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Accident Causal Factors on the Building Construction Sites: A Review

Opeyemi Samuel Williams
Department of Quantity Surveying, Faculty of Environmental Studies, Rufus Giwa Polytechnic, Owo, Ondo State, and
Department of Quantity Surveying, Faculty of Built Environment, Universiti Teknologi Malaysia
Email: yemiwilly2006@gmail.com

Razali Adul Hamid
Department of Quantity Surveying, Faculty of Built Environment, Universiti Teknologi Malaysia
Email: b-razali@utm.my

Mohd Saidin Misnan
Department of Quantity Surveying, Faculty of Built Environment, Universiti Teknologi Malaysia
Email: b-saidin@utm.my

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ABSTRACT

The concerns for cost, quality and timely delivery of projects have been in existence from time immemorial, whereas the passion for these should be extended to safe execution of site works by the construction participants, as safety of life is very paramount. However, high level of commitment that is essential for the safe execution of site works has become a taboo. Hence, a plethora of accidents takes place on the site ranging from falls from height, contact with working tools, vehicle-related, slip and trip, collapse, exposure to harmful substances, to lifting and handling object accidents. It is pertinent to know that, responsibility for accidents on site cuts across all project participants (clients, consultants, contractors, workers), as well as the construction site environment. Recognition of the construction participants and site environmental factors as agents of accident is the focus of this research. Through extensive review of literature, a copious number of factors were identified and subsequently grouped under five factors as client-related, consultant-related, contractor-related, construction workers-related, and construction site-related. However, there has been a dearth of research in the grouping of accident contributing factors. The identification and understanding of these factors will go a long way in mitigating construction accidents, coupled with proven measures taken in positively addressing them. Efforts to prevent these causative factors include inter alia elimination of hazards from design, effective safety management, adequate planning of activities and employment of seasoned professionals by the client. The contractors are to embark on staff safety auditing, set up safety committees, conduct regular training for staff, use innovative technology, uphold housekeeping and report accident occurrence, while strict adherence to safety regulations must be adopted by all construction operatives.

1. Introduction

A vital and dynamic role is played by the construction industry in the development of the economy of any country of the world (Hosseinian & Torghabeh, 2012), with an immense contribution to the GDP of most countries, Nigeria inclusive (Agwu & Olele, 2014). Tanko et al. (2017) reported that construction industry contributed 4.18% to the GDP of Nigeria. Consequently, diverse risks, occupational hazards, accidents and injuries are predominant occurrence to workers on the construction sites (Phoya, 2012; HSE, 2006). Moreover, construction sites are described by Tahir et al. (2008) as an industry

having the potential of creating diverse hazards and dangers to operatives with the capability of resulting in injuries or death. A great challenge is posed to the health and safety of construction workers as a result of the dynamic nature of the industry, coupled with diverse but dangerous operations carried out on construction sites (Asan & Akasah, 2015). However, Al-Tabtabai (2002) was of the opinion that the types of activity performed on site and the nature of the tasks carried out on the site make the profession a hazardous one. Mostly in all countries, United Kingdom (UK) and United States (US) inclusive, the occurrence of construction site accidents as well as injuries is at a very high magnitude (Idoro, 2011), as compared with other industries. Nigeria, like other developing countries (Idoro, 2008), is not left out of this scenario, though the lack of reliable data makes it impossible to know the actual rate of occurrence of accidents in Nigeria (Agwu, 2014; Udo et al., 2016). Furtherance to the above are the consequential effects of an accident which are classified into direct and indirect costs (Wan Faida & Misnan, 2015; Williams et al., 2017). The direct cost being the cost of insurance (Kolo, 2015), medical bills, liability and property loss, and premiums for compensation benefits (Agwu & Olele, 2014), while the indirect costs include transportation (Amartey, 2014), time lost in attending burial ceremonies, time lost in fatality investigation, downtime of damaged equipment and losses arising from site closure (Agwu & Olele, 2014). In an explanation by Holt (2006) on the study conducted by the Health and Safety Executive in consideration of the costs of accidents, it was shown that the construction industry under review then was having a direct to indirect cost ratio of 1:11. Besides, construction accidents impact the operatives psychologically (anxiety, depression, boredom), physically (permanent disability, pains) and financially (Nkurunungi, 2005), while Hosseinian & Torghabeh (2012) were of the opinion that building construction site (BCS) accidents lead to delay in completion of project, increment in expenses and loss of reputation of the constructors.

