

## Oluwasinaayomi Faith Kasim\*

Dr Oluwasinaayomi Faith Kasim\*  
(corresponding author), Lecturer,  
Department of Urban and Regional  
Planning, University of Ibadan, Oyo  
State, Nigeria.  
Phone: +2348055607009,  
Email: <kasimfaith@gmail.com>  
ORCID: [https://orcid.  
org/0000-0002-5985-1534](https://orcid.org/0000-0002-5985-1534)

## Adekunle Moruf Alabi

Dr Adekunle Moruf Alabi, Lecturer,  
Department of Urban and Regional  
Planning, University of Ibadan,  
Oyo State, Nigeria. Phone:  
+2348034385874,  
Email: <morufalabi@gmail.com>  
ORCID: [https://orcid.  
org/0000-0002-0137-7390](https://orcid.org/0000-0002-0137-7390)

## Sunday Wusu

Mr Sunday Wusu, Department of Urban  
and Regional Planning, University of  
Ibadan, Oyo State, Nigeria.  
Phone: +2349093481560,  
Email: <sundaywusu2020@gmail.  
com>

DOI: [http://dx.doi.  
org/10.18820/24150487/as27i1.3](http://dx.doi.org/10.18820/24150487/as27i1.3)  
ISSN: 1023-0564  
e-ISSN: 2415-0487  
Acta Structilia 2020 27(1): 59-84



Published by the UFS

<http://journals.ufs.ac.za/index.php/as>

© Creative Commons With Attribution (CC-BY)

How to cite: Kasim, O. F., Alabi, A. M. & Wusu, S. 2020. Risk assessment  
for hazard exposure and its consequences on housing construction  
sites in Lagos, Nigeria. *Acta Structilia*, 27(1), pp. 59-84.

# RISK ASSESSMENT FOR HAZARD EXPOSURE AND ITS CONSEQUENCES ON HOUSING CONSTRUCTION SITES IN LAGOS, NIGERIA

*Peer reviewed and revised March 2020*

*Published June 2020*

*\*The authors declared no conflict of interest  
for the article or title*

## ABSTRACT

Despite housing construction's economic contribution, the nature of work done is well acknowledged as risky to execute because of the occupational accidents and work-related hazards to which workers are exposed. Most of the workers experience hazards, owing largely to inadequate or lack of safety infrastructure and mechanisms for protective gear. This article examines varying levels of hazards to which workers are exposed at housing construction sites in Lagos, Nigeria. A mixed methods research was used to collect the necessary data for the study. From the total number of 511 residential building construction sites identified, simple random sampling technique was used to select 255 (50%) of the buildings. A questionnaire was administered to the supervisors on each site to obtain information on the exposure of hazards on housing construction sites. In addition, one month's data on incidents of near miss, accident and fatal cases were obtained from construction managers/supervisors for each site. The data was analysed with frequencies, percentages and inferential statistics. Construction workers are exposed to multifaceted hazards. Roughly 91% of the respondents had witnessed

hazards of varying degrees. Paired t-test values showed that, on average, 25.3 more near misses and 12.4 more accidents happened monthly on sites supervised by individuals/owners than on sites supervised by trained supervisors. The Pearson's r test ( $r = -0.705$ ) showed that not enough first-aid kits were provided on sites to meet the needs of workers. Proper safety mechanisms to ensure strict adherence to safety rules and regulations at construction sites must be developed and enforced.

Keywords: Hazards, construction health and safety, housing construction, risks assessment matrix, Lagos

## ABSTRAK

Ondanks die ekonomiese bydrae van behuisingskonstruksie, word die aard van die werk wat gedoen word, as riskant beskou omdat daar werksongelukke en gevare is waaraan werkers blootgestel word. Die meeste werkers ervaar gevare weens grootliks onvoldoende of gebrek aan veiligheidsinfrastruktuur en meganismes vir beskermingsuitrustings. Hierdie artikel ondersoek verskillende vlakke van gevare waaraan werknemers op die konstruksieterreine in Lagos, Nigerië, blootgestel word. Navorsing met gemengde metodes is gebruik om die nodige gegewens vir die studie te versamel. Uit die 511 geïdentifiseerde konstruksieterreine vir residensiële geboue, is 'n eenvoudige ewekansige steekproefnemingsstegniek gebruik om 255 (50%) van die geboue te selekteer. 'n Vraelys is aan die toesighouers op elke terrein gegee om inligting te bekom oor die blootstelling van gevare op behuisingskonstruksieterreine. Ook een maand se data oor voorvalle van byna-misse, ongelukke en noodlottige gevalle is verkry van elke deelnemende konstruksiebestuurder/toesighouer. Die data is geanaliseer met frekwensies, persentasies en inferensiële statistieke. Konstruksiewerkers word blootgestel aan veelsydige gevare. Ongeveer 91% van die respondente het in verskillende mate gevare gesien. Gepaarde t-toetswaardes het getoon dat gemiddeld 25.3 meer byna-misse en 12.4 meer ongelukke maandeliks plaasgevind het op persele wat deur individue/eienaars onder toesig was as op terreine onder toesig van opgeleide toesighouers. Die Pearson r-toets ( $r = -0.705$ ) het getoon dat daar nie genoeg noodhulpkissies op die terrein beskikbaar is om in die behoeftes van werkers te voorsien nie. Behoorlike veiligheidsmeganismes om streng nakoming van veiligheidsreëls en regulering op konstruksieterreine te verseker, moet ontwikkel en toegepas word.

Slutelwoorde: Gevare, konstruksie-gesondheid en -veiligheid, konstruksie van huise, risiko-assesseringsmatriks, Lagos

## 1. INTRODUCTION

The housing construction industry is one of the largest employers globally and can contribute up to \$10.5 trillion to the world economy by 2023 (MGI, 2017: online; NAPBHR, [n.d.]: online). It employs approximately 7% of the global work force (ILO, 2005: 6; MGI, 2017: online; Rhodes, 2019: 3-4) or 180 million people, and it is predicted to account for approximately 10% of the Global Domestic Product (GDP) by 2020 (Murie, 2007: 6-7; Durdyev & Ismail, 2012: 884-885; Nieuwenkamp, 2016: online). Owing to its substantial contribution to the GDP of the vast majority of nations, the development of the housing construction industry has been viewed as the foundation for contemporary and future economic growth and social development (Agbola, 2005: 7-10; Kasim, 2018: 955-959).

Despite its economic contribution, the nature of work done within residential building construction is well acknowledged as risky to execute because of the complexity of its activities and risky external and internal environments (Zou, Zhang & Wang, 2007: 602-603; Lette, Ambelu, Getahun & Mekonen, 2018: 58). The complexities of housing construction activities during execution expose workers to a plethora of hazards and generate enormous risks that may culminate into accidents if not well managed (Orji, Nwachukwu & Enebe, 2016: 282-283).

According to Okeola (2009), workers in the housing construction industry are three times more exposed to a variety of near misses, accidents and fatalities (Churcher & Alwani, 1996: 29-31; Orji *et al.*, 2016: 282-285). The industry also accounts for 30%-40% of the world's fatal injuries; 100,000 workforces are killed on sites every year (MGI, 2017: online; Lette *et al.*, 2018: 57-58).

Absence of a centralised safety agency (Agwu, 2012: 213), inadequate or lack of safety infrastructure, regulations and mechanisms on sites, in the developing countries (Nigeria included), are responsible for the death of one person on site every five minutes (Takala *et al.*, 2014: 326; United States Department of Labor, 2017: online). Prior to 2004, government-centred policies and programmes failed to eliminate the gap between housing need and supply in Lagos, Nigeria (Alabi & Ajide, 2011: 32-33). Post-2004, the Nigerian National Housing Policy allowed for approximately 90% of housing provision in Nigeria, especially Lagos, to be constructed and provided by private sector with its associated hazards in the poorly monitored construction industry sector in Nigeria (Alabi, Muraina & Kasim, 2018: 46-47).

