Hindawi
Journal of Construction Engineering
Volume 2017, Article ID 8496258, 14 pages
https://doi.org/10.1155/2017/8496258

*Research Article*

# Multilevel Safety Intervention Implementation Strategies for Nigeria Construction Industry

**Peter Uchenna Okoye,[1] Kevin Chuks Okolie,[1] and Chukwuemeka Ngwu[2]**

[1] *Department of Building, Nnamdi Azikiwe University, Awka, Nigeria*
[2] *Department of Quantity Surveying, Nnamdi Azikiwe University, Awka, Nigeria*

Correspondence should be addressed to Peter Uchenna Okoye; pu.okoye@unizik.edu.ng

Received 17 July 2016; Accepted 23 March 2017; Published 10 April 2017

Academic Editor: Brian Kleiner



This study was aimed at examining the relationships between the effectiveness of safety intervention programmes and implementation strategies in the Nigeria construction industry. Structured questionnaires were distributed to construction stakeholders across some selected states in Nigeria and the data generated were analysed using Pearson's product moment correlation. The study found that the effectiveness of safety intervention programmes for construction site accidents prevention is significantly related to the communication implementation strategies. Based on the principles of social ecological theory and UNICEF's communication for development strategies, this study developed a multilevel safety intervention implementation strategy for construction industries in Nigeria. Four communication strategies, namely, advocacy, social mobilisation, social change communication, and behaviour change communication, which are central to the effectiveness of safety intervention implementation programmes for construction site accidents prevention, were identified. It further revealed that these communication strategies could be individually and collectively applied at different intervention levels but that the greatest effect would be felt when all strategies are systematically combined with more efficient use of resources. The study recommended systematic actions by policy makers, construction organisations, and various community groups towards construction safety interventions, since maximum effect could only be felt when safety interventions are implemented across all levels.

## 1. Introduction

Construction industry is globally recognised as one of the most hazardous industries due to the unique nature of its products and complexity of its process with array of network of people involved. Accident records in the industry so pronounced that it cuts across developed and developing economies and so the industry is known as one of the industries with very high rate of accident. Mouleeswaran [1] agrees that construction workers are more prone to accidents as the industry is regarded as one of the most dangerous industrial sectors. Mouleeswaran also avers that construction still contributes to a high number of occupational related fatalities despite recent efforts to improve the safety image [1]. The above position is anchored by Sousa et al. [2] who contends that the pace of accidents in the construction industry is still very high despite considerable improvements over the recent years. Buttressing this fact, Hinze [3] avows that when the construction industry is compared with other labour intensive industries, it exhibited a disproportionately high rate of disability injuries and fatalities incomparable to its size. A closer look also reveals that the construction industry is lagging behind most other industries in terms of safety improvement [4]. Nonetheless, Huang and Hinze [5] contend that even though a remarkable safety improvement in the construction industry has been achieved in recent decades, safety records in the industry are still a big concern and one of the poorest, thus, hindering any performance improvement [6]. At the same time, it is a source of social and economic problem to both the individual workers and employers and even the society [7]. In this respect, Umeokafor et al. [8] suggest that adopting adequate intervention strategies is essential in the prevention of accident and improvement of occupational health and safety but regretted that this area remains underexamined by researchers especially in Nigeria.

Whereas there have been substantial efforts, safety intervention strategies, and approaches towards improving safety performance of the construction industry and decreasing rate of accident occurrence [4], accidents continue to happen, even at an increasing rate in some countries. Although Dyreborg et al. [9] acknowledge that the risks of accident at workplace have reduced over the last decades, they observe that the number of accidents at workplace is significantly very high, which has generated great concern from different fields of human endeavour. More worrisomely, accident data and reports on construction site have not been officially documented in Nigeria over the years, even as Ezenwa [10] and Umeokafor et al. [11] found that occupational accidents in Nigeria are increasing as years roll by. Correspondingly, a case study by Nkem et al. [12] conducted on an Engineering and Construction Company that was carrying out an upgrade on a flow station in Nigeria between 2008 and 2012 reveals that, within this period, there were 582 unsafe acts/conditions and 91 recorded construction accidents on site which increased as construction progressed. Anecdotal evidence also shows that accidents still occur at construction sites despite all efforts. When added to the records of fatalities and casualties arising from the incessant collapse of building in Nigeria, the situation calls for a decisive action and policy readjustment.

The questions, however, are why do accidents continue to increasingly happen at various construction sites? Why do various safety intervention strategies fail to yield the desired safety improvement? The answers rest with identifying and applying appropriate safety intervention implementation strategies, even though Dyreborg et al. [9] had argued that the knowledge regarding knowing which interventions and programmes are most efficient in minimising workplace accidents is still lacking. In addition, DKM Economic Consultants Ltd. [13] observes that implementation of occupational health and safety intervention is weak, inconsistent, or even nonexistent just as it is in any other field. Despite this pesky situation, there is inadequate research profiling in this respect and virtually none in the Nigerian context. For example, Kennedy et al. [14] state that the knowledge about the most effective occupational health and safety interventions to reduce upper extremity musculoskeletal disorders (MSDs) and injuries is limited. Thus, it is worth noting that implementation research studies are aimed at systematically documenting how an intervention is carried out [13, 15]. Thus, attempt by Okoye [16] only gave an insight into what is desired. Consequent upon this, therefore, this study argues that available safety interventions lack efficient and effective implementation mechanisms through which they can be permeated into the subconscious of construction workers, thereby influencing their safety behaviours for optimum safety performance. It further argues that appropriate implementation mechanism holds the potential to infuse safety interventions into the main stream of accidents prevention framework on construction site.