Moreover, safety is very paramount to human life, and has become a vital matter in all sectors, for example in agriculture (Smith & Program, 2002), in mining (Liang et al., 2011), in manufacturing (Carrillo-Castillo et al., 2013; Willquist & Törner, 2003), and in healthcare (Joint Commission, 2008). A great number of Nigerian working populations are employed in construction works and very large proportion of them is exposed to varying levels of risk. However, Aniekwu (2007) posited that construction works do take place in the open, exposed to the weather and for limited periods of time, making it different from production industry. Also, Orji et al. (2016) described construction industry as a unique one, with operations executed in an open and confined spaces, involving many untrained labourers. The authors further said that construction industry is having a tight schedule of short targeted project duration, and characterized with psychologically and physically vulnerable working environment. Additionally, it was observed that construction industry is noted to be one of the most dangerous industries, ranking 3rd after mining and fishing industries in terms of fatality, with each of these fatal or non-fatal accidents causing suffering to the victim (s), waste of money, and waste of time to the industry (Wikipedia, 2015; Udo et al., 2016). Other scholars like Sejas (2014), saw construction accidents as part and parcel of the construction industry. However, statistically, the study carried out by Edwards and Nicholas (2002) on health and safety consistently revealed that accidents involving construction plant and equipment are responsible for a high magnitude of serious and fatal injuries on site, while Chi et al. (2005) placed falls from height as the leading cause of fatalities in construction operations. Nevertheless, other researchers (Al-Tabtabai, 2002; Dėjus, 2007; Umeokafor et al., 2014; Nkem et al., 2015), corroborated Chi et al. (2005) to classify fall from height as the leading cause of site accidents. Furthermore, in the comparative research of Edwards and Nicholas (2002), it was revealed that accident rates occurring within the United Kingdom construction industry is higher than other identified industries, such as forestry, agriculture, fishing, hunting, extractive and utility supply industries, as well as manufacturing industry. However, with the study of Edwards and Nicholas (2002), the rate of accident in the construction industry remains consistently high, whereas the rates of accident in other industrial sectors have steadily declined. Although, they attributed such alarming rate to inadequate health and safety management within the sector, both in terms of training and implementation.

2. Theoretical Background

2.1 Health and Safety Issues in Nigeria

Globally, health and safety related issues call for grave concerns. Nevertheless, in consideration of the openness in the working places in the construction site and the unpalatable exposure to weather conditions, a large proportion of the construction workers are unfavourably exposed to varying levels of risk in relation to their health and lives. However, comparing the situation of construction sites in Nigeria as a developing country to other countries, Idoro (2008) described the vulnerability of workers to hazards as being worse, with reasons given as lack of concern by stakeholders, lack of statutory

regulations on health and safety (H&S), and non-availability of accurate records. Furthermore, there was a corroboration between Okoye & Okolie (2014) and Idoro (2008) in that workers are subjected to numerous hazards and unsafe conditions on the sites, while this is as a result of lack of medical facilities, lack of training programs for the staff and workers, lack of orientation conducted for new staff and workers, failure to hold safety meeting and inability to point out hazards. This prompted Okoye & Okolie to further classify the hazardous situation on construction sites as cave-ins during excavation in deep trenches (in the absence of proper shoring or bracing), cement burns due to failure to put on protective gloves and boots, workers falling from heights, sustenance of injuries on the head, fingers, eyes, feet, and face consequent upon lack of personal protective equipment (PPE). This prevailing occurrence of accidents on site can be adduced to the degree of compliance with Occupational Safety and Health (OSH) regulations in Nigeria which was described as being very low by Umeokafor et al. (2014), since stakeholders accord little or no attention to OSH in Nigeria (Udo et al., 2016).

Moreover, Umeokafor et al. (2014) expatiated on the factors contributing to non-compliance to OSH as bribery and corruption, fear of legal sanctions, higher profit margin, inadequate funding, inadequate staff and workplace issues, management commitment, neglect of human rights, perception of stakeholders in the industry, wrong beliefs, reputation of firms, and the type of tendering process adopted. Additionally, the Nigerian building construction sites are bombarded with inexperienced construction operatives, where site workers carry out operations with no regards to regulations on safety, most essentially in small and medium-scale firms. The use of safety items is refuted by most workers, with much disregard given to it as a result of lack of knowledge (Lubega et al., 2000), lack of enforcement of safety regulations (Idubor & Oisamoje, 2013; Umeokafor et al., 2014), inconveniences created by putting on PPE (ILO, 1995; Chong & Low, 2014), and poor safety culture (Agwu & Olele, 2014).

It is, nevertheless, saddening in noticing that the Federal Ministry of Labour and Productivity (Inspectorate Division) which is responsible for overseeing the OSH in Nigeria has been found inefficient (Umeokafor et al, 2014), while OSH system is concluded to be a failure in Nigeria (Diugwu and Dorothy, 2012) consequent upon the weak statutory OSH regulations and provisions. Against this backdrop, Idoro (2008) traced the origin of the regulations of OHS to the United States (US) and United Kingdom (UK) from where greater part of the regulations adopted in Nigeria was extracted. In addition, Idoro (2008), Diugwu & Dorothy (2012) and Umeokafor et al. (2014), reported that Factories Act of 1990 which the country adopts is exclusive of the construction industry thereby making the regulations unenforceable in the construction sites. This has made construction industry remained unregulated, and consequently leaving the implementation of the UK/USA adopted regulations at the discretion of the practising construction firms.