Although a number of studies has been done on construction hazard and risk assessment in general (Babovic, 2009: 22-26; Oladinrin, Ogunsemi & Aje, 2012: 50-60; Zolfagharian Ressang, Irizarry, Nourbakhsh & Zin, 2011: 151-161; Orji *et al.*, 2016: 282-289), there is a dearth of study on exposure to hazards specifically in the housing construction industry. The scarcity of scientific research on exposure to hazards in the housing construction industry highlights the need to assess the hazards and risks, taking into consideration the safety measures in place to reduce hazards. The purpose of this article is, therefore, to investigate the exposure to hazards and the consequences thereof on workers, working on housing construction sites in Lagos, Nigeria. Findings will be useful for all employers of construction workers, governmental and private employers, developers and other agencies that are involved in housing construction through the proffered safety measures towards mitigating hazard prevalence.

## 2. LITERATURE REVIEW

To understand hazard exposure and its consequences on housing construction sites in Lagos, Nigeria, it is important to introduce the current theory on hazard exposure concepts included in this article. The existing theory focuses on the concepts of human error, hazards, and vulnerability of workers in housing construction.

### 2.1 Housing construction workers and human errors

The construction industry is an economically important industry in any country. The sector supply infrastructure and physical structures of a country provides basic needs such as housing for the population (Haupt & Harinarain, 2016: 80). The construction industry employs workers cutting across different occupations and trades. The categories of workers in typical housing construction include carpenters, masons, painters, electricians, machine operators (concrete mixer, crane, and soil compactor operators and forklift drivers), iron benders, plumbers, machinists (precision material worker who assemble or fabricate mechanical parts, pieces or products, using a variety of tools and equipment at construction sites), foremen and professionals such as architects, civil engineers, builders, foremen and urban planners. Jobs in the construction field require workers to hold various skills, from construction managers to floor installers. The skills are required as a gateway to the sector, but they can hardly protect the workers against hazards. The construction sector, including residential building construction sites, has a set of occupational hazards that are specific to the sector. Work done on construction sites is considered to be high risk and may result in occupational accidents that are mostly viewed as human-induced incidents or human error (Guo, Yiu & González, 2016: 5)

Human factors engineering is a relatively new engineering field dedicated towards understanding human interaction in the work environment such as executing construction activities (Abdelhamid & Everett, 2000: 54). Human factor models capture worker interaction best in behaviour models that portray workers as being the main cause of accidents. This approach studies the tendency of human beings to make errors under various situations and environmental conditions (Abdelhamid & Everett, 2000: 54-55). In the construction industry, human error is always or sometimes attributed to accidents at construction sites, even at adherence or non-adherence to safety rules (Babovic, 2009: 22; Guo *et al.*, 2016: 5-6). When the label 'human error' is used, it sometimes refers to the processes and systematic factors that influence people's behaviour and performance in any situation. Therefore, the scientific study of human error or failure should be concerned with the understanding of factors influencing the cognition, collaboration and behaviour of workers in a work environment (Woods & Cook, 2000).

However, it is important to holistically analyse the work environment with its inherent unsafe characteristics and analyse the design of workplaces and tasks that do not consider human limitations before the blame on workplace mishap can be labelled as 'human error' (Abdelhamid & Everett, 2000: 54-55). Human factors engineering aims to achieve efficiency and better designed tasks, using appropriate tools, in a safe workplace, but it also acknowledges limitations of human physical and psychological composition and capabilities which, if not properly managed, can trigger latent hazards and inherent vulnerability (Breeding, 2011: online).

## 2.2 Construction hazards

A hazard is a situation that poses a level of potential threat or risk to life, health, property, or environment (CCOHS, 2020: online). The vast majority of hazards are dormant or potential, with only a theoretical risk of harm; however, once a hazard becomes active, owing to the relationship between a person and the work environment, it can lead to accidents and emergency situations (Breeding, 2011: online). Hazard exposure is driven by any activity, situation or condition within the physical environment with the potential to cause harm, injury or death to persons, and damage to assets and the environment (Rausand, 2004). Cardona (2001) notes that hazard refers to a latent danger or vulnerability to an external risk factor from an exposed system or subject.

According to OSHA (2017), health hazards in the construction industry can be grouped under chemical, physical, and ergonomic hazards. Chemical hazards can affect the body via inhalation, ingestion, or skin absorption, including toxic gas from welding; fumes from dusts; burns from chemicals; skin irritation from cement and paints, as well as respiratory irritation from thinners and insulation materials (OSHA, 2017: 3-7). Physical hazards are noise, heat, vibration and radiation, including acute noise generation; acute vibration; electrocution; exposure to excessive heat, and exposure to hot or pressurised liquid (OSHA, 2017: 10-15). Ergonomic hazards include mainly manual handling of loads such as objects falling from a height; fall of workers from a scaffold; fall of workers from a roof or upper floor of a building; workers pierced by sharp objects; workers falling into unfenced excavation, and workers struck by earth-moving machines (OSHA, 2017: 27-29).

In the context of this article, a hazard is defined as any form of mishap or injury suffered by workers as related to specific occupational demands or job requirements on site.

## 2.3 Construction hazards management

Scope, environment and working conditions on construction sites can trigger inherent hazards that could be managed, using safety management approaches. Inadequacies in the safety system could influence and/or lead to occupational accidents (Ford & Tetrick, 2011: 49-50; Andersson, 2012: 210-212). For example, poor work ethics and flagrant disobedience to safety rules and regulations by workers would lead to accidents, regardless of the existing safety management approach. Human- and, to a larger extent, non-human-related events are beyond control and prediction, as encapsulated in the safety management concept. Hence, as observed by Imriyas, Phen and Teo (2006: 272-274), estimation of exposure to hazards and the functionality of any occupational injury risks analysis in construction projects should be assessed, using two factors, namely a project's safety management level and inherent hazard level (Imriyas *et al.*, 2006). Figure 1 shows that, in construction safety management, inherent hazard level identification is fundamental, because unidentified hazards are the most unmanageable risks (Carter & Smith, 2006: 198).

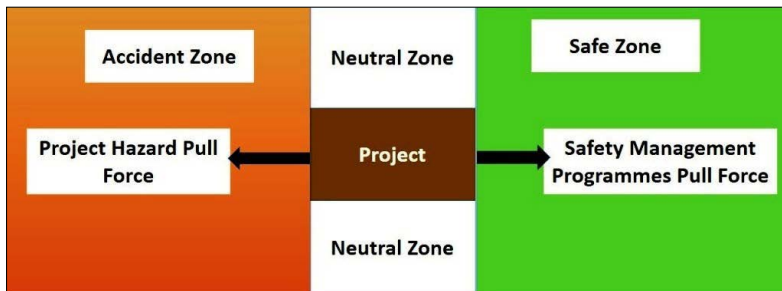


Figure 1: Hazard versus safety trade-off  
Source: Adapted from Imriyas *et al.*, 2006

As shown in Figure 1, unmanageable and unidentified hazards would gravitate a construction project towards the accident- and hazard-related zone, while informed safety measures would pull the construction activities towards the safety zone. In addition, when and where the safety management force is equal to the degree of hazard generated, the construction activities would be inclined towards the neutral zone. However, if the safety management structure is lower than the hazard level, the project would be driven towards the accident zone. Hence, the linkage and/or the assessment of a construction project hazard level and safety management structure prediction of occupational accidents inherent within the environment of a project.

