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Causes of building construction related accident in the south-western states of Nigeria

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ABSTRACT

Within the focus of the outcome of any construction activity is the realisation of minimal cost, timely delivery and quality-oriented structure. Nevertheless, above all is the safe execution of the construction site activities, which is a matter of life, most especially lives of the operatives. The study aimed at the identification of the common types of accident, the level of occurrence, as well as the causes of the identified accidents, in order to enable subsequent development of practicable preventive measures against such occurrence. Through an extensive literature review, eighteen (18) different types of accident were identified and were subsequently classified into seven (7) categories. Moreover, well-structured and self-administered questionnaires were administered to construction stakeholders (clients, consultants, contractors, health and safety experts, and the artisans), with the data analysed descriptively, using Relative Important Index via Likert scale. The outcome revealed the four categories of frequently occurring accidents to be: contact with working tools, vehicle-related, slip and trip, and falls. Some crucial inclusions in the list of causes are failure of edge protection, safety standard violations, overloading of scaffold and crane, wrong placement of ladder, loss of control over body movement, failure in the designs, absence of warning signs, over speeding of vehicle, wrong selection of working tools, non-usage of personal protective equipment, improperly installed equipment, horseplay, and poor housekeeping. The study shed light on the most frequent caused of accident which is instrumental to establish a safety planning and precautions.

1. Introduction

The input of the construction industry in the development of a nation cannot be overemphasized, being among the largest industries that significantly subscribe to nation's development (Babalola et al., 2015). The industry is found to have contributed 4.18% to the Nigerian economy (Tanko et al., 2017), as it produces commercial, educational, government, industrial, medical, military, religious and residential buildings. Nevertheless, activities ranging from site clearance, excavation, concreting, blocklaying to roofing are embarked upon on site, such activities which involve the use of a plethora of tools, equipment, and machinery which pose a great danger to the operatives on the building construction site (BCS). Besides, the nature of the construction site coupled with the high platform at which workers operate, and the weather conditions that these workers are exposed to serve as threats to their safety. However, such accidents are identified to include falls from heights/falling hazards (Orji et al., 2016), explosion (Hovden et al., 2008), vehicle-related accidents (Edwards and Nicholas, 2002), fire outbreak (HSE, 2006), electrocution/electrical incidents (Nkem et al., 2015), roof construction falls (Weeks, 2011), contact with electric current (Umeokafor et al., 2014), and fall of heavy objects during lifting. Consideration must be given to the fact that different types of accident happen at different construction sites, as types and causes of an accident have been identified by various scholars (Williams et al., 2018; Radmin, 2017; Asanka & Ranasinghe, 2015; Socias et al., 2014; Maloney, 2012; Jørgensen et al., 2010; Gambatese et al., 2008; Baksteen et al., 2007; Bellamy et al., 2007; Chi et al., 2004; Haslam et al., 2004). However, accident is considered as one of the obstructive agents of construction activities, as its occurrence interrupts site works, disables construction workers, reduces contractors' profit, destroys equipment, and extends project delivery period. The incidence is rightly described as an unplanned and unexpected occurrence (Hollnagel, 2004), which upsets a planned sequence of work; resulting to loss of production, injury to personnel, damage to plant and equipment and eventually interrupting production flow. The usual occurrence of all these safety threats (accidents) has made the industry tagged as an accident-prone sector (Hunter, 2011). Nevertheless, the reasons behind the occurrence of accidents on the BCS are not far-fetched, being simply because of the types of activity (Al-Tabtabai, 2012), as well as the dangerous operations (Asan & Akasah, 2015) that are performed on site. This motivated Idoro (2011) to conclude that the occurrence of construction site accidents is at a very high magnitude, while Tahir et al. (2008) described the construction sites as an industry having the potential of creating numerous hazards and dangers to workers with the capability of resulting in injuries or death. Moreover, Aniekwu (2007) and Udo et al. (2016) submitted that construction activities take place in the open and exposed to the weather. On a general note, many factors are

responsible for accidents ranging from chemical impairment, engagement of incompetent personnel, lack of awareness and enforcement of safety regulations, mechanical failure of construction machinery/equipment, non-vibrant professionalism, poor regard for safety by people involved in construction projects, physical and emotional stress. However, in many cases, poor safety culture (Misnan et al., 2008) is responsible for occupational accidents, while unsafe acts (Asan & Akasah, 2015; Ibrahim, 2012; Abdul Hamid et al., 2008) of employee's pool very high. In an attempt to holistically address the accident scenarios in Nigeria, an exploratory study was carried out to identify and establish the most frequent categories of accident and the proximal factors responsible for the identified ones. This became necessary following the fact that accident statistics are dear to come by in Nigeria (Orji et al., 2016, Agwu & Olele, 2014; Umeokafor et al., 2014; Ehi, 2010), and in identifying these types of accident it would permit the development of workable preventive measures against the occurrence of accident.