The above arguments are based on the premise that accidents were formerly seen from a technical, legal, or human factors perspective, while, presently, cultural and organisational dimensions have become important safety intervention programmes in the workplace [17]. Furthermore, the possibility of not knowing whether any strategies used on a regular basis by work health and safety regulators are being effective in achieving desired policy outcome of reducing work-related deaths, injuries, and disease has been suggested [18]. Farooqui [19] surmises that the traditional application of normative approach of safety intervention ignores how the individual characteristics, groups, and production system processes influence workers behaviours and affect the possibility of errors and accidents, despite aiming at creating safe work behaviours. Accordingly, the efficiency of production and economic pressures is not considered in the normative approach. In addition, the approach does not consider such factors as individual commitments, cultural norms, attitudes, and perceptions of an individual and group, which shapes the work environments. According to Farooqui [19], these factors create the environments in which workers work and at the same time the ability of workers to collectively perform safely, continuously, and consistently. Nevertheless, a number of safety-related communications, according to Olson et al. [20], have been associated with higher levels of safe behaviours and conditions and higher perceived safety climate. Thus, it is obvious that increasing number of safe behaviours at construction site is essential for elimination of site accidents [21]. To this end, this study is aimed at establishing a multilevel safety intervention implementation strategy for accident prevention in the Nigeria construction industry. On this premise, the following hypotheses are postulated:

$H_0$: there are no significant relationships between the effectiveness of safety intervention programmes and the implementation strategies.

$H_1$: there are significant relationships between the effectiveness of safety intervention programmes and the implementation strategies.

## 2. Literature Review

*2.1. Construction Industry Safety Scenario.* Occupational Safety and Health Administration (OSHA) [22] reports that, every day, there are more than 12 workers that die on job (this is more than 4,500 a year); likewise, every year, more than 4.1 million workers suffer a serious work-related injury or illness. According to McKenzie et al. [23], the construction industry alone accounts for about 30% of all fatal industrial accidents across the European Union (EU), yet only 10% of the working population is employed in the industry. Che Hassan et al. [24] affirm that construction industry is responsible for about 22% of all fatal accidents in The United States of America (USA). However, based on the statistics from the USA Bureau of Labour Statistics for the year 2010 OSHA's reports [22] that the number of deaths arising from work is about 4,547, the estimated annual cost is almost $40 billion, while the estimated value of each life lost is $8.7 million.

In the developed countries of the world, accidents still occur on construction site. For instance, the report of Health and Safety Executive (HSE) [25] shows that annually between

2011/12 and 2014/15 about 69,0000 (3.1%) workers in the construction sector in Great Britain suffered from an illness that they believe was caused or made worse by their work in the sector. The report [25] further indicates that between 2012/13 and 2014/15 about 65,000 (3%) construction workers in Great Britain sustained an injury at work. A quarter of these cases according to the report result in absence from work of over 7 days. Furthermore, the report [25] states that, in 2014/15, there were 35 fatal injuries to workers in the construction sector which is 20% lower than the five-year average for 2010/11–2014/15. Accordingly, these have resulted in the loss of about 1.7 million working days [25], despite a downward trend in the rate of fatal injury in the last 20 years and, more recently (since 2008/09), a less clear accident trend [26].

The significant improvements made by Singapore through a comprehensive Occupational Safety and Health (OSH) framework such as strong legislation, policies, a sound structure, and functional systems do not stop accidents from happening neither, because, according to Siang and Tan [27], the gaps between Singapore and other leading countries of the world in OSH are still great when benchmarked against each other. Asanka and Ranasinghe [28] concur that accident still happens at construction sites in Singapore and even at increasing rate when compared with the global benchmark.

The same accident scenario applies in the Middle East and Asian countries even with their sophisticated technologies. For instance, General Organization for Social insurance (GOSI) [29] reports that, in 2014, the total number of reported work accidents in Saudi Arabia was about 69,241; out of these, construction industry was responsible for 51.35%. To this end, scholars [2, 30, 31] have attributed the high percentage of workplace accidents to many factors related to the construction industry, such as the dynamism of the working environment where the working environment is usually unstable. More still, even though construction labour accounts for about 7.1% of the labour force in Jordan, accidents in construction industry account for about 10.5% of incidents [32].