Bosher and Dainty (2011: 1-3) observe that inherent hazards could lead to risks and these identified risks could be minimised, transferred, shared, accepted or managed, but should never be ignored. Fundamentally, two phases are required in the control and management of construction hazards. First, the hazardous events prevention phase and, secondly, mitigating and adapting to the potential severity of hazards, if and when they occur (World Bank, 2013: 6-10). Varying degrees of hazards occur at construction sites. Their degree of severity or fatality is dependent on the safety measures taken by workers on site. At construction sites, preventive measures are taken for different probable types of hazards such as protective boots against piercing; protective helmet against fall impact on the head; nose mask to filter fumes and dust, and to protect against respiratory diseases, and so on (ILO, 1999: 79-83).

### 3. RESEARCH METHODS

This study assessed the hazards faced by workers on housing construction sites in Eti-Osa, Lagos State, Nigeria, taking into consideration the level of exposure to, and the impact of the identified construction hazards. The study used a mixed methods design, in which qualitative and quantitative data are collected in parallel, analysed separately, and then merged (Creswell, 2014). A quantitative structured questionnaire survey enables researchers to generalise their findings from a sample of a population (Bryman, 2012: 232; Creswell, 2014). It also allows for descriptive and inferential statistical analysis (Naoum, 2013: 104). In this study, hazard exposure records of housing construction sites were used to build the theory on hazard exposure, predicting that experience of 'high-risk' hazards will negatively affect the health of workers on housing construction sites in Nigeria. The questionnaire assessed the level of hazards experienced by workers. The reason for collecting both quantitative and qualitative data is to elaborate on specific findings from the breakdown of the hazards incident records, such as similar 'high-risk' hazards experienced from the respondents' groups (Creswell & Plano-Clark, 2007).

#### 3.1 Sampling method and response rate

From a preliminary survey by the authors, a total of 511 new residential building projects, at different stages of construction, were identified in the study area. Random sampling was utilised to select 255 of the residential buildings under construction. From these, at least one worker acting as supervisor/construction manager or owners' representative from each site was targeted to participate (Alvi, 2016: 35). The survey was undertaken with a sample of 255. The sample size for research done in construction-related populations was calculated in accordance with the table recommended by

Krejcie and Morgan (1970: 608). From the table, the recommended sample size for a population of 500 is 217, and for 550, 226. This recommendation validates the sample size of 255 as efficient for the population of 511 in Table 1.

Table 1: Sample and response rate

Localities in Eti-Osa LGA	Sample frame	Sample size 50%	Ownership		Responses	Response rate (%)
			Individual	Corporate		
Ado/Langbasa/Badore	164	82	65	17	82	100
Ajah/Sangotedo	91	45	38	7	45	100
Ajiran/Osapa	101	51	35	16	51	100
IkateLekki	87	43	37	6	43	100
Ikoyi	8	4	1	3	4	100
Maroko Okun Alfa	48	24	19	5	24	100
VI/Oniru	12	6	4	2	6	100
Total	511	255	199	56	255	

### 3.2 Data collection

Structured questionnaires were used to collect data from 255 construction managers or owners' representatives (supervisors) working on new residential building construction sites in Eti-Osa, Lagos, Nigeria, from 2 to 17 November 2016.

The questionnaire consisted of five sections. The first section, on the respondents' demographic profile, obtained personal information on age, educational level, and occupation. The second section set 14 tick-box options on hazard experiences to obtain if and how often workers experience hazard situations on site. Section three set one Likert-scale question with 18 items on the construct 'exposure to hazard' and section four set one Likert-scale question with 18 items on the construct 'consequence of hazard exposure'. Participants were requested to rate the level of frequency and the level of consequence on the statements regarding hazard exposure on housing construction sites. Section five contained four tick-box questions and one Likert-scale question with 5 items on the construct 'control strategies'. Participants were requested to rate their level of agreement on statements regarding safety management of hazards on site. The results from these measurements form the items used in the descriptive analysis, matrix analysis, and the inferential statistics. To reduce the respondents' bias, closed-ended questions were preferred for sections two and three (Akintoye & Main, 2007: 601).



In addition to the questionnaire survey, supervisors also provided a tabulated record sheet of one month's data (2 November to 1 December 2016) on incidents of near misses, accidents and fatalities in all the sampled sites. All the 255 copies of the questionnaire administered were returned and used for analysis. The authors also recorded their own observations on safety management from the sites sampled.

### 3.3 Analysis method and how to interpret data

The Statistical Package for Social Science (SPSS) version 24 was used to determine the frequency and consequences of hazard exposure, by using descriptive and inferential statistics (Pallant, 2013). The frequencies and/or percentages of responses were generated and reported, in order to analyse the respondents' profile, supervisor status and exposure to hazards, incidents records and safety management structure.

For the analysis on the frequency, and consequences of hazard exposure, a 5-point Likert scale was used to measure how strongly respondents felt regarding the statements in the Likert-scale constructs. Likert-scale rankings are effective where numbers can be used to quantify the results of measuring behaviours, attitudes, preferences, and even perceptions (Wegner, 2012: 11; Naoum, 2013: 89). For the purposes of analysis, it is important to note that the following scale measurement was used regarding mean scores (MSs), where 1 = very low/insignificant; 2 = low/minor; 3 = regular/moderate; 4 = high/major, and 5 = very high/catastrophic. Data was analysed, using frequencies and MS rankings.

To identify the major risks from hazard exposure, a risk matrix analysis was done to rank the 25 initial item scores on the basis of frequency and consequence. The matrix assessment is the multiplication of hazard exposure and its consequence: (hazard exposure x consequence). Only one score for each item (as labelled) was considered to determine the influence of each item in the row on the statement in the column. For example, both consequences and occurrences range from 1 to 5. The risk matrix score for a specific hazard is the product of the rate of occurrence (row value) and consequence (column value). Items in the matrix were weighted (scored) on a 5-point Likert scale were 1 = very low risk; 2 = low risk; 2 = moderate risk; 3 = high risk; 4 = high risk, and 5 = very high risk. They were then classified according to their risk level where 1-4 = 'low'; 5-15 = 'medium', and 16-25 = 'high', stipulated in the risk matrix assessment model of Zolfagharian (Zolfagharian, Nourbakhsh, Irizarry, Ressang & Gheisari, 2012: 1753) (see Table 2).

To analyse the hazards incidence records, a paired samples *t*-test with  $p=0.05$  was done to compare the mean of cases, and to find any

correlations between the cases examined (Ross & Willson, 2017: 17). A Pearson's correlation test with  $p=0.05$  was done to find any significant relationship between workers' need for first-aid kits, and the provision of such kits by housing construction site managers.

Table 2: Risk level classification of construction hazards

Consequence	Hazard and risk classification matrix				
5	5 (M)	10 (M)	15 (H)	20 (H)	25 (H)
4	4 (L)	8 (M)	12 (M)	16 (H)	20 (H)
3	3 (L)	6 (M)	9 (M)	12 (M)	15 (H)
2	2 (L)	4 (L)	6 (M)	8 (M)	10 (M)
1	1 (L)	2 (L)	3 (L)	4 (L)	5 (M)
Occurrence	1	2	3	4	5

*L = low; M = medium; H = high*

Source: Adapted from Zolfagharian *et al.* (2012: 1753)

### 3.4 Limitations

Owing to time constraint, focus-group discussions could not be organised in order to identify the sociocultural dimension influencing hazards in construction sites. A section of Lagos and construction activity was also sampled; this may not be a true reflection of construction activities in Nigeria.

## 4. RESULTS

### 4.1 Respondents' demographics

Table 3 displays the demographic profile of the participants. It is obvious that the majority of the respondents were foremen (19.4%), masons (16.9), carpenters (14.1%), and iron benders (11.4%); the professionals (architects, civil engineers, builders, and urban planners) constituted only 9.4% of the respondents. The results show that the respondents represented all relevant workers in the housing construction.

