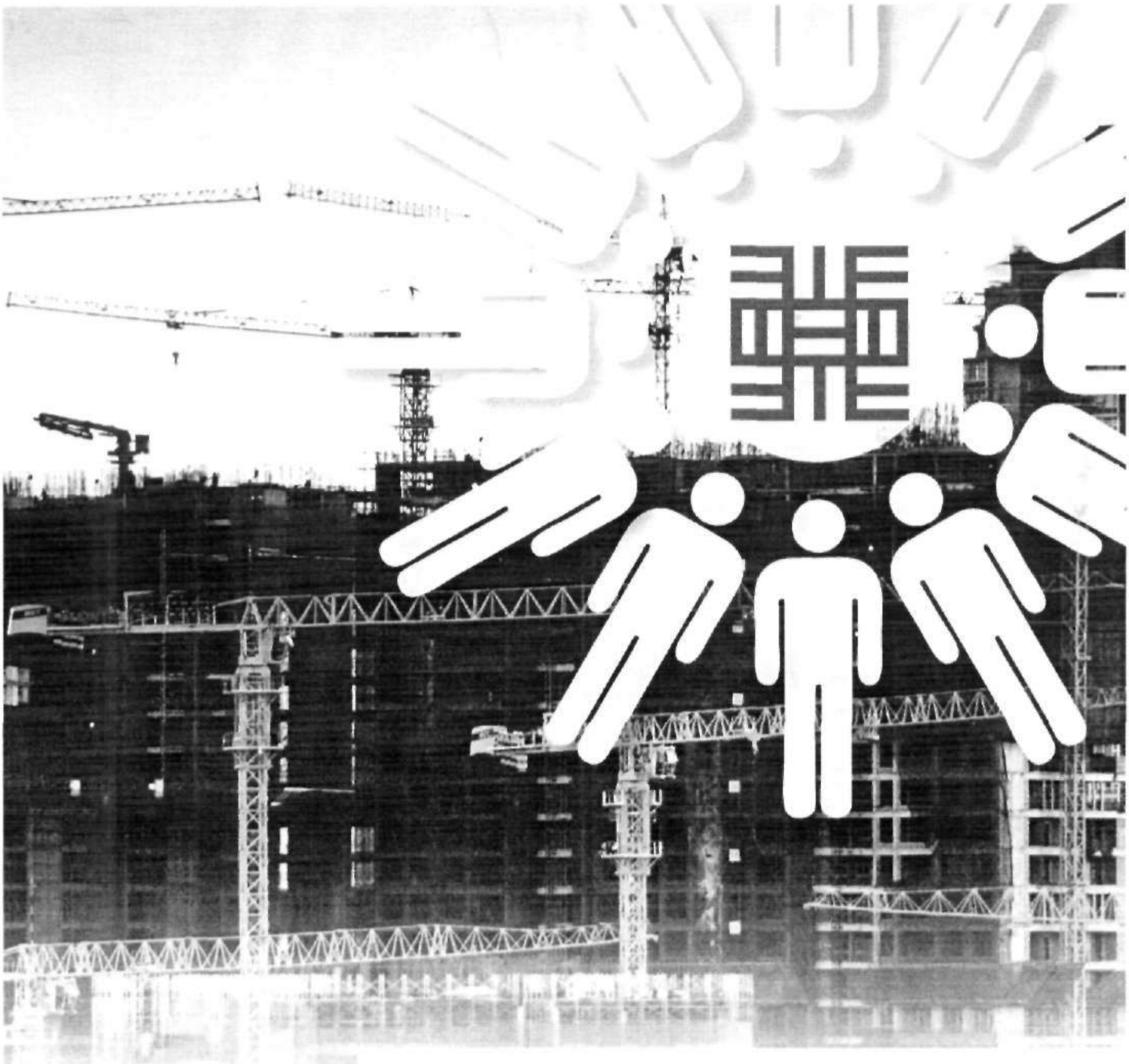

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ASSESSING THE LEVEL OF AWARENESS ON THE CONCEPT OF DESIGN FOR SAFETY (DFS) AMONGST DESIGN PROFESSIONALS IN THE CONSTRUCTION INDUSTRY IN NIGERIA