Other developing countries are not also left out. For instance, Somasundaraswaran et al. [33] reveal that about 25% of total workers' accidents were from the construction industry in Sri Lanka. They maintain that the fatal accident rates in the construction industry were higher than other industries. In the Malaysian construction industry equally, Chong and Low [34] report that the statistical data and court cases on the construction site accidents show that accident is not declining, despite its compelling legal consequences. In Iran, report of Soltanzadeh et al. [35] on occupational accidents recorded from 2009 to 2013 shows that the rate of construction accident is still high even among largest Iranian construction companies.

In Africa, the situation has not fared well. Smallwood et al. [36] report that in South Africa, construction health and safety is not improving commensurately with the efforts of many industry players and stakeholders. Notably also, it was observed that the construction has continue to contribute a greater number of fatalities and injuries when compared with other industrial sectors, which has resulted to continuous high levels of noncompliance with health and safety legislations generally [36]. In support of this claim, the Department of Labour (DoL) statistical data on construction health and safety quoted by Smallwood et al. [36] that covers from 2004/05 to 2007/08 reveal a sharp increase in accidents to about 160 fatalities and 400 nonfatal accidents (i.e., temporary or permanent disablements) in 2007/08 [36]. Irumba [37] also reports that the Ugandan construction industry health and safety condition is worsening. This situation is the same across African countries, and even worse in some cases.

In Nigeria, dearth of reliable accident records on construction site makes the situation more wretched. Abubakar [38] argues that workplaces in some countries like UK have become safer over the years unlike in Nigeria. Hämäläinen et al. [39] equally reveal that the work-related death rate in Nigeria is one of the highest in the world, and it stood at an average of 24 fatalities per 100,000 employees annually based on data available in 2003. A repeat of Ezenwa's [10] study by Umeokafor et al. [11] using data from a field study conducted by the then Federal Ministry of Labour and Productivity Inspectorate Division between 2002 and 2012 agrees with Ezenwa's. This gives credence that work-related accidents in Nigeria are increasing. Just recently, Abdulahi et al. [40] conducted a survey on artisans' working condition in the Nigerian construction industry in some states in northern Nigeria and found that about 76.40% of the artisans have been involved in one form of accidents or the other on construction sites. Notwithstanding the high level of awareness of importance of occupational health, Akinwale and Olusanya [41] found that there is inadequate investment in safety intelligence programmes and prevalence of occupational hazards in various organisations in Nigeria. From the above scenarios, it does indicate that something is amiss with safety intervention efforts of construction stakeholders. Examining what makes these efforts ineffective in improving safety situation of construction industry and formulating an appropriate intervention implementation mechanism form the thrust of this study.

*2.2. Safety Interventions at Construction Workplace.* Safety intervention has been defined as an attempt to change how things are done in order to improve safety [42, 43]. Safety interventions (which entail a number of activities) are resourceful tools in the control or prevention of workplace accidents [44]. On their part, MacEachen et al. [45] define safety intervention as a planned systematic programme or strategy that is aimed at reducing occupational health problems, which include programmes focusing on education to workplace staff and/or programmes focusing on general organisational factors. For Dyreborg et al. [9], safety interventions for prevention of accidents at work are characterised as a complex process and integrate a number of components such as safety campaigns, safety training, legislations, and machines' guarding.

Over the years, researchers have proposed different approaches of safety interventions for prevention of accidents at work; however, Mohan et al. [46] argue that the standard package for interventions suitable for all contexts and countries is nonexistent. van der et al. [47] argue that though there are some injury control strategies proposed by different organisations, their effectiveness in reducing the rate of injuries in the construction industry cannot be ascertained. To this end, Mohan et al. [46] suggest a careful adaptation and evaluation of every intervention strategy since interventions proven in one case may not be easily transferable in another case. They further suggest a scientific research where effective interventions are totally lacking, so as to develop and test new measures [46]. Even Peden et al. [48] agree that there are many good practices which can be followed, irrespective of the country's economic status. Nevertheless, the issue remains with the implementation strategy within which safety intervention approaches can be applied. This is attested by Robson et al. [49] who observe a lag phase, dependent on the type of safety intervention and the context in the implementation of safety interventions.

In the last 4 decades, therefore, several researchers [46, 48, 50–56] have stressed integrating different components or approaches of safety interventions so as to achieve a high level of safety at work. Adebiyi [57] posits that no single safety intervention can bring about the much desired reduction in accidents rather a combination of more than two interventions. Ajayeoba et al. [44] and Adebiyi and Ajayeoba [56] agree with the above assertion but maintain that a combination of these interventions achieved more results compared with individual application of these interventions.

Regrettably, there are uncertainties in the effectiveness of any accidents preventing measures at work till date [48, 58], even though there are several efforts towards realising that [9] in addition to existence of several proposed safety interventions measures [59]. The effectiveness of these measures is not widespread across the globe, when compared with the rate at which accidents still occur at construction site. This suggests that the problem lies on the application of intervention programmes rather than the programme itself. Supporting this, Oyewole and Haight [42] aver that the application of safety interventions programmes should be at different levels of an industrial safety system instead of generalising. Responding to this, Celis [43] outline the levels at which safety interventions can occur to include the level of safety management (policy, procedures, organisational structure, and communications mechanisms); human subsystem level (safety attitude and perceptions, knowledge, motivation, behaviour, and safety culture); and technical subsystem level (physical settings, machine design, and protective gears). The above view is shared by different researchers in their findings.