The highest number (59%) of the respondents had a secondary school education (36%) or a primary school education (23%), and 12% had a technical college qualification; only 8% had a tertiary qualification. Furthermore, the analysis of the respondents' academic qualifications showed that 20% of the respondents did not have any formal education, especially the carpenters and the painters; they were trained through the artisanship system, the predominant informal training arrangement for tradesmen and artisans in Nigeria (Sanni & Alabi, 2008: 17; Adewale, Siyanbola & Siyanbola, 2014: 37-38). In addition, 19% of the foremen did not receive any formal education. Analysis of the respondents' age showed that 55% were younger

than 40 years, except for the machinists, foremen, and machine operators, the majority of whom were above 40 years of age. From the information on the academic qualifications of the respondents, it can be inferred that the majority of the supervisors possessed satisfactory education qualifications to understand the questionnaire and supply data for this study.

Table 3: Respondents' profile

Demographic								Frequency (N = 255)	Total %
Occupation / Trade	Age (years)		Educational level						
	15-39 (%)	40-59 (%)	No formal education (%)	Primary (%)	Secondary (%)	Technical college (%)	Tertiary education (%)		
Carpenter	26 (72)	10 (28)	19 (52)	12 (33)	4 (11)	1 (4)	0	36	14.1
Mason	30 (68)	14 (32)	7 (17)	14 (32)	21 (49)	1 (2)	0	43	16.9
Painter	4 (39)	7 (61)	6 (55)	3 (27)	2 (18)	0	0	11	4.3
Machine operator	6 (39)	9 (61)	0	2 (13)	8 (53)	4 (27)	1 (7)	15	5.9
Electrician	10 (47)	12 (53)	0	3 (12)	17 (78)	2 (9)	0	22	8.6
Plumber	9 (52)	8 (48)	1 (5)	2 (12)	4 (24)	10 (59)	0	17	6.7
Foremen	19 (38)	31 (62)	10 (19)	14 (28)	19 (39)	7 (14)	0	50	19.6
Iron bender	21 (72)	8 (28)	8 (28)	9 (31)	12 (41)	0	0	29	11.4
Machinist	2 (25)	6 (75)	0	0	6 (75)	2 (25)	0	8	3.1
Professionals	15 (65)	9 (35)	0	0	0	5 (20)	19 (80)	24	9.4
Total	142 (55)	114 (45)	51 (20)	59 (23)	93 (36)	32 (12)	20 (8)	255	100

## 4.2 Supervisor hazard experience

Table 4 shows the status of supervisors as well as if and how often they experienced hazard situations on site. A vast majority (78%) of the residential building construction activities were supervised by owners (private individuals) or appointed cronies of the owners. As observed, most of these persons (74.3%) do not have prerequisite qualifications to supervise and manage housing construction projects.

Registered construction companies were involved in the construction of 22% of the residential building projects, and almost 98.2% employed qualified personnel to supervise work on site. Construction activities are laden with hazards of varying magnitude and the level of exposure varies among the workers. Analysis of the respondents' experience with hazards showed that the majority of them (91.1%) had witnessed one form of hazard or other, while 9.9% had not witnessed any construction work-related hazard. From the total number of those who had witnessed hazards previously, 68.4% and 31.6% were supervised by persons without prerequisite qualifications in individual and corporate construction sites, respectively. A vast majority of respondents experienced hazards occasionally (45.5%) and frequently (47.2%).

Table 4: Supervisor status and exposure to hazards

<i>Supervisors</i>	<i>Category</i>	<i>Frequency (N=255)</i>	<i>%</i>
Ownership	Individual	199	78
	Corporate	56	22
Qualification (individual)	Qualified	51	25.6
	Not qualified	148	74.3
Qualification (corporate)	Qualified	55	98.2
	Not qualified	1	1.8
Experienced hazards (overall)	Yes	230	90.1
	No	25	9.9
Experienced hazards frequency (overall)	Barely	19	7.4
	Occasionally	116	45.4
	Frequently	120	47.2
Exposed to hazards (overall)	Individual	180	70.5
	Corporate	49	29.5
Exposed to hazards by qualification (individual)	Qualified	63	31.6
	Not qualified	136	68.4
Exposed to hazards by qualification (corporate)	Qualified	34	60.7
	Not qualified	22	39.3

### 4.3 Ranking of exposure to hazards and its consequences

Table 5 shows the ranking of the level of exposure to hazards as well as the consequences of the exposure, as perceived by the respondents. The majority of the respondents (53.7%) perceived very high exposure to objects falling from a height, and 49.3% indicated that falling objects from a height (MS = 3.99) constituted a major health risk to workers.

With an average MS of 3.24, results in Table 5 show that respondents perceived regular exposure to hazards on construction sites. With MS ratings above 4.0, respondents perceived high exposure to 'objects falling from height' (MS = 4.25) and 'skin irritation from cement, and paint' (MS = 4.17). The majority of the respondents (85.6%) indicated that 'skin irritation from exposure to cement and paint' (MS = 4.14) is a major and sometimes catastrophic health risk to workers. Almost three quarters of the respondents (73.1%) indicated high to very high levels of exposure to noise pollution. With MS ratings above 3.5, respondents are regularly exposed to 'piercing by objects' (MS = 3.79); 'air pollution' (MS = 3.67), and 'falling from a roof' (MS = 3.59). More than half of the respondents (60%) also indicated that 'falling from a roof' (MS = 3.62) and 'piercing by sharp objects' (MS = 3.57) may pose a major health risk to workers.

Table 5: Respondents' perception on hazard exposure and its consequences

Hazard	Exposure N=255 (%)					Rank	MS	Consequence N=255 (%)					Rank
	Very low	Low	Regular	High	Very high			Insignificant	Minor	Moderate	Major	Catastrophic	
	1	2	3	4	5			1	2	3	4	5	
Object falling height	0	10 (4.0)	51 (20.1)	57 (22.2)	137 (53.7)	1	4.25	9 (3.7)	47 (18.6)	125 (49.3)	72 (28.4)	2	
Falling from a Scaffold	6 (2.4)	25 (9.8)	111 (43.5)	89 (35.0)	24 (9.3)	8	3.39	5 (1.8)	19 (7.6)	120 (47.1)	29 (11.4)	5	
Falling from a roof		35 (13.7)	70 (27.6)	114 (44.5)	36 (14.2)	7	3.59	36 (14.3)	66 (25.7)	111 (43.6)	42 (16.4)	3	
Piercing by objects		16 (6.3)	72 (28.4)	118 (46.1)	49 (19.2)	4	3.79	32 (12.6)	91 (35.7)	85 (33.3)	47 (18.4)	4	
Noise pollution		30 (11.7)	39 (15.2)	106 (41.7)	80 (31.4)	3	3.92	35 (13.8)	57 (22.4)	41 (15.9)	53 (20.7)	7	
Electrocution	118 (46.5)	20 (7.7)	74 (29.2)	14 (5.3)	29 (11.3)	11	2.27	112 (43.8)	77 (30.3)	58 (22.6)	3 (1.2)	12	
Fall into trench	108 (42.3)	94 (36.7)	37 (14.5)	13 (5.2)	3 (1.2)	13	1.85	119 (46.6)	86 (33.7)	30 (11.7)	10 (4.0)	13	
Struck machine	105 (41.1)	75 (29.4)	54 (21.0)	21 (8.4)		12	1.96	135 (53.1)	27 (10.4)	64 (25.0)	29 (11.5)	11	
Toxic gas form welding	56 (22.2)	78 (30.5)	40 (15.5)	52 (20.5)	29 (11.3)	10	2.68	70 (27.3)	94 (37)	51 (20.2)	15 (5.8)	10	
Air pollution	14 (5.4)	15 (5.9)	81 (31.7)	75 (29.4)	70 (27.4)	5	3.67	20 (8.0)	63 (24.7)	79 (31.1)	54 (21.1)	9	
Burns from chemicals	14 (5.8)	82 (32.0)	72 (28.2)	38 (14.9)	49 (19.1)	9	3.10	16 (6.2)	80 (31.5)	65 (25.3)	43 (17)	8	
Skin irritation from cement, paint		10 (3.9)	28 (11.2)	125 (48.9)	92 (36.1)	2	4.17	1 (0.4)	7 (2.6)	29 (11.4)	134 (52.4)	1	
Irritation from thinners and insulation materials	1 (0.4)	5 (2.0)	114 (44.7)	108 (42.3)	27 (10.6)	6	3.60	15 (6.0)	16 (6.3)	101 (39.7)	108 (42.1)	6	
Total							3.24					3.03	