2. The Types and Causes of Building Construction Accidents (BCA)

An accident does not just happen, a factor is responsible, and the principles underlying the accident prevention techniques are the identification and control of these causes. Nevertheless, in order to position a workable preventive measure in the improvement of the overall safety performance, investigation into the root causes of the construction accidents is indispensable (Abdul Hamid et al., 2008), and with the corroboration of Khosravi et al. (2014) clear understanding of the factors playing key roles in accident causation serves as a precursor to its prevention. Besides, emphasis was laid by Hinze et al. (1998) on the fact that the first step in preventing an accident is the determination of the risk factors that are responsible for the accident, implicating that for any successful preventive measures to be implemented there is need for the determination of the root causes of the accident. It is, therefore, imperative to take the initial step of determining the causes of the identified categories of accident, which are discussed below.

2.1 Contact with Objects Accident

Electricity, welding arc flash, and working tools are usual objects that workers do always have contact with during the progress of construction activities. Electrical workers are the people that are commonly affected by electrical injuries or electrocution (Al-Tabtabai, 2002), which is consequent upon their exposures to cables or machines carrying electric current, working without personal protective equipment, contact with energised power line, improperly installed or damaged equipment, and safe voltage or earth failure. Where electric arc welders operate, arc flash is not an uncommon occurrence, as welding works require a high degree of experience, carefulness and supervision, being a hazardous activity. However, gases (in gas welding), electricity (electric welding), high temperatures, of which their combination or at separate instance affects workers' health significantly whenever they are in contact with any. Equally, with the daily use of different kinds of tool in the execution of construction works, users of these tools are susceptible to having contact with the working tools/equipment resulting in injuries of varying categories, for instance loss of limbs. This type of accident is found to be as a result of failure or non-usage of personal protective equipment (Orji et al., 2016; Carrillo-Castrillo, 2013), poor condition of equipment/tools (Haslam et al., 2005), wrong selection of tools for a particular activity (Olatunji et al., 2007), and non-adherence to safety guidelines (Kadiri et al., 2014).

2.2 Vehicle/Machine-related Accident

Machine-related activities on site employ the use of machine for faster and effective operations. Though they are indispensable, yet they are characterised by eventualities that result in accident on the site. However, crane accidents, struck by moving vehicles, struck by operating machines, and defective machines are all identified vehicle or machine-related accidents (Oladiran & Sotunbo, 2012; Arslan & Kaltakci, 2008). Among the list of such defective machines, which are susceptible to accident, are backhoes, boilers, bulldozers, forklift, scrapers, tractors, winches, and the like. Arslan & Kaltakci (2008) were of the opinion that overturning of a tower crane do happen on site causing damages to structures. Hence, the identified causes of crane accident are failure to test the stability after assembling of crane, extension of the crane boom beyond manufacturer's specifications, overloading beyond the crane's capacity, and unstable or uneven ground conditions. The factors responsible for the vehicle-related accidents include visual or audible contact failure, mechanical failure, driving ability of the operator, crowding workers into one area (congestion), driving on slopes that are too steep, and speedy movement especially around bends.

2.3 Slip & Trip Accident

Safe Work Australia (2012) identified slip and trip as construction accidents that end up in thousands of injuries every year, resulting in bruises, cuts, dislocations, fractures, musculoskeletal injuries. Besides, slip and trip (Orji et al., 2016; Udo et al., 2016) can result in fall, and have been identified as construction accidents. However, responsibility lies in the hands of the design professionals and building materials manufacturers on the type of floor finishes or materials specified or produced respectively. According to Lin et al. (1995), slips occur to a site worker by losing with the surface of the ground traction as a result of wearing inappropriate footwear or when walking on slippery floor surfaces. Slip interrupts the normal pattern of human locomotion and results to a fall, while it constantly happens as the heel of the victim strikes the walking surface with an attendant forward slide (Lin et al., 1995). The occurrence of trips holds when a worker unexpectedly catches his foot on a surface or object, and very often workers trip on low obstacles that are very difficult to notice, for example, loose mats or cables from electrical equipment, uneven edges in flooring, untidy tools, and opened drawers. The wet, greasy or highly polished surface is identified as an agent of slip and trip and coupled with this are poor housekeeping and horseplay by worker.