However, a dearth of research on a workable model in prevention of mishaps on BCS is still bedevilling the country, as reading between the lines it could be seen that only some measures of recommendations were put up by most scholars who carried out research on safety on BCS in Nigeria. For instance, Aniekwu (2007) who identified the causes of mishaps on BCS concluded with recommendation of some preventive measures. Besides, different types of BCS accident were identified in Nigeria by Oladiran et al. (2008) with recommendation of extensive control measures in relation to the use of PPE. Also, consideration was put on the fatalities involved in the Nigerian construction industry by Agwu & Olele (2014), while the conclusive part of the authors' research involved some recommendations on the improvement of safety culture of project participants. Additionally, a comprehensive discussion was engaged by Umeokafor et al. (2014) on occupational accidents in Nigeria, while the authors' study was without the development of any preventive model.

Moreover, a plethora of construction hazards was considered by Orji et al. (2016), with a conclusive part of the research coming up with some precautionary measures to be adopted in mitigating hazards on site. However, considering the focus and direction of the good number of these scholars, it could be presumed that the dearth of reliable data on accident (Ezenwa, 2001; Idoro, 2008; Ehi, 2010; Agwu & Olele, 2014; Umeokafor et al., 2014; Orji et al., 2016) has prevented the scholars from laying emphasis on the development of accident prevention model for the Nigerian construction industry, since most models that were ever developed globally were not without the utilisation of accident reports (Suraji et al., 2001; Bellamy et al., 2007). Furthermore, it was reported by Muhammad et al. (2015) that Nigeria is one of the nations having no adaptive health and safety laws and regulations, that the regulations are so weak to the extent that each organisational firm is reserving little resources to health and safety management on site. This ugly situation has extended an invitation to the occurrence of accidents on building construction sites in Nigeria (Abubakar, 2015), as Nigeria's BCS is found to be unsafe when liken to the developed countries. Testimony concerning this avails in the global estimate data of 2003 in the study of Hämäläinen (2009), as reported by Abubakar (2015), that the rate of fatal

accident in Nigeria per 100,000 workers was placed at 24, as Nigeria herself have no concrete accident data to bounce on (Abubakar, 2015). This deficiency of safety information is confirmed in the submissions of the following researchers: in Nigeria, there are neither injuries reports nor statistics (Ehi, 2010); contractors are not likely reporting all injuries and accidents (Idoro, 2011); contractors on site hardly keep, release, or report accurate records of accidents (Diugwu & Dorothy, 2012); in Nigeria, there are no accurate data on accident (Idubor & Oisamoje, 2013); the system of reporting is ineffective and weak (Adeogun & Okafor, 2013); there is no reliable data on accident cases in Nigeria (Agwu & Olele, 2014); injuries generally are unreported in Nigeria (Okoye & Okolie, 2014); in Nigeria, statistics on accident are not available (Orji et al., 2014); in Nigeria, occupational safety and health databanks are hard to come by (Abubakar, 2015), injuries and accidents are not reported in Nigeria (Udo et al., 2016); Nigeria rarely keeps, reports, or releases accurate records of accidents (Muhammad et al., 2015). However, as much concern is placed on the cause of this scarcity of accident records in Nigeria, Idoro (2011) submitted that contractors see such reports as having a negative influence on their image.

2.2 Types of Construction Accident

Different types and causes of an accident are identified by various scholars (Al-Tabtabai, 2002; Edwards and Nicholas, 2002; Aniekwu, 2007). Accidents do mostly occur on site, ranging from falls from heights/falling hazards (Orji et al., 2016), explosion (Hovden et al, 2008), Vehicle accidents (Edwards and Nicholas, 2002), fire outbreak (HSE, 2006), electrocution/electrical incidents (Nkem et al., 2015), contact with electric current (Umeokafor et al., 2014), to fall of heavy objects during lifting. However, HSE (2006) identified the most frequent accidents as falls, mobile plant, falling material and collapses, electrical accidents as well as trips**.** Apart from the occurrence of an accident, HSE also identified the various ill-health conditions that the workers are exposed to, which include asbestos, manual handling, noise and vibration, and finally chemical exposures. Furthermore, going through literature extensively, thirteen types (categories) of accident were differently identified. These are: Fall-related accident; Contact with objects; Vehicle/ Machine-related accident; Lifting and handling objects accident; Explosions; Collapse accident; Welding accident; Drown/Asphyxiation accident; Animal behavior accident; Slip and Trip accident; Victim of human aggression; Equipment/tools related accident; and Electrocution accident. Furthermore, with the exploratory study carried out by Williams et al. (2017) on the types and frequency of accident in the South-western states of Nigeria, four categories of accident were most prominent which were contact with working tools, vehicle-related accidents, slip and trip, and fall-related accident, although there are subtypes of accident under each category.