A systematic evaluation of 53 different research reports by Guastello [50] using 10 different approaches shows that Behavior-Based Safety (BBS) approach was the most effective accident reduction measure, followed by the ergonomic and engineering approaches with an average of 60%, 52%, and 29% reduction, respectively. The study further reveals that other approaches such as group problem solving, government action, management audits, stress management, poster campaign, personnel selection, and near-miss reporting have an average accident reduction that ranged from 20% to 0%. Though recent studies [44, 51] have advocated for an integrated approach, Guastello's findings were affirmed by [60–62]. This means that Behaviour-Based Safety (BBS) is attracting more attention across industry sectors globally, with its numerous advantages [63]. Nevertheless, the issue remains that implementation holds greater percentage of effectiveness of any intervention approach.

An exploratory study conducted by Whysall et al. [53] reveals that workers' resistance to changing their behaviour, gaining managerial commitment, and managers' general attitudes towards health and safety were among the top barriers and facilitators to effective implementation of safety interventions. It further found the existence of patterns of mutual influence between these factors and structural issues such as allocation of resources. Based on this, it emphasises giving attention to work environments and psychosocial domain of workers for effective safety intervention implementation.

Bhattacharjee et al. [4] evaluated nine major safety improvement approaches in construction industry in terms of techniques and effectiveness and found that all the approaches (personnel selection, technological intervention, behaviour modification, poster campaign, quality circle, exercise and stress management, near-miss accident reporting, safety climate, and zero injury technique) transfer the burden of responsibility on contractors. They, however, recognise the indisputability of the role of contractors in ensuring safety of workers and aver that researchers are of the opinion that ideal time to consider construction safety is during design phases. In this regard, Bhattacharjee et al. [4] propose a new approach of preventing accidents and incidents through design (prevention through design) as future direction of safety improvement in the construction industry which is based on the prolonged involvement of architects and engineers from the phase of inception and important role they can play in identifying and mitigating potential hazards to construction workers.

There is no doubt about, therefore, the efficacy of this concept in reducing or eliminating certain identifiable risks on construction site, but the frameworks within which it can be applied remain unclear. On this premise, Lingard et al. [64] contend that the current policy and legislative approaches to Construction Hazard Prevention through Design (CHPtD) are intrinsically limited, because they do not adequately reflect the sociomaterial complexity of decision-making in construction design. Lingarg et al. [64] further contend that attributing the sole responsibility to one sociotechnical actor called "the designer" does not reflect the multiple and disparate influences that have an impact upon occupational health and safety outcomes, despite the fact that Spangenberg [17] recommended that future safety research and practice should be focused on injury prevention measures in the design phase, based on the claim that many accidents are the product of design error. Therefore, this suggests that multi-intervention approaches are most desirable.

Systematically, van der Molen et al. [47] review a literature on preventing occupational injuries among construction workers and found that neither the introduction of regulation only nor the regionally oriented interventions such as safety campaign, training, inspections, or introduction of occupational health services are evidently responsible for effective prevention of nonfatal and fatal injuries in construction workers. However, a multifaceted safety campaign and a multifaceted drug-free workplace programme at the company level were observed to have a low-quality effect in reducing nonfatal injuries. While acknowledging the ineffectiveness of introducing regulation alone in reducing nonfatal and fatal injuries in construction workers, they suggest having additional strategies that will increase workers and employers' compliance to safety regulations.

Another systematic review by Dyreborg et al. [9] identified six categories of safety intervention approaches that could be applied in preventing accident at work. The following safety intervention approaches were identified: multifaceted approaches; attitudinal approaches; behavioural approaches; safety climate approaches; structural approaches; and safety culture approaches. Dyreborg's finding was in line with the findings of the following researchers [49, 51, 65–69] who also recognised the above approaches in their separate studies.

Supporting, Adebiyi and Ajayeoba [56] pointed out that research on safety planning and management has revealed that focusing on one safety intervention programme and use of lagging measures for safety evaluation are not sufficient. Thus, they propose an integrated model for safety intervention programme management using system dynamics and combinatorial approaches. In another development, Ajayeoba et al. [44] used retrospective accident analysis to determine the effectiveness indices (Uk) of various identified safety intervention strategies, so as to ascertain the preventable number of accidents (Sk). Fifteen strategies (S1 to S15) were determined from six safety interventions (Personal Protective Equipment (PPE), Training (Tr), Guarding (Gu), Accident Investigation (AI), Awareness (Aw), and Incentives (In)), out of which PPE and Tr were considered prominent. Their respective effectiveness indices ($\mu$1 to $\mu$15) were calculated. It was revealed that $\mu$15, $\mu$12, and $\mu$11 have highest effectiveness indices of $5.50\times10^{-06}$ (Q/N), $5.47\times10^{-06}$ (Q/N), and $5.46\times10^{-06}$ (Q/N), respectively. The effectiveness indices $\mu$3 and $\mu$4, however, have the lowest effectiveness indices of $3.50 \times 10^{-06}$ (Q/N) and $3.52E \times 10^{-06}$ (Q/N). The highest effectiveness index reduced the highest number of accidents of 46, while lowest effectiveness index reduced accidents by 19. This suggests where more emphasis should be placed while planning and managing safety issues.