2.4 Fall-related Accident

Falls from holes in floor, ladder, roof, on the same level, scaffold, stair or ramp, and falling objects are the predominantly classified fall-related accidents on BCS. McDonald & Hrymak (2002) and Irumba (2014) opined that falls-from-height are the leading causes of injuries to operatives and deaths of workers on the construction sites, while HSE (2015) rated falls as three in ten injuries to workers (41 out of 142). Sejas (2014) and Orji et al. (2016) corroborated other scholars declaring that the leading cause of deaths is fall, and in addition to this was the research of Al-Tabtabai (2002) on Kuwait construction industry, where it was figured out that 30% of reported accident cases on site was as a result of falls from heights. However, working at height is indispensable by the workers (Freeman, 2015) as construction works involve structures of many storeys, necessitating the climbing of either unsteady scaffolding or unstable ladders in handling activities. Moreover, fall on the same level is classified as being a unique accident taking place on the construction site, having its severity lower than that of ladder, roof, and scaffold. Al-Tabtabai (2002), Tappin et al. (2004), Nolan (2011) and Mewes (2017) combined this type of fall with slip and trip, with the believe that slip and trip result in fall, and therefore treated alike, howbeit fall on same level is a unique accident on its own.

Table 1 *Summary of Types of Accident on Building Construction Sites*

Types of Accident	Authors													
	Radmin (2017)	Orji et al. (2016)	Asan & Akasah (2015)	Socias et al.(2014)	Maloney (2012)	Jørgensen et al. (2010)	Gambatese et al. (2008)	Baksteen et al. (2007)	Bellamy et al. (2007)	HSE (2006)	Chi et al. (2004)	Haslam et al. (2005)	Al-Tabtabai (2002)	Lin et al. (1995)
1.Contact with objects														
Contact with electricity	√	√	-	-	√	√	-	√	√	-	-	√	√	-
Contact with tools, welding arc flash	√	√	-	-	√	√	√	√	√	-	-	√	√	-
2.Vehicle/Machine Related														
Crane accident	-	-	√	-	√	-	-	√	√	-	-	-	√	-
Struck or run over by moving/ operating machine	√	√	√	-	√	√	√	√	√	-	-	√	√	-
Overturned vehicle	√	-	-	-	√	-	-	-	-	-	-	√	√	-
3. Slips and Trips	-	√	√	-	√	-	-	-	√	-	-	-	√	√
4. Fall Related Accident														
Fall from roof	√	√	√	-	√	√	√	√	√	√	√	√	√	-
Fall from scaffold	√	√	√	-	√	√	√	√	√	√	√	√	√	-
Fall from ladder	√	√	√	√	√	√	√	√	√	√	√	√	√	-
Fall from holes in flooring	√	√	-		√	√	√	√	√	√	√	√	-	-
Fall on the same level	√	√	√	-	√	√	-	√	√	√	√	√	√	√
Fall on stair or ramp	√	√	√	-	-	√	-	√	√	√	√	√	-	-
Falling or flying objects	√	-	√	-	√	√	-	√	√	√	-	√	√	-

Furthermore, the last of the fall-related accidents is the falling object, of which workers on site are prone to the danger of falling objects whenever they position themselves or carry out activities beneath where overhead work is being performed. Moreover, the analysis carried out by Al-Tabtabai (2002) on Kuwait construction sites, reported that 355 falling objects out of 1182 construction accidents were falling objects, thereby resulting in the second leading accident in Kuwait. Besides, as identified by Umeokafor et al. (2014), 13% of site accidents resulting in death in the Nigerian construction sites are as a result of fall of heavy objects, particularly during lifting. Further identification of falling object as one of the fall-related accidents on construction sites were made by Haslam et al. (2005), Chahuayo (2011), Gürcanli & Müngen (2013), Sattineni (2014), Goh et al. (2016), and Li et al. (2016). However, the causes of the fall from heights are unstable ladder, faulty or poorly constructed scaffold, inadequate training (Orji et al., 2016), engagement of defective equipment, improperly maintained or inadequate scaffolding (Aniekwu, 2007), failure/absence of edge protection, insufficient physical and mental capacities of roof worker, roof not designed to support exerted weight, non-usage of fall arrest system, scaffold not complying with safety standards, user's error, overloading of scaffold, wrong placement of ladder, loss of control over body movement, failure of the strength and stability of ladder, design failure of the stairs, and user's negligence in the use of hand rails. Additionally, the fall on same level traces its causes to uneven or damaged floor, loss of grip on surface/floor, and poor housekeeping, while that of falling objects are caused by absence of warning sign in danger zone, failure/non-usage of personal protective equipment, failure of object securing (attachment), and failure of hole cover due to substandard material or cover being overloaded. Table 1 shows the summary of the four categories of accident considered mostly occurring in the Nigerian BCS.