Owing to the specialised nature of work to be done in electrical wiring and installation of electrical equipment in buildings, in addition to the fact that most of the work was done without active connections to electricity gridlines, 46.5% of the respondents considered exposure to electrocution to be very low and 43.8% of the respondents adjudged the consequence to be insignificant. Exposure to 'fall into trench' (MS = 1.85) and 'struck by a machine' (MS = 1.96) were rated very low, showing that at housing construction sites the consequences of exposure to these two hazards (MS = 1.84; 1.94) is insignificant.

#### 4.4 Risk matrix results

Adopting the computation in Table 2, the observed risk matrix assessment shows the classification level of hazard exposure and its consequences in Table 6. With classification levels from 16 to 20, 'fall of object from a height', 'fall of workers from a roof or upper floor of a building', 'acute noise generation', 'exposure to excessive heat', and 'skin irritation from cement and paint' were classified as 'high-risk' hazards. Experience of these high-risk hazards will have a major effect on the workers' health.

Table 6: Risk level classification matrix

Hazard	Exposure					Consequences					Hazard occurrence	Risk level
	Very low	Low	Average	High	Very high	Insignificant	Minor	Moderate	Major	Catastrophic		
	1	2	3	4	5	1	2	3	4	5		
Fall of object from a height					5				4		20	H
Fall of workers from a scaffold			3					3			9	M
Fall of workers from a roof or upper floor of a building				4					4		16	H
Pierced by sharp objects				4				3			12	M
Acute noise generation				4					4		16	H
Acute vibration			3					3			9	M
Electrocution	1					1					1	L
Falling into unfenced excavation	1					1					1	L
Struck by earth-moving machine	1					1					1	L
Toxic gas from welding		2				2					4	L
Toxic fumes from dusts			3					3			9	M
Hot or pressurised liquid	1					1					1	L
Exposure to excessive heat				4					4		16	H
Burns from chemicals		2					2				4	L
Skin irritation from cement and paint				4					4		16	H
Respiratory irritation from thinners and insulation material			3						4		12	M

L = low; M = medium; H = high

## 4.5 Hazard incidents results

Table 7 shows the records for near misses, accidents and fatal incidents recorded for the sampled housing construction sites. Supervisors recorded 1,213 hazard-related incidents for one month, showing that workers are exposed to 40 hazard experiences daily.

Incident records also indicated that 631 near misses had been recorded (176 cases from private and 455 cases from corporate sites). Approximately 380 actual accidents had happened (257 cases from private and 120 cases from corporate sites); 205 fatal cases were recorded (122 cases from private and 83 cases from corporate sites). Falling objects from a height (249); piercing by sharp object (186); workers falling from scaffolds (175) and/or from roof or upper floor (155); exposure to excessive heat (143), and burns from chemicals (112) were hazards that occurred the most.

Table 7: Hazard incidents record

Hazard	Individual supervisors				Corporate supervisors			
	Accident	Near miss	Fatal	Total	Accident	Near miss	Fatal	Total
Object falling from height	53	31	27	111	17	102	19	138
Worker falling from a scaffold	37	19	11	67	15	65	28	108
Worker falling from a roof	50	23	18	91	16	38	10	64
Piercing by objects	46	17	32	95	13	72	6	91
Electrocution	6	6	0	12	3	13	0	16
Fall into unfenced trench	5	4	1	10	3	12	0	15
Struck by earth-moving machine	0	11	0	11	11	12	1	24
Machine contact overhead cables	1	6	0	7	3	6	0	9
Hot/pressurised liquid	17	23	11	51	13	22	3	38
Exposure to excessive heat	24	22	13	59	18	61	5	84
Burns from chemicals	18	14	9	41	8	52	11	71
Total	257	176	122	555	117	455	83	658

Table 8 shows the t-test results on the mean difference between incidents reported by individual/owner and corporate supervisors. There was a significant difference between scores reported for near misses by individual and corporate supervisors ( $t=-3.322$ ,  $p<0.008$ ). The results show that, on average, 25.3 more near misses happened on sites supervised by individuals/owners than on sites supervised by trained people (95% CI [-42.37, -8.35]).

Table 8: Paired samples test of incidents at the construction sites

		Paired differences					t	df	*Sig. (2-tailed)
		Mean	Std. deviation	Std. error mean	95% Confidence interval of the difference				
					Lower	Upper			
Pair 1	Near miss individual – Near miss corporate	-25.36364	25.31905	7.63398	-42.37321	-8.35406	-3.322	10	0.008
Pair 2	Accident individual – Accident corporate	12.45455	16.15155	4.86988	1.60378	23.30531	2.557	10	0.028
Pair 3	Fatal individual – Fatal corporate	3.54545	10.43421	3.14603	-3.46434	10.55525	1.127	10	0.286

\*significant at 0.05

There was also a significant difference between scores for accidents reported by individual and corporate supervisors ( $t=2.557$ ,  $p<0.028$ ). The results show that, on a monthly average, 12.4 more accidents happened on sites supervised by individuals/owners than on sites supervised by trained people (95% CI [1.60, 23.3]). However, there was no significant difference between scores for fatal incidents reported by individual and corporate supervisors ( $t=1.127$ ,  $p<0.286$ ). The results show that, on average, only 3.54 more fatal incidents happened on sites supervised by individuals/owners than on sites supervised by trained people (95% CI [-3.46, 10.5]).

#### 4.6 Safety management to mitigate hazards

Table 9 shows the results on how safety control and management prevent hazards on sites sampled. Overall, only 7.8% of the supervisors provided regular medical orientation about the hazards to which construction workers were exposed in the course of carrying out day-to-day activities. The vast majority of the individual/owner supervisors (97.9%) did not provide any medical orientation drills to keep workers abreast of hazards associated with construction activities. Corporate supervisors (80.4%) and individual/owner supervisors (only 5.1%) provided safety officers on site to monitor compliance with safety regulations in the sampled housing construction sites.

Overall, more than half (64.7%) of the supervisors did not provide adequate emergency response plans and procedures to workers on site and 72.1% (the majority from the private/owner) of the supervisors did not provide the availability of on-the-job safety requirements and training to workers. Overall, only 5% of the supervisors indicated that they provided insurance cover for workers on sites. None of the workers from the private construction sites had insurance cover, while roughly 23.2% of the workers in corporate construction sites had insurance cover. In the sampled sites, only 27.4% had functional first-aid kits to respond to emergencies.