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Designing for construction safety entails safety considerations of construction workers and end users in the design of a project with a view to improve safety performance in construction project delivery. Despite the apparent potential benefits of Design for Safety (DfS) in curbing the persistent safety hazards and accidents faced in the conduct of construction activities, little or no effort has been made in most developing countries including Nigeria to ensure its wide adoption and implementation. This has been argued to be largely due to the dogmatic: attitude of such developing industries towards conventional safety support systems and mechanisms. Thus, with a view to put the argument into clearer perspective, and also set the scene for effective DfS implementation in Nigeria, this study aimed to assess the level of awareness and readiness of professionals towards accepting the concept of DfS, and the possible changes that need to be made in the industry to facilitate its implementation. A quantitative research approach was adopted using a structured questionnaire to elicit data from randomly sampled professionals often involved in design for construction projects in the Nigerian construction industry. Data collected was analyzed using descriptive statistical methods. Findings of the study showed a relatively low level of awareness on the concept of DfS amongst industry professionals, and the need to constitute safety training programs which will go a long way in changing the perception of the design professionals towards safety. This will provide them with deeper insight on the contemporary trends in safety management tools and techniques for an improved safety performance.

Keywords: awareness, construction industry, design for safety (DfS), Nigeria, professionals

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INTRODUCTION

Over the years, there has been a great concern on the need for the construction industry around the globe to improve its safety performance in project delivery (Awwad et al., 2016; Kheni et al., 2008; Sawacha et al., 1999; Törner & Pousette, 2009). The global construction industry has been often regarded as a dangerous industry which holds a bad reputation among other industries for its high fatalities and injuries (Fang et al., 2004; Williams et al., 2020; Zhang et al., 2013). According to International Labour Organisation (ILO, 2005), one in six fatal accidents at work occur on a construction site, and that no less than 60,000 fatal accidents occur on construction sites around the world every year. This Poor safety performance recorded in the construction industry as compared to other industries has been often attributed to certain factors such as the fragmented and complex environment on construction sites, difficulties in managing risk on an ever-changing site, and the multifaceted networks of members on the project team, each with their own goals and objectives (Abubakar et al., 2020; Leung et al., 2010; Sawacha et al., 1999).

Furthermore, inadequate safety consideration in design has also been highlighted to be the major source of safety hazards and accidents (Behm, 2005) as it is widely believed that design forms the blueprint of all construction activities. The design defines the configuration and components of a facility and thereby influences, to a large extent, how the project will be constructed and the consequent safety hazards (Gambatese, 2000; Jeelani et al., 2017). Several studies around the globe support this argument with glaring numbers. Notably, Behm, (2005) noted that the lack of planning and design decisions in the construction industry in Australia was found to have influenced 63% of fatalities, whereas 42% of construction fatalities in the United States could be linked to inadequate safety consideration in design. These numbers show an urgent need to address the safety challenges in the design of construction projects.

The notion that the safety of construction activities can be increased through better design is both intuitively appealing and supported by research indicating that better planning, scheduling, and design could reduce hazards on construction worksites (Atkinson & Westall, 2010). Design for construction safety as an intervention is supported by the hierarchy of controls common to the safety and health professions which identifies designing to eliminate or avoid hazards as the preferable means for reducing risk (Manuele, 1997). The concept involves the practice of anticipating and "designing out" potential occupational safety and health hazards and risks associated with new processes, structures, equipment, or tools, and organizing work, such that it takes into consideration the construction, maintenance, decommissioning, and disposal/recycling of waste material, and recognizing the business and social benefits of doing so. It involves eliminating the need to control safety hazards and risks during work operations (Korman, 2013).

Although the design community has not come very far in terms of implementing safety-in-design, recognition of and interest in design for safety across the construction industries in world is growing. Several regulatory bodies across the globe such as American Society of Civil Engineers (ASCE), the United Kingdom's Construction Design and Management Regulations (CDMR), as well as the South

African Construction Regulations (SACR), are starting to set strict policies to ensure safety considerations in design. However, little or no effort has been made in most developing countries including Nigeria to ensure the wide practice of safety considerations in design (Kolo, 2015; Okeola, 2009). This begs the question on the viability of DfS practice in the construction industry in Nigeria, as implementation can only be achieved when the viability of the concept has been ascertained. In this regard, this study set out to serve as a footing for effective DfS implementation by assessing the awareness and readiness of professionals towards accepting the concept, and the changes that need to be made in the industry to facilitate its implementation.