3. Research Methodology

3.1 Method

Having the main goal of this research in focus, a reasonable number of scholarly articles were reviewed to identify eighteen different types of accident. These were consequently categorised into seven groups following experts' input. Besides, an exploratory study was carried out to establish the most commonly occurring accidents on BCS in Southwest Nigeria. Thus, four categories of accident were established, being above the average mean of 2.99 after the statistical analysis, and these formed the focus of this research. Additionally, proximal causal factors responsible for the accident were included in the questionnaire, while the basis for the selection of the study questionnaire was the reviewed literature of safety-related articles.

3.2 Sampling Technique

The research adopted non-probability purposive sampling technique, patterned after the studies of Tanko et al. (2017) and Dodo (2014), as this method afforded the researchers in reaching the target groups, with a high output of response.

3.3 Population and samples

The target population included the construction stakeholders, while three hundred and ninety-three were reached with the open-ended questionnaires in the South-western states of Nigeria. However, the sampling frame spans across the clients (public and private organisations), consultants (Arch, QS, and Engineers in government ministries, academic institutions, medical institutions, contracting and consultancy firms), safety professionals (in contracting organisation, government ministries, consultancy firms), and craftsmen (masons, carpenters, electricians, plumbers, and welders employed in contracting organisations, government offices and self-employed).

3.4 Data Analysis

The questions on the types, frequencies, and causes of BCS accident were pilot-tested using some construction experts for the purpose of confirming the consistency and reliability of the questionnaires. However, in testing for the reliability and consistency of the instrument, Cronbach's alpha was used through the application of Statistical Package for the Social Sciences Software Version 20 (SPSS V20), thus providing a good reliability value of 0.977. Since

Cronbach's alpha provides a measure of internal reliability of items in a questionnaire, the value (0.977) establishes the fact that the research items are measuring the same thing. Moreover, the collected data were descriptively analysed using the Mean and Relative Importance Index (RII), in relation to Tanko et al., (2017), Fung Man-Kam (2014), Muhwezi *et al.* (2014). The RII provides the relative importance of the causal factors of each type of accident. Equally, the computation made use of the average formulas as the respondents indicated their opinions based on their experiences in the construction industry on a 5-point Likert scale. The mean and the RII were statistically calculated for each item with the usage of the following formulas:

i) Mean for the types of accident;

$$\ddot{X} = \frac{1n^1+2n^2+3n^3+4n^4+5n^5}{N}$$

Where, $\ddot{X}$ = Mean; n^1 = number of respondents for "Never happen"; n^2 = number of respondents for "Rarely happen"; n^3= number of respondents for "Neutral"; n^4= number of respondents for "Sometimes happen"; n^5 = number of respondents for "Always happen"; N = Total Number of respondents.

ii) RII for the causes of accident:

$$RII = \frac{\sum ni*pi}{N*Rv}$$

Where, ni = number of respondents choosing pi; pi = 1 to 5 on the scale of Likert; N = total number of respondents; Rv = highest value in Likert scale.

Furthermore, the perceptions of each group of respondents were weighted while the overall weights were averagely calculated. Besides, by employing RII statistical analysis, the factors which are above the overall average are considered to be the important factors responsible for the causes of accidents, as shown in Tables 7-10.

4. Results and Discussion

4.1 Demographic Information of the Respondents

The demographic information of the respondents is presented in Figures 1 and 4. In relation to the three hundred and ninety-three (393) questionnaires that were administered, three hundred and ten (310) were correctly answered and found useful for this research. The missing data were treated and replaced using the SPSS software. The usable questionnaires represent 78.88% of the administered questionnaires, which was adequate for the establishment of types, frequencies and causes of accidents. The years of experience of the respondents, as indicated in Figure 1, are less than 3years (21%), 3-5years (22%), 6-10years (17%) and above 10years (40%). However, with the level of the percentage of 57% (17+40=57) of the respondents having an experience above 6years, their responses are adequately enough to rely upon and found very useful for the analysis.

The academic qualifications show ND (15%), HND (30%), BSc/PGD (30%), MSc (15%), PhD (6%) and others (4%), with an indication that 81% of the respondents are holders of degrees. Taking cognizance of the possessed academic achievement, their experiences in the construction industry are not to be reckoned with as being "shallow" while their contributions are vital and significant. This is presented in Figure 2.