2.3 General Factors Contributing to the Occurrence of Construction Accidents

An attempt to unravel factors linked to occurrence of construction accidents, many scholars have delved into many of these causes ranging from personal, technical, physical, to environmental**.** For instance, Nkurunungi (2005) was of the opinion that technical, physical, and environmental factors are responsible for accident on construction sites. To Abdul Rahim et al. (2008), unsafe equipment, job site conditions, unique nature of the industry, unsafe method, human element are the identified factors that are mostly responsible for construction accidents. Moreover, Goh et al. (2016) classified the causes of construction accidents as man-made factors, environmental factors, as well as machinery factors. Furthermore, Kazan (2013) identified the two factors responsible for accident as human and environmental. The Department of Occupational Safety and Health (2009) laid emphasis on enforcement failure, defective personal protective equipment (PPE), horseplay, and inadequate labelling as the causes of an accident on site. Additionally, Kemei et al. (2015) discovered some lacking features that invite the occurrence of accident on site to be: technical guidance, training, experienced project managers, enforcement of safety regulations, certified skilled labour, first aid measures, personal protective equipment, teamwork spirit, organizational commitment, innovative technology on safety measures, with the inclusion of reluctance to invest in safety, poor safety consciousness of workers, low level of education of workers (Wan Faida & Misnan, 2015), poor maintenance of equipment, poor safety awareness from top leaders, lack of strict operational procedures as factors responsible for construction accidents. Other researchers (Lubega, 2000; Toole, 2002; Palaniappan et al., 2007; Kolo, 2009; Kadiri et al., 2014) carried out studies on accident occurrence and identified various reasons why accident takes place on site to include the following: Lack of awareness of safety regulations; Lack of enforcement of safety regulations; Poor regard for safety by people involved in construction projects; Engaging incompetent personnel; Non-vibrant professionalism; Mechanical failure of construction machinery/equipment; Physical and emotional stress; Chemical impairment. In

addition, Kadiri et al. (2014) corroborated other scholars to identify accident's causes to be lack of: protection in material carriage and storage, teamwork, attention from leaders, training, emergency measure, the experience of managers, technique guide, and putting on of PPE. Moreover, further in-depth study was made by Kadiri et al. (2014) on the accident's causes to be carelessness and negligence, failure to follow safety rules, improper use of safety items, reckless action, poor safety conscientiousness of managers, non-certified skill labour, poor equipment and maintenance, non-rigorous enforcement of safety regulations, non-definite organization commitment, non-effective operation on safety regulations, poor education of labourers, poor safety conscientiousness of labourers, non-strict operation procedures, non-perfect of safety regulations, overtime work for labour, shortage of safety management, and poor information flow. Nevertheless, all these factors are interrelated.

2.4 Project Participants as Causative Agents of Construction Accidents

The on-going research regards construction participants as the client or his/her representatives, architects, engineers, contractors and the construction workers which is in agreement with the submission of Chiocha et al. (2011) considering the construction participants as the stakeholders apart from the workers. However, the involvement of these participants in one way or the other influences construction accident either through commission or omission of responsibilities (Williams et al., 2017).

2.4.1 The Client (Employer)

The appointment of inexperienced project managers by the client in the management of the construction work, and lack of organizational commitment of the client's project manager are identified by Kemei et al. (2015) and Kadiri et al. (2014) to be responsible for failure of safety on the construction sites. Besides, enforcement of safety regulations which is one of the responsibilities of the project managers is being compromised on site (Toole, 2002; Kemei et al., 2015). Non-availability of Health and Safety file to the contractor, deficient enforcement of safety standards (Lubega, 2000), poor safety consciousness of the client or his/her representative (Tam et al., 2004; Kadiri et al., 2014) are various ways lives of workers are put in jeopardy. Palaniappan et al. (2007) were of the opinion that safety is compromised through inefficiencies in project planning, of which workers are exposed to unnecessary hazards in the handling of operations on site as work progresses. Moreover, failure of the client's project manager to prepare safety plan has been identified as a contributor to site accident (Dodo, 2014). Poor planning of project activities (Toole, 2002), as well as non-employment of vibrant professionals (Lubega, 2000), are equally presented as factors leading to construction accident through the client or his manager.

2.4.2 The Consultants (Designers)

The consultants, being participants in project activities, have major roles to play in fostering safety on the construction site. It is the responsibility of the designers to prepare construction designs that are safe, adequate and easy to construct. However, bad building designs, inadequate designs, faulty designs (Leo, 2014) and risky designs are major ways the designers contribute to the inability of ensuring the safety of workers on the site, whereas hazards that may give rise to risks from the design ought to have been eliminated at the design stage. Moreover, good, weather-proof and quality materials are the characteristics of standard building, but it is unfortunate that poor quality building materials are sometimes specified by the designers (Palaniappan et al., 2007). Furthermore, it is established that failure to supply sufficient information (Hawksley, 1999) that can aid safe construction deprives the construction workers in maintaining safety procedures during the progress of the work, as the workers are found disregarding safety rules (Abdelhamid and Everret, 2000). Besides, some building designs are commenced without the awareness of the client, though this may have little or no impact on the safety of workers, as the design can still be stopped halfway by the client if so embarked upon without his consent (Williams et al., 2017).