Table 9: Safety management to prevent hazard

Safety management	Category	Individual (N = 199)	%	Corporate (N = 56)	%	Frequency (N = 255)	%
Medical drills on site	Regular	6	3.1	14	25	20	7.8
	Irregular	195	97.9	42	75	237	92.9
First-aid kit	Adequate	24	12.1	46	82.1	70	27.4
	Not adequate	175	87.9	10	17.9	185	72.5
Safety officer on site	Available	10	5.1	45	80.4	55	21.5
	Not available	189	94.9	11	19.6	200	78.4
On the job safety training	Yes	24	12.1	47	83.9	71	27.8
	No	175	87.9	9	16.1	184	72.1
Insurance	Provided	0	0.0	13	23.2	13	5.0
	Not provided	199	100	43	76.8	242	94.9
Emergency response	Adequate	60	30.2	30	53.6	90	35.2
	Not adequate	139	69.8	26	46.4	165	64.7

In Table 10, the results from the Pearson’s test show that there was a significant relationship between the number of first-aid kits required by construction workers and the number of first-aid kits provided by construction site supervisors [ $r = -.705^*$ ,  $n = 255$ ,  $p = .005$ ]. This implies that the number of first-aid kits needed on site to respond to worker emergency situations and the number of first-aid kits provided by housing construction site supervisors are not enough. The situation was extremely dire in the private/owner-supervised sites, where 87.9% of the sites did not provide first-aid kits for the workers. Site observations, during the course of the study, showed that in most sites visited, especially in owner-/individual-supervised construction sites, workers were not kitted up with the required wear and assemblage necessary to perform tasks assigned and to ensure personal protection from hazards. In addition, only a few made it mandatory for visitors to wear personal protective equipment before accessing construction sites.

Table 10: Correlation between the need for and the provision of first-aid kits

		First-aid kits required	First-aid kits provided
Request for first-aid kits	Pearson Corr.	1.000	-.705*
	Sig. (1 tailed)		.005
	N	255	255
Provision of first-aid kits	Pearson Corr.	-.705*	1.000
	Sig. (1 tailed)	.005	-
	N	255	255

\* Correlation is significant at the 0.05 level (1 tail test)

## 5. DISCUSSION

Housing construction activities in Lagos, Nigeria, are initiated and executed by private individuals, corporate organisations and government as part of infrastructural facility and social support to the citizens. As shown in this study, safety measures expected to be enforced on site is a function of the executor and quality of supervision. It is clear from the study that most of the supervisors did not possess the required qualification to supervise construction projects. This has implications on the capacity to identify risks, reduce hazards and enforce hazard-abatement measures, in order to avert accidents.

Findings revealed that 91% of the respondents had direct or indirect exposure to hazards of varying degrees. There are hazards that presume high risks, due to high or very high level of exposure (occurrence) and a major or catastrophic consequence. In this study, exposure and consequence of object falling from a height; workers falling from roof top or upper floor; noise pollution; exposure to excessive heat and skin irritation as a result of contact with cement and paint were classified as 'high-risk' hazards. The hazards that pose 'medium risks', owing to average exposure and moderate consequences, include fall of workers from scaffold; piercing by sharp object, and poor ambient air quality with toxic atmospheric condition from fumes and dust particles. 'Low-risk' hazards identified with rare or very low exposure with insignificant or minor consequences were electrocution; fall into unfenced excavation; struck by earth-moving machine; toxic gas from welding; burn from chemicals, and uncontrolled release of pressurised liquid.

The leading causes of private sector worker fatality, as noted by the United States Department of Labor (2017: online), in the construction industry included falls, struck by object, electrocution, and caught-in/between (compressed by equipment or objects, and struck, caught, or crushed in collapsing structure, equipment, or material). The four causes were collectively responsible for more than half (58.6%) of construction worker deaths. Except for electrocution and caught-in/between, the hazards with high chance of occurrence and with major consequences identified in this study fall within the leading causes of fatality. In addition, electrocution may have a very low exposure as shown in this study, but its consequence is always fatal.

As shown in the study, more than any other workplace activity, work at a height is very risky and accounts for more injuries and deaths yearly on construction sites (Nadhim *et al.*, 2016: 638-640; Hamalainen, Takala & Kiat, 2017: 11-13; *Vanguard Newspaper*, 2017: online). Falls from roofs is one of the leading causes of construction work-related fatalities (Toscano, 1997: 38-40;

Nadhim *et al.*, 2016: 640; United States Department of Labor, 2017: online). It accounts for roughly one-fifth of all housing construction fatalities (Bosher & Dainty, 2011: 2-3; Ede, 2011: 156). Fall accidents in construction projects, particularly building works, are the most frequent accidents (Parsons & Pizatella, 1985; Gillen *et al.*, 1997: 650-651; Latief, Suraji, Nugroho & Arifuddin, 2011: 81-81; Nadhim *et al.*, 2016: 638-640). Housing construction workers must adhere to stage hierarchy to all work at a height. These are the avoidance of work at height, the prevention of personnel from falling, and mitigation of effect of falls, should falls occur. For example, assembling of components should be done at ground level. However, if an activity must be done at a height, site managers must take appropriate measures to prevent workers from falling from a distance that could cause injury and fatality. The use of guard rails and scaffolding platforms to prevent falls and individual measures such as safety harnesses must be enforced.

A plethora of hazards is associated with scaffold use and misuse (Davies & Tomasin, 1996). These include slippery conditions on the platform; defects in the members of the scaffold/ladder; overloading of materials and workers on the platform, and the nature of the platform on which the scaffold/ladder rests. However, observation from the sampled sites showed that most of the scaffolds, especially in the private-owned housing construction sites, were makeshift and the majority of these were constructed/made from bamboo. The design factors, particularly adequacy of design, have been compromised. This increases vulnerability to hazards, regardless of the safety management structure in place.

Overall safety management structures on housing construction sites sampled do not adhere to environment and occupational health and safety regulations of Nigeria. For example, 72.5% of the sites did not have first-aid kits available for workers needed to respond to emergency situations. In the private-supervised sites, 87.9% of the sites did not provide first-aid kits for workers and only 0.5% had safety officers on site to monitor compliance with safety regulations. This non-compliance by the private construction supervisors may be as a result of additional cost to be incurred in engaging such safety professionals. Housing construction activities is a capital-intensive venture, where the proponents usually seek avenues to reduce cost (Agbola, 2005: 16; Turok, 2016: 235; Alabi *et al.*, 2018: 47; Kasim, 2018: 958). However, cost reduction should not override the dignity in labour and value of human well-being and for human lives.

The provision of safe, hazard-proof construction sites is a function of the level of planning and decisions taken by qualified personnel appointed to supervise work on site. Supervisors are technically excellent at their job, owing to years of experience, coupled with the engagement of workers who are also highly skilled, in terms of getting something built correctly. However,

this level of competence is not a guarantee for safety and hazard abatement at the construction site. This is made more precarious when the majority of the supervisors are not qualified and may have the general notion, as shown in this study, that the construction site is unsafe and the hazards and risks, to which the workers are exposed, are the usual dictates of the work environment (ILO, 2014: 2; Guo *et al.*, 2016: 5-6; Lette *et al.*, 2018: 57). Therefore, nearly all construction hazards leading to accidents occur as a result of negligence on the part of the supervisor to impose supervisor-worker responsibilities. The supervisors' laxity transfers hazard to workers on site, because the supervisor is charged with the responsibility of overall site safety. The deficiency in the enforcement of construction sites' health, safety and environment provisions manifests in workers carrying out responsibilities in blatant disregard for safety measures, by using inadequate and unsafe equipment in unsafe site conditions, as shown in this study.

## 6. CONCLUSION AND RECOMMENDATIONS

Workers are prone to different construction work-related hazards in Lagos, Nigeria. The hazards have been identified and, with the probability of occurrences and consequences of impact, classified as high-, medium- and low-risk hazards. To correctly avoid fatalities caused by these risk hazards, proper safety mechanisms are needed. In this study, these mechanisms include qualified professionals as site supervisors, the enforcement of safety regulations on the sites, and the usage of appropriate personal protective equipment for specific jobs.