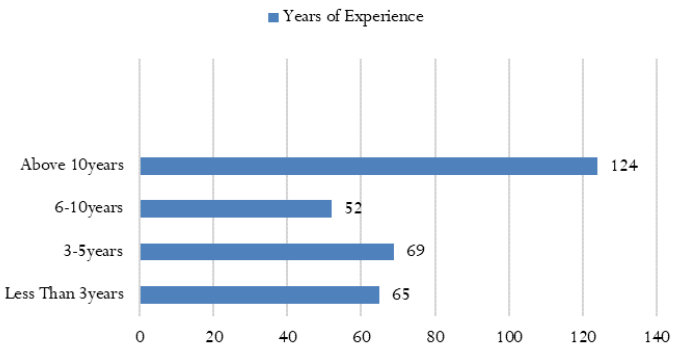

Figure 1 *Year of Experience*

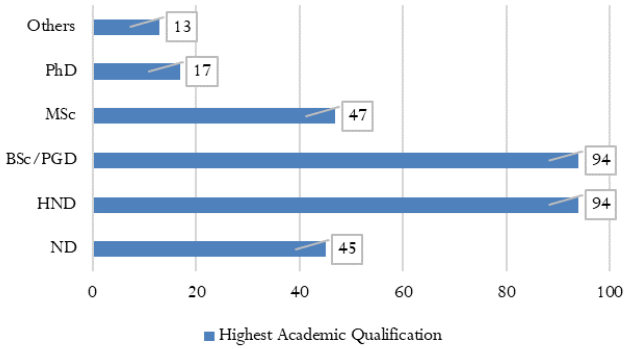

Figure 2 *Highest Academic Qualification*

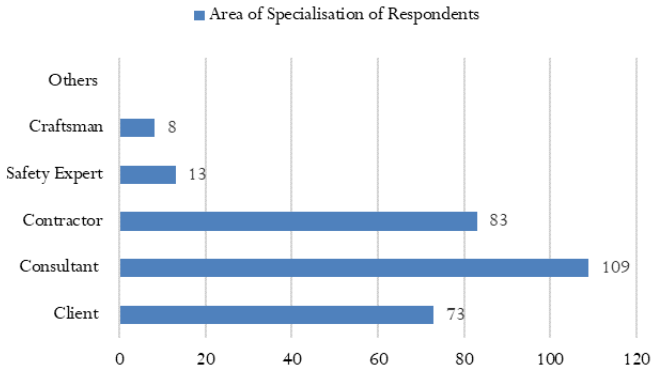

Figure 3 *Area of Specialization*

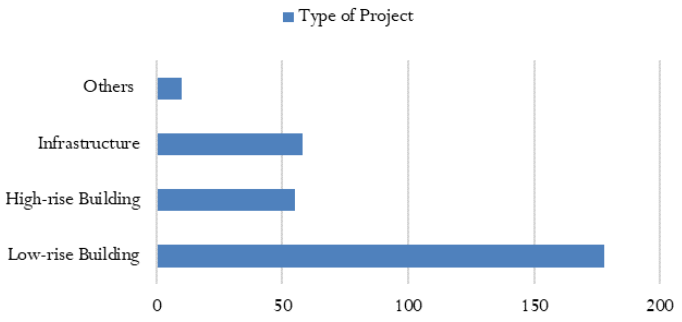

Figure 4 *Type of Project*

The areas of specialisation (professions) of the research respondents, as indicated in Figure 3, are client (23%), consultant (35%), contractor (27%), safety practitioner (4%), craftsman (3%), and others (6%). The consultants comprise of the architects, engineers, builders, and the quantity surveyors.

Table 2 *Summary of Responses on the Types and Frequencies of Accident on the BCS*

Categories of accident	Response (%)					N	MS	Results		
	NH	RH	N	SH	AH			Av. MS	SD	Rank
Contact with objects	9.7	21.3	14.5	35.8	18.7	310	3.33	2.99	1.267	1
Vehicle/machine related	13.95	23.5	12.6	36.1	13.9	310	3.13		1.302	2
Slip and trip	15.2	21.0	15.8	34.5	13.5	310	3.10		1.303	3
Fall-related	11.0	34.8	7.1	37.1	10.0	310	3.00		1.250	4
Lifting and handling	11.3	31.0	17.7	29.0	11.0	310	2.97		1.222	5
Collapses	23.9	25.2	10.6	27.7	12.6	310	2.80		1.398	6
Exposures to harmful substances	24.8	30.0	16.1	17.1	11.9	310	2.61		1.341	7