2.4.3 The Contractors (Constructors)

The contractors have higher and wider roles to play in ensuring accident-free operations on the site, being the executors and constructors. They are the employers of labours (operatives), be it skilled or unskilled. Greater responsibility is placed on the contractors to employ and involve qualified, experienced (Kadiri et al., 2014), competent (Lubega (2000), skillful (Kolo, 2009) and trained (Jocelyn, 2016; Kemei et al., 2015) personnel to carry out operations on the site. Lack of certified skilled labour (Kolo, 2009), assigning job to untrained workers (Kemei et al., 2015) and engagement of incompetent personnel (Lubega, 2000) are identified as multiple ways the contractors are hazardously contributing to the safety of

workers on the site. Moreover, lack of training for workers (Toole 2002) particularly in recognition and avoidance of job hazards, was identified to be responsible for accident on site. Besides, lack of: provision of PPE, and technical guidance (Kemei et al., 2015), provision of first aid measures, strict operational procedures (Abdul Rahim, 2008; Harms-Ringdahl, 2013), provision of safety devices (Carrillo-Castrillo et al, 2013), innovative technology on safety measures (Tam et al., 2004; Ali & Kamaruzzaman, 2010) are copious ways the contractors are listed among the influential factors of accident. It is no longer news that most contactors fall short of the requirement for the appointment of safety personnel on site, safety management manuals, and flow of information (Kemei et al., 2015). Other instances where the contractors contribute to accident occurrence on site are given as ineffective operation of safety regulations (Abdul-Rahim, 2008), improper supervision, lack of concern for safety matters, misinterpretation of working plan and detail drawings, reluctance to invest in safety (Kemei et al., 2015), and poor arrangement of construction materials and equipment.

2.4.4 Construction Operatives as Agents of Construction Accident

The construction workers are the victims of an accident on any construction site. They are involved in activities through the engagement of equipment, machinery, tools, and other construction-related items. They are, indeed, having direct contact with all the equipment, and this has been resulting in high risk of danger being exposed to by these workers. Majority of them acts unsafe, while in some other instances they work in unsafe conditions. The discharge of duties on site by the workers is not exclusive of a poor attitude towards safety. Some workers are in the habit of getting involved in some unethical behavior like drug addiction or alcohol intake (Lubega, 2000; Toole, 2002). Majority of the operatives lack safety consciousness and their attitude towards safety (Misnan et al., 2008) is zero, and some are not even aware of the presence of a risk, nor safety regulations (Lubega, 2000). This is seen as they operate without putting on PPE (Kadiri et al., 2014). This scenario is coupled with the fact that they are possessed with a very low level of education and knowledge (Kolo, 2009). In addition, they are ignorant in the handling of new techniques or materials, while some are using safety items in an improper manner, making the activities unsafe for them. Besides, the available equipment is poorly maintained, resulting in working with defective equipment (Toole, 2002; Palaniappan et al., 2007) creating a danger to their safety, while some operate with these equipment recklessly and at an unsafe speed (Kolo, 2009). However, a good reason may be adduced to this, which is the ability to meet up with the promised bonus. Furthermore, negligence or carelessness (Kadiri et al., 2014), horseplay (Suraji et al., 2001), removal of safety device or incorrect work procedures, failure to secure and warn (Abdelhamid and Everret, 2000), lack of teamwork spirit (Kadiri et al., 2014), have been identified as ways in which the construction workers get involved in an accident on site. The unsafe act of another worker, and operating equipment without authority as identified by Abdelhamid and Everret, poor housekeeping (Palaniappan et al., 2007), and fatigue by workers as a result of too much overtime work, cannot but be mentioned as causative factors to construction accident by the workers.

2.4.5 Influence of Site Environmental Factors on Accident

The influence of the clients, project managers, architects, engineers, and the contractors in putting the lives of construction workers in jeopardy have been extensively explored, while the involvement of the site workers have been explicitly spelt out. The totality of the factors responsible for unsafe situations will be left incomplete in the absence of the site environment where the victims of accidents operate. The Occupational Safety and Health Administration (OSHA) expects all employers to enforce proper safety techniques in order to create safe and productive working environments for their workers. In this regards, the onus is greatly on the contractors in ensuring the safety of the working environment where the operatives carry out activities. However, there are some site occurrences that adversely affect the safety of construction workers on site thus; fire hazards, housekeeping hazards, inadequately guarded site, slippery and muddy work surface, and limitation of working area (Abdelhamid and Everret, 2000). Moreover, excessive noise, poor illumination and ventilation have been identified by Abdul Rahim et al. (2008) to be impacting the safety of the construction operatives. With a critical look, some of these causes are interwoven as it can be seen that it is the responsibility of the contractor to make some of these features available or have the adverse ones removed. It is worthy of note that rainstorm (flood), poor weather condition (extreme cold or hot) (Nkurunungi, 2005) are beyond the control of the clients, designers and contractors. To be given attention is the fact that the condition of weather on site has a severe impact on site operations (Chamberland, 2014). Chamberlain was of the opinion that the construction industry and others that

engage in outdoor construction wholly need to give consideration to weather conditions while planning and executing their activities. The author identified cold weather, windstorm, dust or fog, hot and dry weather as environmental factor affecting the site operations and causing serious injuries to the workers. Hence, performing construction operations in a windy atmosphere requires a great deal of judgement. Besides, working at great height has constantly resulted in falls (Attwood et al, 2006; Irumba, 2014).