Supervisors have the highest influence on site safety, because they coordinate, direct and monitor the work of all the subsectors within the construction sites. It should be mandatory for housing construction projects to be supervised by professionals with the requisite knowledge of construction hazards and safety measures. The enforcement of compliance with specific safety regulations and rules for different construction activities in the context of construction methods, materials and execution is very important.

Adequate and continuous training for construction workers through workshops, regular site meetings focusing on safety must be adopted. Laws regarding employers' responsibility towards employees for every site construction activity must be enacted and enforced. It is expected that workers and visitors alike in the housing construction sites should undergo a safety drill and be supplied with head-protection gear and mandatory head-protection signs and footwear displayed around the site, especially at private construction sites. For the sustainability of the contribution that housing construction projects make to the overall economy of Nigeria, a centralised regulatory framework to ensure that safety rules are acquired for every construction activity should be implemented.

## 7. ACKNOWLEDGEMENTS

The authors are grateful to the anonymous reviewers for their enlightening, constructive, and useful comments on the manuscript.

## REFERENCES

Abdelhamid, S.T. & Everett, J.G. 2000. Identifying root causes of construction accidents. *Journal of Construction Engineering and Management*, 126(1), pp. 52-60. [https://doi.org/10.1061/\(ASCE\)0733-9364\(2000\)126:1\(52\)](https://doi.org/10.1061/(ASCE)0733-9364(2000)126:1(52)).

Adewale, P.O., Siyanbola, A.B. & Siyanbola, S.O. 2014. Building craftsmanship skill development and Nigeria's Vision 20:2020: Imperatives and daunting challenges. *International Journal of Vocational and Technical Education*, 6(4), pp. 36-42.

Agbola, S.B. 2005. "The housing debacle". Inaugural lecture delivered at the University of Ibadan, Thursday, 4 August 2005.

Agwu, M.O. 2012. The effects of risk assessment (hirarc) on organisational performance in selected construction companies in Nigeria. *British Journal of Economics, Management & Trade*, 2(3), pp. 212-22. <https://doi.org/10.9734/BJEMT/2012/1317>.

Akintoye, A. & Main, J. 2007. Collaborative relationships in construction: The UK contractor's perception. *Engineering, Construction and Architectural Management*, 14(6), pp. 597-617. <https://doi.org/10.1108/09699980710829049>.

Alabi, M. & Ajide, B.K. 2011. Political economy of formal residential land delivery in metropolitan Lagos, Nigeria. *Ife Journal of Environmental Design and Management*, 5, pp. 31-45.

Alabi, A.M., Muraina, M.A. & Kasim, O.F. 2018. Private developers' participation in housing production and wetland encroachment along Lekki-Epe corridor in Lagos, Nigeria. *Journal of Environment Protection and Sustainable Development*, 4(3), pp. 46-54.

Alvi, M.H. 2016. *A manual for selecting sampling techniques in research*. Pakistan: University of Karachi, Iqra University.

Andersson, R. 2012. The role of accident theory in injury prevention – Time for the pendulum to swing back. *International Journal of Injury Control and Safety Promotion*, 19(3), pp. 209-212. <https://doi.org/10.1080/17457300.2012.658577>.

Babovic, P. 2009. Occupational accidents as indicators of inadequate work conditions and work environment. *Acta Medica Medianae*, 48(4), pp. 22-26.

Bosher, L. & Dainty, A. 2011. Disaster risk reduction and 'built-in' resilience: Towards overarching principles for construction practice. *Disasters*, 35(1), pp. 1-18. <https://doi.org/10.1111/j.1467-7717.2010.01189.x>.

Breeding, D.C. 2011. What is hazardous? Dallas – Occupational Health & Safety. [Online]. Available at: <<https://ohsonline.com/Articles/2011/07/01/What-Is-Hazardous.aspx>> [Accessed: 16 May 2020].

Bryman, A. 2012. *Social research methods*. 4<sup>th</sup> edition. New York: Oxford University Press.

Cardona, O.D. 2001. The need for rethinking the concepts of vulnerability and risk from a holistic perspective: A necessary review and criticism for effective risk management. *Journal of Integrated Disaster Risk Management*, 1(1), pp. 27-47. <https://doi.org/10.5595/idrim.2011.0014>.

Carter, D. & Smith, S.G. 2006. Safety hazard identification on construction projects. *Journal of Construction Engineering and Management*, 132(2), pp. 197-205. [https://doi.org/10.1061/\(ASCE\)0733-9364\(2006\)132:2\(197\)](https://doi.org/10.1061/(ASCE)0733-9364(2006)132:2(197)).

CCOHS (Canadian Centre for Occupational Health and Safety). 2020. OSH Answers Fact Sheet. Government of Canada [Online]. Available at: <<https://www.ccohs.ca/oshanswers/about.html>> [Accessed: 16 May 2020].

Churcher, D.W. & Alwani, G.M. 1996. Incorporating construction health and safety into design process. *Proceedings of the First International Conference of CIB Working Commission W99*, 4-7 September, Lisbon, Portugal, pp. 29-39.

Creswell, J.W. 2014. *Research design: Qualitative, quantitative and mixed methods approaches*. 4<sup>th</sup> edition. Thousand Oaks, CA: Sage Publications.

Creswell, J.W. & Plano-Clark, V.L. 2007. *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.

Davies, V.J. & Tomasin, K. 1996. *Construction safety handbook*. New York: Thomas Telford Publishing.

Durdyev, S. & Ismail, S. 2012. Role of the construction industry in economic development of Turkmenistan. *Energy Education Science and Technology Part A: Energy Science and Research*, 29(2) pp. 883-890.

Ede, A.N. 2011. Measures to reduce the high incidence of structural failure in Nigeria. *Journal of Sustainable Development in Africa*, 13(1), pp. 155-156.

Ford, M.T. & Tetrick, L.E. 2011. Relations among occupational hazards, attitudes, and safety performance. *Journal of Occupational Health Psychology*, 16(1), pp. 48-66. <https://doi.org/10.1037/a0021296>.

Gillen, M., Faucett, J.A., Beaumont, J.J. & McLoughlin, E. 1997. Injury severity associated with nonfatal construction falls. *American Journal of Industrial Medicine*, 32(6), pp. 647-655. [https://doi.org/10.1002/\(SICI\)1097-0274\(199712\)32:6<647::AID-AJIM11>3.0.CO;2-1](https://doi.org/10.1002/(SICI)1097-0274(199712)32:6<647::AID-AJIM11>3.0.CO;2-1).

Guo, B.H.W., Yiu, T.W. & González, V.A. 2016. Predicting safety behavior in the construction industry: Development and test of an integrative model. *Safety science*, vol.84, pp. 1-11. <https://doi.org/10.1016/j.ssci.2015.11.020>.

Hamalainen, P., Takala, J. & Kiat, T.B. 2017. *Global estimates of occupational accidents and work-related illnesses*. Singapore Workplace Safety and Health Institute.

Haupt, T. & Harinarain, N. 2016. The image of the construction industry and its employment attractiveness. *Acta Structilia*, 23(2), pp. 79-108. DOI: <http://dx.doi.org/10.18820/24150487/as23i2.4>

ILO (International Labour Organization). 1999. *Safety, health and welfare on construction sites: A training manual*. Geneva, Switzerland: ILO.

ILO (International Labour Organization). 2005. Prevention: A global strategy promoting safety and health at work. The ILO Report for World Day for Safety and Health at Work. Geneva, International Labour Organization. [Online]. Available at <[https://www.ilo.org/legacy/english/protection/safework/worldday/products05/report05\\_en.pdf](https://www.ilo.org/legacy/english/protection/safework/worldday/products05/report05_en.pdf)> [Accessed: 16 May 2020].

ILO (International Labour Organization). 2014. Safety and health at work: A vision for sustainable prevention. The XX World Congress on Safety and Health at Work, 24-27 August, Frankfurt, Germany. Geneva, Switzerland: International Training Centre of the ILO, pp. 1-40.