Table 3 *RII and Ranking of Causes of Fall-Related Accident*

Type of Accident	Causes	RII of Items	Rank	RII of Accident Type	Rank
Fall from roof	Failure of roof edge protection	0.623	23	0.640	7
	Insufficient physical and mental capacities of roof worker	0.674	20		
	Roof not designed to support exerted weight	0.632	21		
	Non usage of fall arrest system	0.629	22		
Fall from scaffold	Failure of scaffold edge protection	0.700	17	0.726	4
	Scaffold not complying with safety standards	0.745	6		
	User's error	0.722	13		
	Overloading of scaffold	0.738	10		
Fall from ladder	Wrong placement of ladder	0.745	5	0.747	1
	Loss of control over body movement	0.743	7		
	Failure of the strength and stability of ladder	0.753	3		
Fall from holes in floor	Hole cover failure due to substandard material	0.696	19	0.710	5
	Cover overloaded	0.699	18		
	Absence of edge protection or mark	0.736	11		
Fall on the same level	Loss of grip on surface /floor	0.707	16	0.708	6
	Loss of control over operative's own body	0.708	14		
	Uneven or damaged floor	0.708	15		
Fall from stairs	User's negligence in the use of hand rails	0.740	8	0.740	3
	Design failure of the stair	0.740	9		
Falling objects	Absence of warning sign in danger zone	0.761	1	0.743	2
	Poor housekeeping	0.727	12		
	Failure of Personal Protective Equipment	0.757	2		
	Object securing (attachment) failure	0.747	4		

In relation to Figure 4, 57.4% of the respondents are involved in the construction of low-rise buildings, 17.7% in high-rise buildings, 18.75% are into infrastructures, while 6.1% did not specifically indicate the scope of their operations. Hence, the involvement of the respondents makes it possible to know the types of construction accident and the rate of occurrence on the BCS.

4.2 Responses on the Types and Frequencies of Accident on the Building Construction Site

The distribution of the summary of responses on the categories and frequencies of accident on the BCS is shown in Table 2 below. Seven categories of accident are indicated in the table, while it can be deduced from the table that four categories of accident out of the seven categories are most prominent, being above the average mean of 2.99. The most frequently occurring accident is the contact with objects, having a mean score of 3.33, which ranks first. It is followed by the vehicle/machine-related accident (3.13), being the second in ranking, while the third is slip and trip accident (3.10). The fourth is the fall-related accident (3.00).

Tables 3 shows the causes associated with the fall-related accident. The causes of each subtype of accidents are clearly indicated in the mentioned table, together with the relative importance index and ranking of each factor causing the accident. However, as indicated in the table, twenty-three causes are responsible for the accident, thus covering the seven subtypes of accident. The RII as indicated in the table shows fall from roof (0.640), fall from scaffold (0.726), fall from ladder (0.747), fall from holes in floor (0.710), fall on the same level (0.708), fall from stairs (0.740), and falling objects (0.743).

In respect of the vehicle-related accident, twelve causes were identified across the three accident subtypes as shown in Table 4. The RII of each item as well as their ranking are all indicated. The RII of each subtype of accident with their raking are shown, having crane accident (RII=0.723), struck or run over by moving/operating machine (RII=0.701), and overturned vehicle (RII=0.736).

Table 4 *RII and Ranking of Causes of Vehicle/Machine-Related Accident*

Type of Accident	Causes	RII of Items	Rank	RII of Accident	Rank
Crane accident	Unstable or uneven ground conditions	0.681	11	0.723	2
	Failure to test the stability after assembling	0.731	6		
	Extending the crane boom beyond manufacturer's specifications	0.737	4		
	Overloading beyond the crane's capacity	0.743	3		
Struck or run over by moving/ operating machine	Visual or audible contact failure	0.684	10	0.701	3
	Mechanical failure	0.751	2		
	Driving ability of the operator	0.690	9		
	Crowding workers into one area	0.678	12		
Overturned vehicle	Driving on slopes that are too steep	0.704	8	0.736	1
	Moving over uneven ground	0.713	7		
	Being overloaded or unevenly loaded	0.736	5		
	Speedy movement, especially around bends	0.790	1		

Table 5 *RII and Ranking of Causes of Contacts with Objects Accident*

Type of Accident	Causes	RII of Items	Rank	RII of Accident	Rank
Contact with electricity	Contact with bared wires due to lack of Personal Protective Equipment	0.726	5	0.718	2
	Contact of worker or vehicle with energized power line	0.696	8		
	Improperly installed equipment	0.742	4		
	Safe voltage or earth failure	0.708	7		
Contact with equipment, tools	Failure of Personal Protective Equipment	0.719	6	0.761	1
	Poor condition of equipment/tools	0.774	3		
	Wrong selection of tools for a particular activity	0.775	1		
	Non-adherence to safety guidelines.	0.774	2		

In relation to Table 5, eight causes are in relation to contact with objects accident, which are responsible for the two subtypes. The table shows the RII of each item as well as their ranking. Equally, the RII of each subtype of accident with their raking are indicated, having contact with electricity (RII=0.718), and contact with equipment/tools (RII=0.761).