3. Methodology

Having the exploration of the types and causative factors of building construction site accident as the main focus of this research, a reasonable number of health and safety-related articles was reviewed extensively, with the inclusion of books and theses. With over five dozens of literature, the identification of different types of accident occurring on building construction sites was made possible as discovered by past researchers. The various factors causing the occurrence of accident were identified, and subsequently categorised in this on-going research into client-related, consultant-related, contractor-related, construction worker-related and construction site environment-related. The review study considered how individual related factor contributed to accident occurrence. The influential characteristics of the project participants (client, consultant, contractor, operative) and construction site environment on site accidents were explored. Equally, the most frequent factors responsible for accident were unveiled, as the tabulation of the various factors was positioned. Being an on-going research, a search for relevant literature was embarked upon through the imputation of the keywords like accident, accident prevention, accident causation, accident prevention, health and safety.

4. Discussion

Numerous types of accident occur on site comprising of contact with objects, and such objects are inclusive of working tools, electricity, and welding arc flash, with the causes being as a result of the workers' exposures to cables or machines carrying electric current, contact with energised power line, working without personal protective equipment, improperly installed or damaged equipment, and safe voltage or earth failure. Also, vehicle or machine-related accidents involving overturning of vehicle as a result of over speeding, overloading, uneven distribution of loads, working in steep places, and climbing on kerbs and the like are recognised. Besides, crane accident is identified as one of the hazardous occurrence on site. Crane is indispensable as it is used to lift up heavy objects, work at great heights, and in moving objects vertically or horizontally on the site. Crane accident is one of the accidents identified by Oladiran & Sotunbo (2012) in Nigerian construction sites, with other scholars (Baksteen et al., 2007; Asanka & Ranasinghe, 2015; Maloney, 2015) globally identifying accident involving crane as one of the accidents on construction sites. Moreover, struck-by is a regular occurrence on the site which has been constantly identified and analysed by many scholars (Hinze et al., 2005; Fass et al., 2016). However, in respect of slip and trip accident, they normally occur on site as a result of poor housekeeping, uneven floor surfaces, walking on slippery floor, and the usage of traction footwear. Also, fall-related accident, which is seen to be the falls from roof, scaffold, ladder, stairs and floor holes. Majorly, these falls are caused by unprotected edges, overexertion, absence of guard rails, non-usage of protective equipment and the like. Hence, Table 1 below shows a plethora of research that has been carried out in relation to causes of BCS accidents.

Moreover, as shown in Table 1 are the sixty factors responsible for accident as being exhumed by the researchers through an extensive and comprehensive literature review, though the list contains some other factors that are not mentioned in the review for want of space and time. In the absence of any iota of doubt, fourteen distinct authors have identified different factors impacting the safety of workers on site, though the causes identified are interwoven and could be so impossible to segregate them or categorise them in relation to the client/ representative, consultant, contractor and the construction worker. Some factors are mentioned nine times while some only once, but the latter having being mentioned only once does not mean that such factor is not impacting worker's safety. For instance, fire hazard, horseplay, slippery work surface, lack of proper instructions and the like are all factors that can result in accident on construction site. All depend on the perspective with which different scholars view accident.

As shown in Table 2, eleven causative factors are found to be most common causes of accident as they are seen being made mentioned of by the scholars viz: lack of personal protective equipment (PPE)(9times), defective or poor unsafe equipment (7times), lack of training (6times), poor safety consciousness of workers or managers (6times), unsafe method of handling materials or equipment during operations (6times), lack of experienced project managers or workers (5times), fatigue by workers because of

Table 1: *Previous Research on General Factors Contributing to Construction Accidents*