Imriyas, K., Phen, L.S. & Teo, E.A.L. 2006. A fuzzy expert system for computing workers' compensation insurance premiums in construction: A conceptual framework. *Architectural Science Review*, 49(3), pp. 270-284. <https://doi.org/10.3763/asre.2006.4937>.

Kasim, O.F. 2018. Wellness and illness: The aftermath of mass housing in Lagos, Nigeria. *Development in Practice*, 28(7), pp. 952-963. <https://doi.org/10.1080/09614524.2018.1487385>.

Krejcie, R.V. & Morgan, D.W. 1970. Determining sample size for research activities. *Educational and Psychological Measurement*, 30, pp. 607-610. <https://doi.org/10.1177/001316447003000308>.

Latief, Y., Suraji, A., Nugroho, Y.S. & Arifuddin, R. 2011. The nature of fall accidents in construction projects: A case of Indonesia. *International Journal of Civil & Environmental Engineering*, 11(5), pp. 80-84.

Lette, A., Ambelu, A., Getahun, T. & Mekonen, S. 2018. A survey of work-related injuries among building construction workers in southwestern Ethiopia. *International Journal of Industrial Ergonomics*, 68, pp. 57-64. <https://doi.org/10.1016/j.ergon.2018.06.010>.

MGI (McKinsey Global Institute). 2017. *Reinventing construction: A route to higher productivity*. New York: McKinsey Global Institute, in collaboration with McKinsey's Capital Projects and Infrastructure Practice.

Murie, F. 2007. Building safety: An international perspective. *International Journal for Occupation and Environmental Health* 13(1), pp. 5-11. <https://doi.org/10.1179/oe.2007.13.1.5>.

Nadhim, E.A., Hon, C., Xia, B., Stewart, I. & Fang, D. 2016. Falls from height in the construction industry: A critical review of the scientific literature. *International Journal of Environmental Research and Public Health*, 13(7), pp. 638. <https://doi.org/10.3390/ijerph13070638>.

Naoum, S.G. 2013. *Dissertation research and writing for construction students*. 3<sup>rd</sup> edition. Oxford: Butterworth-Heinemann. <https://doi.org/10.4324/9780203720561>.

NAPBHR (National Action Plans on Business and Human Rights). [n.d.]. Construction sector. [Online]. Available at: <<https://globalnaps.org/issue/construction/>> [Accessed: 26 April 2020].

Nieuwenkamp, R. 2016. The global construction sector needs a big push on corporate responsibility. OECD Insights Debates and Issues. [Online]. Available at: <<http://oecdinsights.org/2016/08/22/global-construction-sector-corporate-responsibility/>> [Accessed: 22 March 2020].

Okeola, O.G. 2009. Occupational Health and Safety (OHS) assessment in the construction industry. In: *Proceedings of the 1<sup>st</sup> Annual Civil Engineering Conference*, 26-28 August, University of Ilorin, Nigeria, pp. 32-40.

Oladinrin, T.O., Ogunsemi, D.R. & Aje, I.O. 2012. Role of construction sector in economic growth: Empirical evidence from Nigeria. *FUTY Journal of the Environment*, 7(1), pp. 50-60. <https://doi.org/10.4314/fje.v7i1.4>.



Orji, S.E., Nwachukwu, L.N. & Enebe, E.C. 2016. Hazards in building construction sites and safety precautions in Enugu Metropolis, Enugu State, Nigeria. *Imperial Journal of Interdisciplinary Research*, 2(1), pp. 282-289.

OSHA (Occupational Safety and Health Academy). 2017. *Health hazards in construction*. OSHA Academy Course 8750 Study Guide. Beaverton, OR: Geigle Safety Group Inc.

Pallant, J. 2013. *A step by step guide to data analysis using SPSS program survival manual*. 4<sup>th</sup> edition. Crow's Nest, Australia: Allen & Unwin.

Parsons, T.J. & Pizatella, T.J. 1985. Safety analysis of high-risk activities within the roofing industry. Technical Report, NTIS PB-85163236, National Technical Information Service, Springfield, VA.

Rausand, M. 2004. Some basic risk concepts. In: Rausand, M. & Høyland, A. (Eds). *System reliability theory: Models, statistical methods and applications*. 2<sup>nd</sup> edition. New York: Wiley.

Rhodes, C. 2019. Construction industry: Statistics and policy briefing paper number 01432, 16 December. London, House of Commons Library.

Ross, A. & Willson, V.L. 2017. Paired samples T-test. In: Ross, A. & Willson, V.L. (Eds). *Basic and advanced statistical tests*. Rotterdam: Sense Publishers, pp. 17-19. [https://doi.org/10.1007/978-94-6351-086-8\\_4](https://doi.org/10.1007/978-94-6351-086-8_4).

Sanni, L. & Alabi, F.M. 2008. Traditional apprenticeship system of labour supply for housing production in Saki, Southwestern Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 1(2), pp. 16-25. <https://doi.org/10.4314/ejesm.v1i2.41576>.

Takala, J., Hämäläinen, P., Saarela, K.L., Yun, L.Y., Manickam, K. & Jin, T.W. (et al.) 2014. Global estimates of the burden of injury and illness at work in 2012. *Journal of Occupational and Environmental Hygiene*, 11(5), pp. 326-337. <https://doi.org/10.1080/15459624.2013.863131>.

Toscano, G. 1997. Dangerous jobs, fatal work place injuries in 1995: A collection of data and analysis, Report 913. Washington, DC, US Department of Labor, BLS, pp. 38-41.

Turok, I. 2016. Housing and the urban premium. *Habitat International*, 54(3), pp. 234-240. <https://doi.org/10.1016/j.habitatint.2015.11.019>.

United States Department of Labor. 2017. Commonly used statistics. Washington, DC. Occupational Safety and Health Administration, United States Department of Labor. [Online]. Available at <<https://www.osha.gov/data/commonstats>> [Accessed: 17 May 2020]

*Vanguard Newspaper*. 2017. One worker dies every 15 seconds, 153 have work-related accidents – ILO. 28 April 2017. [Online]. Available at: <<https://www.vanguardngr.com/2017/04/one-worker-dies-every-15-seconds-153-work-related-accidents-ilo/>> [Accessed: 19 May 2020].

Wegner, T. 2012. *Applied business statistics methods and excel-based applications solutions manual*. 4<sup>th</sup> edition. Cape Town, South Africa: Juta.

Woods, D.D. & Cook, R.I. 2000. Perspectives on human error: Hindsight biases and local rationality. Cognitive Systems Engineering Laboratory Institute for Ergonomics, The Ohio State University; Department of Anaesthesia and Critical Care, University of Chicago.

World Bank. 2013. *Managing risk for development. World development report 2014*. Washington, DC: World Bank.

Zolfagharian, S., Nourbakhsh, M., Irizarry, J., Ressang, A. & Gheisari, M. 2012. Environmental impacts assessment on construction sites. *American Society of Civil Engineers (ASCE)*, pp. 1750-1759. <https://doi.org/10.1061/9780784412329.176>.

Zolfagharian, S., Ressang, A., Irizarry, J., Nourbakhsh, M. & Zin, R.M. 2011. Risk assessment of common construction hazards among different countries. In: *Proceedings of the Sixth International Conference on Construction in the 21<sup>st</sup> Century (CITC-VI) "Construction Challenges in the New Decade"*, 5-7 July, Kuala Lumpur, Malaysia, pp. 151-161.

Zou, P., Zhang, G. & Wang, J. 2007. Understanding the key risks in construction projects in China. *International Journal of Project Management*, 25(6), pp. 601-614. <https://doi.org/10.1016/j.ijproman.2007.03.001>.