Table 6 shows the three causes associated with the slip and trip accident. Shown further in the table is the RII of each item as well as their ranking, having 0.738 as the overall RII.

In consideration of the relative importance index and ranking of the different types of accident, fall from ladder appears first (Av. RII=0.747) under fall-related accident in Table 3, followed by falling objects (Av. RII=0.743), while fall from stairs ranks 3rd (Av. RII=0.740). In vehicle/machine-related accident (Table 4), overturned vehicle ranks first (Av. RII=0.736), while crane accident follows as second (Av. RII=0.723), and the third in ranking being struck or run over by moving/operating machine (Av. RII=0.701). Besides, contact with objects type of accident (Table 5) has contact with equipment/ tools as first in ranking (Av. RII=0.761), while contact with electricity appears second (Av. RII=0.718). Moreover, slip and trip had no subtypes as earlier indicated in table 6, having RII of 0.738 as overall average. Significantly, giving regards to the overall ranking of all the types of accident, the order appears as contact with equipment/tools (RII=0.761), fall from ladder (RII=0.747), falling objects (RII=0.743), fall from stairs (RII=0.740), slip and trip (RII=0.738), overturned vehicle (RII=0.736), scaffold (RII=0.726), crane accident (RII=0.723), and the like. However, presented in Table 7 are the most important factors responsible for fall-related accident, as thirteen factors are indicated.

Table 8 contains the six most important factors responsible for vehicle-related accident, with the RII of each item and the ranking shown explicitly.

Table 9 shows the four most important factors responsible for contact with objects accident, with the RII of each item and the ranking shown clearly.

Table 6 *RII and Ranking of Causes of Slip and Trip Accident as Perceived by the Respondents*

Type of Accident	Causes	RII of Items	Rank	RII of Accident
Slip and Trip	Poor housekeeping	0.717	3	0.738
	Horseplay by worker	0.745	2	
	Loss of foot traction with the ground surface as a result of slippery, wet or highly polished floor surfaces	0.753	1	

Table 7 *Most Important Factors Responsible for Fall-Related Accident*

	CAUSES	RII	RANK
Fall-related accident	Absence of warning sign in danger zone	0.761	1
	Failure of PPE	0.757	2
	Failure of the strength and stability of ladder	0.753	3
	Object securing (attachment) failure	0.747	4
	Wrong placement of ladder	0.745	5
	Scaffold not complying with safety standards	0.745	5
	Loss of control over body movement	0.743	7
	User's negligence in the use of hand rails	0.740	8
	Design failure of the stair	0.740	8
	Overloading of scaffold	0.738	10
	Absence of edge protection or mark	0.736	11
	Poor housekeeping	0.727	12
	User's error	0.722	13

Table 8 *Most Important Causes of Vehicle/Machine-Related Accident*

	CAUSES	RII	RANK
Vehicle/machine-related accident	Speedy movement	0.790	1
	Mechanical failure	0.751	2
	Overloading beyond the crane's capacity	0.743	3
	Extending the crane boom	0.737	4
	Being overloaded or unevenly loaded	0.736	5
	Failure to test the stability after assembling	0.731	6

Table 9 *Most Important Causes of Contact with Objects Accident*

	CAUSES	RII	RANK
Contact with objects accident	Wrong selection of tools	0.775	1
	Non-adherence to safety guidelines.	0.774	2
	Poor condition of equipment/tools	0.774	2
	Improperly installed equipment	0.742	4

Table 10 *Most Important Causes of Slip and Trip Accident*

	CAUSES	RII	RANK
Slip and Trip accident	Loss of foot traction etc.	0.753	1
	Horseplay by worker	0.745	2

Table 10 contains the two most important factors responsible for slip and trip accident, with the RII of each item and the ranking unequivocally shown.