LITERATURE REVIEW

Safety issues in the construction industry

The global construction industry has remarkably evolved over the years, with significant stake in economic development through infrastructure projects (Okeola, 2009; Oladinrin et al., 2012). Despite this stride, issues regarding operational safety still plagues the industry. This according to Abdul Hamid, Abd Majid, and Singh (2008) is largely due to the fact that safety performance is given less priority amongst other performance measures such as time, cost and quality. Trinh and Feng (2020) opined that ensuring safety in construction might seem a challenging task due to diversity, complexity, and extensive scope of works involved in the industry. A survey conducted by the Centre to Protect Worker's Rights (CPWR) showed that just a few industries across the globe recorded a higher rate of occupational injuries and fatalities than the construction industry in 2005. Regardless, Ayomoh and Oke (2006) argued that setting up of an effective safety system poses to prevent or minimize the occurrences of accidents and hazards that threaten work operations. Previous works have provided evidence that safety hazards can be controlled, and accidents can be prevented through the implementation of basic safety practices leading to a sound safety program (Abubakar et al., 2020; Albert et al., 2017; Hallowell et al., 2013; Sawacha et al., 1999).

Safety dynamics in the Nigerian construction industry

Despite the socio-economic benefits derived from the construction industry in Nigeria (Isa et al., 2013; Oladinrin et al., 2012), the safety dynamics in the industry has been deplorable (Agbede et al., 2016). The construction industry employing the largest labour force in developing countries such as Nigeria has been noted to account for a relatively high number of all occupational injuries and fatalities resulting from accidents on work sites (Arumugam & Thirumurthy, 2007). Adeogun and Okafor (2013) observed that the industry consistently lags behind in the adoption and implementation of contemporary safety practices that pose the potential of yielding positive benefits. Evidently, there are evidences of safety legislations and policies that guide the execution of construction activities in Nigeria. Regardless, Diugwu et al. (2012) observed that there is a very low compliance to the stated safety laws and regulations in the country. Idoro (2004) also linked the country's poor safety status to lack of concern, lack of accurate records and poor statutory regulations.

However, Adeyemo & Smallwood (2017) argued that an improvement in legislation, and the adoption of novel practices has the potential of mitigating the occurrences of accidents and injuries on construction sites. The study posits that there should be new safety paradigm that would meet the present-day construction hazard through the enforcement of safety legislation, and the adoption of contemporary and sustainable safety practices. An innovative approach to the management of safety challenges in the construction industry is therefore required, which needs to be specific, monitored and enforced.

Design for construction safety

The concept of design for safety can be traced far back to the 1800s manifesting through safer designing and implementation of guards for machinery; and subsequently ergonomic design of workstations (Schulte et al., 2008). However, Behm (2005) noted that it wasn't until the year 1985 that the International Labour Organization (ILO) proposed the idea that designers should be enforced to consider safety issues in their respective designs. Design for construction safety entails procedures in which the safety and health of construction workers are clearly taken into account by designers during the design process. Taiebat and Ku (2011) consider it as a design method which takes into account the cost, schedule and quality goals of a project while still considering safety issues. Overall, it can be regarded as the practice of anticipating and "designing out" potential occupational safety and health hazards and risks associated with new processes, structures, equipment, or tools, and organizing work, such that it takes into consideration the construction, maintenance, decommissioning, and disposal/recycling of waste material, and recognizing the business and social benefits of doing so.

There are evidences that academic efforts in previous years have significantly changed the safety practices in several construction environments. Many European Union (EU) countries have structured legislation with regards design for safety. Aires et al. (2010) studied the effect of such legislations on the safety performance of respective construction environments. It was observed that within a span of a decade, countries have experienced averagely 10% reductions in work place accident rates. Relatedly, a study conducted in the UK indicated that safety considerations in design has the potential to significantly reduce the risk associated with design in construction accidents (Haslam et al., 2005).

Overall, Manuele (2008) argued that one of the best ways to prevent and control occupational injuries, illnesses, and fatalities is to "design out" or minimize hazards and risks early in the design process. Thus, it becomes paramount to adopt apt consideration of safety issues right from the design and planning stage of construction projects considering the fretting safety challenges plaguing the construction industry in Nigeria and the broader global context towards an improved performance as opined by (Farooqui et al., 2008).