In line with the scenario above, Dyreborg et al. [9] opine that safety intervention can be for a shorter or longer period of time or can represent a permanent change; they further suggest that the programme can be initiated at the workplace by any of the industry players or stakeholders. Kines [70] also suggests that safety communication should form a fundamental part of the entire construction process, from planning to construction and operation and that group influence should also be taken into account when designing an intervention. This means that the object of any intervention(s) which is improving safety at workplace or during work should not be misplaced. For example, Oldenburg and Brodie [71] suggest that an intervention designed around a theoretical model should recognise the influence of a wide range of factors from intrapersonal and interpersonal factors to institutional and community level factors as well as societal level factors such as public policy on behaviour. It should also develop a framework for implementing such strategies that are aimed at the multiple levels of influence [71]. That is to say that interventions aimed at preventing accidents at work can be implemented at different levels, for example, individual, group, or organisational or broader societal-industry level [17, 51, 72, 73], depending on the specific target.

In the construction industry specifically, it is acknowledged that the construction worksite and workforce vary between projects and over time; thus, for most construction projects, interventions for reducing injuries are likely to work in similar ways [47]. Based on this, Haslam et al. [72] advance four areas for interventions that can be applied in a typical construction project and their causal factors as presented in Table 1. Haslam et al. [72] maintain that these casual factors are subject to more distal originating influences, which include the permanent works design, project management, construction processes, safety culture, risk management, client requirements, economic climate, and education provision.

Although there is evidence that these programmes are effective in improving safety, it is only when they are effectively implemented [74, 75]. Consequently, the effectiveness of safety interventions and the extent to which involvement of parties' contributes to the success of the programme were measured by Zulkefli et al. [75]. The study reveals that when safety intervention programme is implemented, there is improvement on site safety performance which inadvertently motivates workers. Increasing evidence also supported public health and safety behaviour interventions that are based on social and behavioural science theories because they are more effective than those lacking a theoretical base [76].

In line with this, Okoye [16] develops a safety performance improvement framework based on social ecological theory. Unlike Whysall et al. [53], Okoye [16] proposes four strategic steps through which safety performance improvement framework can be implemented in the construction industry. Although these steps include identifying and implementing the intervention mechanisms, the framework fails to establish which mechanism(s) is required and how efficient the mechanisms are if any, thus, limiting its applicability. Secondly, the appropriateness of the framework in implementing safety interventions is not established. Two critical determinants through which effective behaviour change interventions can be utilised were even suggested by Fabrizio et al. [77]. They are thoughtful formative research to develop and implement intervention and a hypothesis of the programme impact pathway with assessment of intermediary behaviour outcomes. Nonetheless, in the developing countries, improvement of safety performance in the construction industry still remains a subject of intense debate. Since effective implementation requires interventions at multiple levels, SEM becomes the most appropriate. According to Finkelstein [78], effective response to labour hazards depends on working condition information, risk data, accurate indicators, and high-quality safety knowledge. On this premise, therefore, a theory-based framework through which this intervention can be applied for effective reduction or prevention of accidents on construction site becomes very crucial.

Table 1: Areas of safety intervention in a typical construction project.

| | Area for intervention | Causal factor |
|---|---|---|
| 1 | Worker and work team | Worker actions and behaviour, capabilities, communication, health, and available supervision |
| 2 | Workplace | Site conditions and layout, work environment, work scheduling, and housekeeping |
| 3 | Materials | Material suitability, usability, and condition |
| 4 | Equipment | Equipment suitability, usability, and condition |

[72].

*2.3. Social Ecological Model (SEM).* Glasgow and Linnan [79] advocate the need to understand the conditions where intervention can be effectively implemented and those targeted for such intervention when assessing its impact. Accordingly, there is also a need to understand the contextual issues surrounding such intervention both at the organisational and individual levels, especially for most health behaviour and education interventions. According to USAID [80], a social ecology approach to behaviour change planning and communication provides an encompassing framework that aims not only at achieving short-term behaviour change outcomes but also at changing conditions that prevail in interpersonal relationships, in communities, and in the society as a whole.

Thus, the underlying principle of an ecological model according to Sallis et al. [81] is that behaviour is influenced at multiple levels of intrapersonal (biological, psychological), interpersonal (social, cultural), organisational, community, physical environmental, and policy. This means that individual behaviours are influenced by multiple interdependent factors [82] irrespective of the setting. However, for this to be effective, a wide variety of mutually reinforcing communication channels is used to implement the programmes through strategic complementary communication activities [82]. Thus, the overarching object of ecological models is to use multilevel intervention approaches to target its influence. To this end, it is believed that the model does not focus on the individual behaviour change only, but target multiple levels of influence, through the use of a range of interventions in different settings [83].