Accidents on site are described as agents of obstruction of activities, as the research identifies four categories of accident mostly occurring in the Nigerian BCS. These include contact with tools/equipment, vehicle/machine-related, slip and trip, and fall-related accidents. The causes of these accidents are explicitly indicated, both in the literature review and in Tables 3-6. The four categories are considered to be the most commonly occurring accident. Sequel to the perceptions of experts in construction industry the types, frequencies and the causes of accident are plausibly established. As indicated in Table 7, the thirteen most influential causes associated with accident involving falls are errors related to man, most especially the site operatives. By considering the non-provision of warning sign, it makes it possible for workers to experience falling objects accident on the BCS. The consciousness of the presence of warning signs or safety signals allows the workers to

either keep off the environment of such objects or exercise watchfulness when working within the vicinity of such objects. However, lack of precautions, that is, absence of warning sign (Rich, 2012; Oladiran et al., 2008) is sufficient enough in making workers fall victims of falling objects. The failure of workers in the usage of PPE (Chi et al., 2004) is another point of consideration in the building industry in respect to safety. Such PPE, which is inclusive of helmet and the like, reduces the impact of the striking or falling objects on the head of such victim. Though, the usage of PPE may not completely prevent the occurrence of accident but brings its impact to a lesser level if such accident takes place, particularly when objects fall on workers. In relation to the ladder accident, which is being caused by wrong placement, this corroborates the research of (Axelsson & Carter, 1995) that reported that low angle of inclination in the placement of ladder is a common contributing factor for ladder accident. The authors also reported that ladder accidents account for nearly 5% of all reported occupational accidents in the Swedish construction industry. In addition, another major cause of scaffold accident is the overloading of scaffold with working materials. Although some of these errors can be avoided where there is a close supervision. Besides, compliance with safety regulations by the workers is another way of avoiding such errors. In the same vein, for the ladder accident being caused as a result of ladder strength and stability, the onus is greatly on the supervisor to ensure that ladder of adequate strength is provided, tested and inspected before its usage. Nevertheless, to avoid this type of accident, inspection of the ladder is highly necessary, and such inspection should not be limited to ladder only but to other equipment and tools, as some of these equipment and tools are researched to be responsible for accident where they are deficiently provided (Goh et al., 2016), improperly maintained (Williams et al., 2018; Goh et al., 2016; Kemei et al., 2015), wrongly selected (Al-Tabtabai, 2002), and/or poorly installed. Besides, the contractor is under obligation to provide tools and equipment in compliance with the contract specifications, while the client should make adequate provision of fund available. Furthermore, in consideration of the falling of operatives on stairs, which is as a result of non-usage of hand rails, the type of instruction made available to operatives must be questioned. *Is there any specific instruction given to the workers vis-à-vis the usage of stairs? Is there any proper channel of communicating instructions to workers on the site? Is there any penalty for workers who flout safety regulations/instructions?* Plausible answers supplied to these questions will enable a good researcher to understand the root causes of such fall from stairs. In relation to failure of the design of the stairs, such design, which is the sole responsibility of the designers, may be ascribed to appointment of inexperienced designers, non-involvement of structural engineers in design stage, or poor workmanship of the contractor's workforce. Moreover, other causes that are of high importance under fall-related accident are traceable to poor supervision (Aniekwu, 2007; Safe Work Australia, 2002), lack of training (Goh et., 2016; Kemei et al., 2015; Kadiri et al., 2014), and lack of knowledge of workers (Azmi & Misnan, 2013; Al-Tabtabai, 2002), provided adequate research is carried out to explore the root causes. In furtherance to the above, the causal factors of machine-related, slip and trip, as well as contact with objects accident, have their root causes traceable to violation or disregards to safety regulations (Kemei et al., 2015), insufficient or deficient training (Kadiri et al., 2014), inspection challenge (Saurin, 2016), and/or lack of supervision (Aniekwu, 2007). Regards must, therefore, be given to the root causes of all these accidents to enable any preventive measures to be put up. For instance, failure to test the stability of crane after assembling (Schmidt & Clark, 2017)] can be adduced to lack of proper supervision (Aniekwu, 2007), lack of adequate instruction (Goh et al., 2016) or carelessness (Kadiri et al., 2016). However, all the causes of accident with high relative importance index are also indicated in Tables 8, 9, and 10.

5. Conclusion

The most frequently occurring accidents have been identified to be contact with tools/equipment, vehicle/machine-related, slip and trip, and fall-related accidents, while the factors responsible for each were explored statistically. Consideration of the appropriate preventive measures for occurrence of accident include: management enforcing compliance with safety standards and the use of personal protective equipment (safety belts, safety nets etc), correct placement of ladder through proper supervision, constant training on right selection and use of equipment/tools, correctness of design, inspection of equipment. Others include site discipline among workers, appropriateness in the usage of safety items, conspicuous location of warning signs, regular maintenance of tools and equipment, and reporting of accident. Additionally, with the confirmation of the high spate of accident occurrence in Nigeria BCS and the burning passion for its mitigation, a model of accident prevention will be developed, which is the next stage of the on-going research. The model will be cantered on the prevention of accident at dual-stage through the consideration of the involvement of various stakeholders including the clients, consultants, contractors, as well as the health and safety regulators.

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