No	Accident Causal Factors	Authors															
		Goh et al. (2016)	Kemei et al(2015)	Kolo (2015)	Kadiri et al (2014)	Kazan (2013)	Kolo (2015)	Abdul Rahim et al	Aniekwu (2007)	Palaniappan et al.	Haslam (2005)	Nkurunungi (2005)	Tam et al (2004)	Toole (2002)	Lubega (2000)	Abdelhamid et al	Frequency
1	Reluctance to invest/lack of concern for safety by management		*						*				*		*		4
2	Lack of technical guidance		*														1
3	Lack of training	*	*		*					*			*	*			6
4	Lack of experienced project managers/skilled workers		*		*				*			*			*		5
5	Lack of enforcement of safety regulation		*		*									*	*		4
6	Carelessness and negligence			*	*		*										
7	Poor safety consciousness of workers/managers	*	*		*							*	*	*			6
8	Low level of education of workers		*	*	*		*										3
9	Poor maintenance of equipment	*	*		*												3
10	Poor safety awareness from top leaders		*										*				2
11	Lack of first aid measures		*														
12	Lack of personal protective equipment	*	*		*	*				*	*	*		*		*	9
13	Lack of teamwork spirit		*		*						*						3
14	Lack of organizational commitment		*		*												2
15	Lack of innovative technology on safety measures		*														1
16	Poor information flow		*		*												2
17	Fatigue by workers because of overwork		*	*	*		*					*			*		5
18	Shortfall of safety personnel on site		*														1
19	Shortage of Safety management &/or manuals		*		*												2
20	Ineffective operation /lack of compliance to safety regulation		*		*				*							*	4
21	Lack of protection of material during transportation/storage		*		*												2
22	Lack of strict/ safe operational procedures	*			*												2
23	Lack of technique guide/faulty techniques			*	*		*		*								3
24	Misjudgement of hazardous situation					*											1
25	Malfunction in securing/warning					*										*	2
26	Distracting/unsafe actions of workers or others					*										*	2
27	Safety Devices removed/inoperable					*		*									2
28	Defective /poor/unsafe equipment	*			*	*		*						*	*	*	7
29	Lockout/tag out procedure malfunction					*											1
30	Insufficient/lack/housekeeping program	*				*				*						*	4

overwork (5times), unsafe condition of workplace (5), reluctance to invest in or lack of concern for safety by

Table 1: *Previous Research on General Factors Contributing to Construction Accidents (Continued)*

No	Accident Causal Factors	Authors														
		Goh et al. (2016)	Kemei et al. (2015)	Kolo (2015)	Kadiri et al. (2014)	Kazan (2013)	Abdul Rahim et al. (2008)	Aniekwu (2007)	Palaniappan et al.(2007)	Haslam (2005)	Nkurunungi (2005)	Tam et al. (2004)	Toole (2002)	Lubega (2000)	Abdelhamid et al. (2000)	Total number of times
31	Insufficient/Lack of engineering controls					*										1
32	Insufficient/Lack of written work practice program					*										1
33	Overhead moving, falling, or flying object					*										1
34	Unsafe method of handling materials /equipment/operations	*		*		*	*						*		*	6
35	Chemical Action/impairment					*								*		2
36	Poor Illumination/ventilation					*	*									2
37	Overpressure/Under pressure					*			*							2
38	Natural causes (Weather, Earthquake)					*		*			*					3
39	Improper supervision							*								1
40	Unsafe condition of workplace							*		*	*		*		*	5
41	Faults/ inadequate/misinterpretation of design, detailing and specification							*			*					2
42	Inefficiencies in project planning								*				*			2
43	Inappropriate hazard elimination								*							1
44	Lack of quality of construction materials/equipment								*		*					2
45	Lack of ergonomics						*									1
46	Problems with suitability and condition of materials									*						1
47	Human impairment/error										*					1
48	Lack of awareness of presence of risk	*									*					2
49	Drunkenness			*							*					2
50	Lack of awareness of safety regulations													*		1
51	Non-vibrant professionalism													*		1
52	Poor site management/coordination	*					*									2
53	Slippery and muddy work surface						*									1
54	Unique nature of the industry						*									1
55	Horseplay														*	1
56	Operating equipment without authority														*	1
57	Improper assignment of personnel														*	1
58	Public hazard														*	1
59	Fire hazard														*	1
60	Lack of proper instructions	*														1

Table 2: *The Most Frequent Causative Factors of Accident*

Accident Causal Factors	Authors														
	Goh et al. (2016)	Kemei et al(2015)	Kolo (2015)	Kadiri et al (2014)	Kazan (2013)	Abdul rahim et al (2008)	Aniekwu (2007)	Palaniappan et al. (2007)	Haslam (2005)	Nkurunungi (2005)	Tam et al (2004)	Toole (2002)	Lubega (2000)	Abdelhamid et al (2000)	Frequency
Lack of personal protective equipment	*	*		*	*			*	*	*		*		*	9
Defective /poor/unsafe equipment	*			*	*	*						*	*	*	7
Lack of training	*	*		*				*			*	*			6
Poor safety consciousness of workers/managers	*	*		*						*	*	*			6
Unsafe method of handling materials /equipment/operations	*		*		*	*						*		*	6
Lack of experienced project managers/skilled workers		*		*			*			*			*		5
Fatigue by workers because of overwork		*	*	*						*			*		5
Unsafe condition of workplace							*		*	*		*		*	5
Reluctance to invest/lack of concern for safety by management		*					*				*		*		4
Ineffective operation /lack of compliance to safety regulation		*		*			*							*	4
Insufficient/lack/housekeeping program	*				*			*						*	4

management (4 times), ineffective operation or lack of compliance with safety regulation (4times), and insufficient or lack of housekeeping program (4times). However, the non-usage of PPE can be as a result of lack of provision by the management (an attempt to reduce cost), or insufficient provision, while it may also be the lack of enforcement in putting it on or total refusal in complying with the usage as some workers complain of the disturbance the PPE create for them (Goh et al., 2016). The use of defective or poor equipment poses danger to the operatives greatly, being recognised by seven authors. Furthermore, poor safety consciousness of the workers and the managers, unsafe action in handling equipment and materials, engagement of inexperienced managers/ workers, coupled with unsafe conditions of the workplace, lack of concern for safety and poor housekeeping are all responsible for accident both on the part of the management and the workers.