That is to say that the strength of the models lies on their ability to influence at multilevel settings which provides different options for interventions [81]. This further implies that the model emphasises a coordinated and strategic intervention rather than indiscriminate interventions [84]. However, Gielen et al. [85] surmise that the tools available to health professionals to design, implement, and evaluate the underlying theories of health behaviour change programmes are inadequate. They maintain that the appropriateness of selection and application of these tools can determine to an extent the success or failure of the programme [85].

Notwithstanding, the application of social ecological model of human behaviour that focused mainly on the way people interact with their environments has been successful in the fields of sociology, psychology, education, and public health over the decades [86]. In its simplest form, Callahan-Myrick [87] defines the social ecological model (SEM) as a graphic depiction of ecological theory of a given health behaviour or outcome. As a theory-based framework SEM helps to understand the multifaceted and interactive influences between peoples and their environment. It also determines behaviours and identifies behavioural and organisational influencing power that promotes health within organisations. Through SEM framework, many factors and barriers that have an impact on health behaviours of worker can be understood better. The social ecological model, therefore, helps workers in an organisation to understand factors affecting their behaviours and also provides guidance for developing successful programmes through social environments [76, 88]. In addition, it helps to direct attention to external environmental influence (political) that shape individual and interpersonal characteristics of a person [89].

According to McLeroy et al. [82], SEM has five nested hierarchical levels: individual, interpersonal, organisational, community, and public policy (see Figure 1). While recognising the challenge it poses, Elder et al. [90] are of the opinion that the components of social ecological model remain the same but can vary depending on the target population and context. In this case, the construction workers working on construction site are considered. For the purpose of this study, the five levels SEM of McLeroy et al. [82] are adopted. This is because it is comprehensive and addresses the peculiarity of construction industry setting. These levels are briefly discussed below.

*2.3.1. Individual.* This involves individual characteristics that influence behaviour change, including knowledge, attitudes, behaviour, self-efficacy, personal goals and values, age, gender, developmental history, sexual orientation, religious identity, racial/ethnic identity, economic status, financial resources, expectations, literacy, stigma, and others personal attributes peculiar to an individual.

*2.3.2. Interpersonal.* This involves both formal and informal social networks and social support systems that can influence individual behaviours, including family, friends, peers, coworkers, religious networks, customs, or traditions.

*2.3.3. Organisational.* Organisations or social institutions with rules and regulations for operations that affect how or how well, for example, welfare facilities are provided to an individual or group of workers. A good-fit structural model obtained by Khosravi et al. [91] indicates that social and organisational constructs influence safety performance via the general component of safety climate.

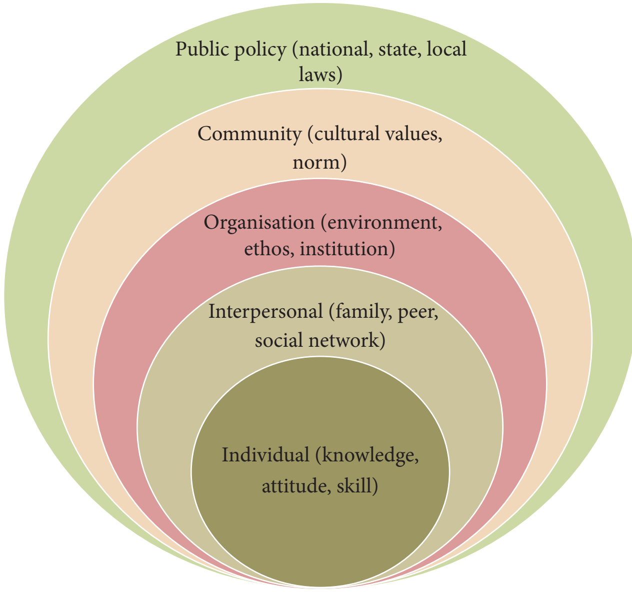


Figure 1: Social ecological model [82].

*2.3.4. Community.* Community level represents the relationships between organisations, institutions, and informational networks within a specified geography or context (e.g., work site, village associations, community leaders, businesses, and transportation).

*2.3.5. Public Policy.* This involves laws, policies, or programmes whether local, state, national, or international that affect directly or indirectly the health and safety behaviour of a worker in a given setting. They include policies regarding the allocation of resources for maternal, newborn, and child health and access to healthcare services, restrictive policies (e.g., health and safety regulations), or lack of policies that require government interventions.