METHODOLOGY

The quantitative methodological approach for research was adopted to achieve the aim of the study which was focused on assessing the level of awareness of construction designers in Nigeria on the concept of design for safety. A two-section questionnaire was designed to elicit data from industry professionals often involved in construction related designs as respondents to the study. The reason for selecting this research instrument is because it allows the researcher to specify a measurement procedure in detail in order to define the quantity of a variable (Lavrakas, 2008). The first section of the questionnaire inquired about the demographic nature of the respondent, while the second section inquired about the respondent's level of awareness on the concept of DfS, and prior safety trainings in that regard. The respondents were sampled from the broad population of design professionals (Architectural, Structural, and Mechanical) in the Nigerian built environment, which at the time of collecting the data for this study there were 49, 842 registered design professionals in Nigeria drawn from the databases of regulatory bodies in respective professions. Subsequently, the formula derived by Anguila and Gonzalez-ramirez (2013) was used to determine the sample size methodically resulting in a sample size of 138. However, only 131 valid responses were gotten and analyzed using descriptive statistical techniques.

$$SS = \frac{Z^2 * (p) * (1-p)}{c^2}$$

Where; SS = Sample Size

Z = Confidence Level

P = Estimated variation of population

C = Standard error

$$\frac{1.96^2 * (0.1) * (1-0.1)}{0.05^2} = 138$$

DATA ANALYSIS AND DISCUSSION

Characteristics of respondents

Characteristic nature of the respondents and the nature of work they were involved in was enquired to define the context of the study findings. Table 1 present the professional background, years of experience and nature of work engaged by the respondents respectively. A large percent of respondents in the study had Architectural and Civil engineering background, which accounted for forty-eight percent (48%) and forty-one percent (41%) respectively. Electrical engineers constituted eight percent (8%) of the respondents, while only three percent (3%) of the respondents were Mechanical Engineers. With regards to the years of experience of the respondents, majority had professional experience ranging from 6-10 years which constituted forty-percent (42%) of the total respondents, while thirty-eight percent (38%) had professional experience spanning less than five (5) years. Years of experience ranging from 11-15 years, and 16-20 years represented eight percent (8%) of the respondents respectively, while respondents having over twenty (20) years of experience representing four percent (4%) of the study population. This shows a relative involvement of a wide spectrum of experienced professionals in the study which broadens the perspective and context of the study findings.

Table 1: Professional background

Professional Background			Years of Experience		
	Frequency	Percentage		Frequency	Percentage
Architect	63	48	0 – 5 years	50	38
Civil/ Structural engineer	54	41	6-10 years	55	42
Mechanical engineer	4	03	11-15 years	11	08
Electrical engineer	10	08	16-20 years	10	08
Total	131	100	21-25 years	3	02

Nature of Job

	Frequency	Percentage
Building works	70	53
Civil works	10	08
Building and Civil works	51	39
Total	131	100

More so, Bamisile (2004) noted that construction activities are often broadly categorized into building works and civil works. Building works involves the construction of general building infrastructure that include residential, schools and hospitals etc. whereas, civil works involves broad civil engineering works that span across large construction projects that include dams, bridges, roads etc. The classification of respondents in this study shows that majority of them were engaged in only Building works representing fifty-three percent (53%), while eight percent (8%) were engaged in only Civil works. Thirty-nine percent (39%) of the respondents were engaged in both Building and Civil works. This result gives an insight on the dynamic involvement of the respondents in the construction industry, which may influence their overall awareness on the study construct.

Awareness on the concept of Design for Safety

Questions regarding the level of awareness on the concept of Design for safety were asked, and the subsequent sections provides the key findings of the study. Respondents were asked whether they had any prior knowledge on the concept of Design for Safety from their dynamic engagements in the construction industry., and Figure 1 highlights their respective responses.

Figure 1: Prior knowledge on Design for Safety

Although a large majority of the respondents representing 84% reported having prior knowledge on the concept, findings presented in Figure 2 show that majority of these respondent only became aware of the concept in recent years with 53% percent learning about it in the last 5 years.