Additionally, commitment of all the construction parties is highly essential as major roles are played by them in the mitigation of accident in the construction site (Zhou et al., 2014). Hence, the raising up of awareness towards occupational safety and health (OSH) in this hazardous industry is paramount (Leo, 2014). Though, Leo declared that stakeholders have made an improvement by investing their time, resources and efforts in bringing to the knowledge of people their passion for OSH, but more is still needed to be done till zero-accident is realised on every site. In respect of the client, he is the initiator of the project, and desires timely, cost-saving, and quality delivery of the project, yet the safety of the operators should be given priority. However, with the report that workers experience accident during construction through speedy operations (Irumba, 2014), such may be traced to the mandate given to the contractor by the client for quick delivery of the project. This is in agreement with Udo et al. (2016) who said that the present day construction is characterised with rapid execution of projects. Where the

client desires a quick delivery of his project, the contractor toes the same line which makes the operatives being on a rash to complete tasks as soon as possible at the expense of safety. Equally, hasty construction leads to poor workmanship, which can result in collapse of structures, as one of the accidents on construction sites is found to be collapse of building (Olagunju et al., 2013). Furthermore, each member of the consultants exhibits a vital and significant role at the design stage, and one out of the many methods of avoiding occupational injuries is to eliminate or minimize risk from the design, that is, to "design out" hazards. However, "prevention through design" was a safety programme launched by The National Institute for Occupational Safety and Health (NIOSH), with the goal and expectation that hazards could be controlled at design level. Greater responsibility rests on the designers in designing in a way that safety will be maintained, thereby avoiding workers putting their lives under a risk during construction. The involvement of the client is of high magnitude during the design stage, as it is seen that in some cases clients are significantly excluded from decision making (Li and Poon, 2013). Hence, work procedures should be designed in a way that employees sustaining injuries on the site will be a forgotten issue, while the onus is on the designers to supply adequate and comprehensive information in aiding construction safety.

Moreover, the contractors who are the constructors, for maximization of profit and minimization of cost employ cheap workers (Olatunji et al., 2007). Some of these workers do not possess the required experience, nor trained in recognising hazards on site, some are not competent enough in handling equipment, while some are foreigners without the possession of work permit (Orji et al., 2016). However, safety training, toolbox talks, risk assessment, hazards identification, enforcement of regulations regarding safety, and lots more are within the capacity of the contractors in ensuring the safety of workers. On the other way round, the workers should be given timely and incessant training in order to improve on their safety culture (Misnan et al., 2008). Additionally, in consideration of the site environment, with the efforts that are put in place to avoid accident, the industry is still known to be exposed to various challenges, varying from poor pay to poor working conditions/environments which lead to health, safety and environmental problems (Rizwan, 2015), while Denny (2012) noted that there are other things, apart from removal of hazards from the working environment, that determine the health and safety of workers. However, in controlling environmental factors such as rainfall, an attempt can be made to engage in work stoppage during rainfall which will ultimately lead to increased number of unproductive hours and invariably to an extension of time in the project delivery. Also, much commitment is desired from the contractor in housekeeping, of which the employment of more site workers and supervisors is necessary to achieve this, but with an attendant increase in the cost of construction on the side of the contractor.

5. Conclusion and Recommendation

Consequently, an effort being put up to minimise or avoid accidents on construction site will require the absolute commitment of all the project participants. Elimination of hazards and prevention of accidents on site are within the capability of each party. The client should be involved in safety management coupled with having a great passion for safety, while adequate time should be given to the constructors for the execution of the project. Adequate planning of activities and the provision of facilities must be given a priority, while the client should imbibe the culture of appointment of only vibrant professionals. Designers should put in their best to recognize the hazard from the design, and pass the information to the contractors (sufficient information indeed), or where possible such hazard-prone design can be eliminated. Contractors with a sounding safety records should be found qualified for award of contract, while safety consciousness should be their major concern above their profits, and with a ready mind to invest in safety. Training of staff and site safety audits should be on a regular basis, with contractor's workforce making up of well trained, experienced, and competent personnel. Reporting of accident and near misses should be given recognition by the contractor. The adoption of innovative technology is recommended for the contractors as well. Safety campaign can be engaged on site, while workers are given bonus if operations are carried out safely on site. Moreover, in respect of overcoming the risk posed by environmental factors housekeeping culture should be imbibed by the workers and the contractors, as the workers are enforced to practise safe operations. To be noted is that, the acts of God are unavoidable, but under intensive poor or adverse weather conditions, workers can be excused from work, particularly during heavy downpour. Also, the importance of knowing the kind of equipment that can handle maximum wind speed is important, which is not commonly available in the user's manual but the exact details can be confirmed through the manufacturers of equipment.

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