*2.4. Communication Implementation Mechanism.* Enough evidence abound that communication is very critical in minimising the health and safety risks in any organisational setting [92, 93]. In case of health education, communication helps to attract the attention of stakeholder because of its influencing power in shaping the human dealings [92]. A health communication activity may be designed to advocate essential changes in health regulations to policymakers or use interpersonal communication to promote actions that prevent accidents on construction site. Thus, depending on the objectives, target groups, and communication channels, health communication activities can widely vary [94]. Applying safety interventions at multilevel scale requires appropriate implementation mechanism. Proper and adequate communication channel is indispensable for effective safety intervention implementation. Liao et al. [95] acknowledge the importance of communication in achieving construction safety, but how it influences unsafe behaviour in the construction workplace is a subject of determination.

Looking at multidynamic and complex nature of construction industry, communication becomes very important for improving safety performance of the industry. Hammer et al. [96] attribute decreased health and safety of construction workers partly to poor safety communication. Therefore, the construction health and safety relies solely on effective communication between individuals, teams, and organisations [97]. Consequently, improvement of construction project communication processes and technologies may change the organisation of future projects and how their business activities and work routines are designed, planned, and performed at different functional levels [98].

Therefore, behaviour change communication is a medium through which individuals, communities, and societies develop communication strategies which promote positive behaviours appropriate to their context. It also provides a supportive environment that enables people to initiate and sustain positive behaviours very vital for human interactions. Sustaining positive behaviour usually requires continuous investment in behaviour change communication as part of an overall safety programme [99]. Nevertheless, the effectiveness of organisations is modelled by the communication strategies which engender relationships and behaviours of people in the workplace [99]. At an individual and team level, people find it difficult to function in the industry if they do not develop a mutually agreed communication modus operandi to underpin their work activities [100].

Finnegan Jr. and Viswanath [92] identify different models that are available for assessing communication impact to include empirical, critical, or applied approaches. However, application of any one of these depends on the research interest. Meanwhile, Lamstein et al. [101] stress the importance of effectiveness of communication-related interventions as it affects the behaviour change and, at the same time, extol the role of structural, environmental, and systems-related interventions in achieving sustainable social and behaviour change (SBC). On this premise, therefore, communication for development (C4D) becomes the mechanism through which the intervention could be applied.

Thus, the World Congress on Communication for Development (WCCD) [102] sees communication for development (C4D) as a social process based on dialogue that uses a broad range of tools and methods to seek change at different levels. C4D creates a platform through which individuals, families, and communities are empowered and engaged through dialogue, consultation, and participation so as to make decision regarding their safety and health [103]. This means that communication for development (C4D) strategies can be applied in developing implementation strategies for safety interventions in accident prevention on construction site since it can promote behaviour and social change in a given setting [104, 105].

## 3. Methodology

This study is framed within the frameworks of social ecological theory using McLeroy et al. [82] model of the social ecological levels and the UNICEF communication for development strategy [105] to examine the relationships between effectiveness of multilevel safety interventions programmes and implementation strategies in accident prevention in the

Table 2: Means, standard deviations, and intercorrelations of variables of safety interventions and implementation (communication) strategies.

| Sn | Variable | Mean | Std. dev. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | IND | 4.38 | 0.73 | 1 | | | | | | | | |
| 2 | INT | 4.32 | 0.76 | 0.9936 | 1 | | | | | | | |
| 3 | ORG | 4.09 | 1.10 | 0.9901 | 0.9995 | 1 | | | | | | |
| 4 | COM | 4.35 | 0.81 | 0.9976 | 0.9835 | 0.9782 | 1 | | | | | |
| 5 | PUP | 4.24 | 0.84 | 0.9940 | 0.9983 | 0.9981 | 0.9854 | 1 | | | | |
| 6 | ADV | 4.29 | 0.78 | 0.9931 | 0.9999 | 0.9993 | 0.9828 | 0.9977 | 1 | | | |
| 7 | SOM | 4.26 | 0.87 | 0.9974 | 0.9984 | 0.9962 | 0.9907 | 0.9967 | 0.9986 | 1 | | |
| 8 | SCC | 3.94 | 1.04 | 0.9297 | 0.9652 | 0.9713 | 0.9031 | 0.9589 | 0.9664 | 0.9521 | 1 | |
| 9 | BCC | 4.21 | 0.88 | 0.9933 | 0.9998 | 0.9990 | 0.9834 | 0.9976 | 1.0000 | 0.9988 | 0.9658 | 1 |

IND = individual; INT = interpersonal; ORG = organisational; COM = community; PUP = public policy; ADV = advocacy; SOM = social mobilisation; SCC = social change communication; BCC = behaviour change communication.

Nigerian construction industry. It adopted the UNICEF's communication for development (C4D) strategy [105] in developing an implementation strategy for safety intervention in construction industry. This approach focuses attention on multiple issues, such as personal, social, and physical environments, and policy implications. Since construction activities are carried out within the social and physical environment, and it affects and/or affected by human and government policies; this approach is greatly suitable.

The study made use of questionnaire administered randomly to the selected construction stakeholders across some selected states in Nigeria. Parts of consideration for selection of participating states are the state's infrastructural development statues and geographical location. The questionnaire was divided and structured into three parts. Part 1 captured the respondents' demographic data (the work trade, job position, nature of employment, site location, age of respondents, and years of experience). Part 2 contains forty (40) statements on the general effects of safety interventions based on five intervention levels of SEM on accident reduction on construction site. Part 3 contains thirty-two statements that measure the effectiveness of communication strategies in implementing safety interventions in the construction industry. The respondents were required to express their level of concordance on a five-point Likert-scale, where 1 means strongly disagreed and 5 means strongly agreed.