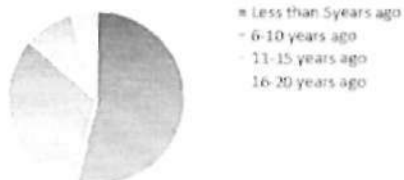

Figure 2: First Learnt about the concept

Basaga et al. (2018) observed that safety training is a fundamental tool used across industries in shaping the safety perception of individuals involved in diverse job tasks. Workers previously engaged in safety training often have more awareness on various safety tools and techniques, and are reported to apply these tools and techniques in the execution of their professional duties. Based on this assertion, respondents were asked on whether they have been involved in a safety training programme. As shown in figure 3, it was observed that only 44% of the respondents had prior safety training, with a large majority representing 61% reporting not ever been engaged in a safety training programme over the course of their respective professional careers.

Figure 3: Prior engagement in a safety training programme

Relatedly, when asked about the perceived level of understanding on the concept of design for safety in construction, a large percentage of the respondents representing 43% and 24% responded having a relatively good and fair understanding of the concept respectively. Only 16.8% of the respondents believe they have a very good grasp of the concepts, and its application in the construction industry, with just below 12% reporting poor understanding of the concept.

Figure 4: Perceived Level of understanding on Design for Safety

More so, the level of significance attached to safety considerations across distinct design professionals in the industry was assessed. Although the fundamental considerations in the design of building infrastructure are functionality and aesthetics (Best & Valence, 2007), 96.15% of the respondents in this study noted the high significance of safety considerations in the design of functional and aesthetical structures. However, only 71.7% of the civil engineering designers often involved in the design of structural elements of infrastructure developments regard so much importance in considering safety in design, with 7.55% feeling its fairly important. Whereas, 100% of the services engineers reported regarding safety in design as very important. This could be attributed the fact that failure in safe execution of such designs often result in high-risk safety hazards (Greenwald, 1991).

Table 2: Importance of Design for Safety

Profession	Extent of importance you attach to considering the safety of construction in design stage		
	Very important %	Important %	Fairly important %
Architects	96.15	3.85	0
Civil/ Structural engineers	71.70	20.75	7.55
Mechanical engineers	100	0	0
Electrical engineers	100	0	0

DISCUSSION

This study adds to the exiting body of knowledge in the area of assessing the viability of diverse and novel safety management tools and techniques that have the potential of curbing the incessant safety challenges facing the global construction industry at large. Although the evolution of the design for safety concept can be traced far back to the 1800s (Schulte et al., 2008), findings of this study showed that most of the design professional only became aware on the concept of Design for Safety in the last few years. This presents additional evidence on the dogmatic attitude of the construction industry in Nigeria towards conventional safety methods, and the nonchalance towards the promotion and adoption of conventional methods. Despite being a party to the Geneva Occupational Safety and Health Convention 1981, the construction industry in Nigeria continues to lag behind in the implementation contemporary safety practices (Adeogun and Okafor, 2013) towards improving the safety performance of the industry.

More so, as largely seen in various developing countries (Awwad et al., 2016; Kheni et al., 2008), a handful of the design professionals in the Nigerian built environment have had no prior safety training. This as argued by Basaga et al. (2018) has the potential to limit their awareness and understanding of novel safety management tools and techniques, which manifest in their abysmal safety performance. Furthermore, it could be seen from the study findings the majority of the design professionals in Nigeria do attach significance importance to safety considerations in design. However, it was observed that fraction of the civil engineers fail to regard safety consideration in design as a fundamental professional practice despite its severe consequences. Similar nonchalant attitude of professionals towards safety in the construction industry could argued to be a major contributor to the continuous building collapse in the country largely due to structural failure. This attitude amongst professionals as argued by Idoro (2004) as a manifestation of lack in safety regulation in the Nigerian construction industry which could promote sustainable safety practices.

CONCLUSION

This study assessed the level of awareness on the concept of design for safety amongst design professionals in the Nigerian built environment with a view to improve their overall safety performance. This became paramount considering the fretting data on construction accidents and fatalities in countries like Nigeria with little or no safety regulations, and the assertions from broad safety management literature on the significant value in taking safety measures right from the design and planning stages of construction activities. Based on the findings of the study, it is recommended that the enforcement of safety regulations be improved, and safety training Programs be constituted that will mandate design professionals to actively engage in safety practices. This will go a long way in changing the perception of the design professionals, especially the civil/structural engineers towards safety, and provide them with deeper insight on the trends in safety management tools and techniques for an improved performance.

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