping work had the least risk with MS=1.83.

Fourteen safety risk hazards in building construction projects were sampled and the result revealed that the five most critical safety hazards in building construction projects were struck by falling objects with MS= 4.26, this is in line with Memarian and Mitropoulos (2013); Gurcanli *et al*. (2015); and Ghousi (2018). Fall from height was second with MS=4.21. This is in consonance with the findings of the Centers for Disease Control and Prevention (2018) who reported that fatal fall are the leading cause of deaths in construction is 2016. Hazard due to machine and tools usage with MS=3.93; Equipment accidents with MS=3.83 and Manual handling of machine/tool hazards with MS= 3.75. this is in line with Udo *et al*. (2016) & Okoye (2018).

CONCLUSION AND RECOMMENDATIONS

The study examined the potential hazards in building construction projects using activity based to determine the most common hazards in building construction projects in Abuja. The result of the study revealed that safety hazards inherent in building construction activities are many and varied, demonstrating that different trade are associated with different hazards implying that depending on the nature and type of activities involved in any trade, there are different dimensions and magnitude of hazard in building construction operations. It can therefore be concluded that the nature and type of activities determines the dimensions and magnitude of hazard in building construction operation.

Based on the findings of this study, it is recommended that all construction safety plan should have provision for adequate risk assessment strategy and periodical hazard identification investigation should be carried out on construction site and provision of health and safety measures be provided on sites. Continuous training and education on safety precaution and equipment and machinery usage, should be conducted for employers periodically to minimize construction accident.

Further research should be carried out to examine the health and safety risk level of the various building construction trades/activities in Nigeria to enable stakeholder discover which work activities have high severity and frequency. The study provides valuable information for site-based construction managers and safety professionals with evidence of hazardous activities associated with different building construction trade/activities and providing a starting point for targeting worker health and safety programs in mitigating the hazards associated with building construction projects.

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