With the help of associates and friends, the questionnaires were administered to 1,960 construction stakeholders (workers (management and operatives), construction firms' representatives, construction professionals, community leaders, and government officials), in the selected sites and states. A total 822 questionnaires were returned and found to be good and adequate for use. The response rate therefore is 58.06% which is good for this kind of study. Subsequently, data generated through the questionnaire survey were descriptively and quantitatively analysed using tables, charts, mean score index, and standard deviation.

To determine the degree to which communication strategies aid implementation of safety interventions in the construction industry, the study employed Pearson's product moment correlation to establish the relationships between various communication strategies and safety intervention variables. The ranges of correlation coefficient ($r$) value varies from −1 for perfect negative correlation to +1 for perfect positive correlation.

However, to determine if the calculated correlation coefficient ($r$) is statistically significant or not, a correlation significant test ($t$-test) was conducted. This test is a two-tailed, nondirectional test where the degree of freedom (df) at 5% ($\alpha = 0.05$) significant level equals ($n - 2$). In this test, the sign of the correlation coefficients ($r$) is immaterial but always assumed to be positive.

*Decision*. Reject $H_0$ if $t_{\text{calculated}} > t_{\text{critical}}$ at df ($n - 2$) and at 5% (0.05) significance level; otherwise, do not reject $H_0$ and conclude.

## 4. Results and Discussion

Table 2 shows the computed means score, standard deviations, and intercorrelations of variables of safety interventions and implementation (communication) strategies. Maximum and minimum average mean scores of the variables are 4.38 and 3.94, respectively. The high mean score suggests that the variables are highly interrelated. The result of the correlation analysis reveals that each of the variables has very strong positive correlation which is statistically significant at 5% significance level with each other. Strongest relationship occurred between advocacy and behaviour change communication strategy with a correlation coefficient ($r$) of 1.000, while the least relationship occurred between community intervention variable and social change communication strategy with a correlation coefficient ($r$) of 0.9031. However, all the variables are strongly correlated and, in each case, are significant. This implies that the variables cannot be separately isolated when the issue of implementation of safety intervention through communication strategy in the construction industry is concerned.

Table 3 presents the results of correlation analysis between safety interventions and implementation (communication) strategies. The result reveals that each of the five safety intervention factors (individual, interpersonal, organisational, community, and public policy) based on SEM has very strong positive correlation with all the communication strategies.

Table 3: Result of correlation and test of significance of the relationship between safety interventions and implementation (communication) strategies.

| S/n | Variables | Advocacy | Social mobilisation | Social change communication | Behaviour change communication |
|---|---|---|---|---|---|
| 1 | Individual | 0.9931<br>(14.668)<br>0.000687* | 0.9974<br>(23.972)<br>0.000159* | 0.9297<br>(4.372)<br>0.022138* | 0.9933<br>(14.887)<br>0.000658* |
| 2 | Interpersonal | 0.9999<br>(122.465)<br><0.00001* | 0.9984<br>(30.582)<br>0.000077* | 0.9652<br>(6.393)<br>0.007751* | 0.9998<br>(86.590)<br><0.00001* |
| 3 | Organisational | 0.9993<br>(46.267)<br>0.000022* | 0.9962<br>(19.811)<br>0.000281* | 0.9713<br>(7.073)<br>0.005811* | 0.9990<br>(38.701)<br>0.000038* |
| 4 | Community | 0.9828<br>(9.218)<br>0.002701* | 0.9907<br>(12.611)<br>0.001075* | 0.9031<br>(3.643)<br>0.035667* | 0.9834<br>(9.387)<br>0.002561* |
| 5 | Public policy | 0.9977<br>(25.494)<br>0.000132* | 0.9967<br>(21.267)<br>0.000227* | 0.9589<br>(5.853)<br>0.009942* | 0.9976<br>(24.955)<br>0.000141* |

Values in parenthesis = $t$-test value; * $p$ value (significant at 5% (2-tailed)).

This suggests that each of these communication strategies can be used to promote implementation of safety interventions at all levels. When the significance of the correlations was tested at $\alpha$ level of 0.05 and df of 3, the result reveals that the computed $t$-values were greater than the $t$-critical value (3.182) (i.e., $t_{\text{cal}} > t_{3,0.05}$). Likewise, the $p$ values of all the factors were less than 0.05 ($p < 0.05$) as can be seen in Table 3. In view of this result, $H_0$ is rejected in all cases and the study concluded that there are significant relationships between the multilevel safety interventions programmes and implementation (communication) strategies.

This implies that the four communication approaches for implementation of safety interventions identified were interrelated and interactive. When these approaches were combined strategically, the maximum effectiveness of safety interventions is achieved. Advocacy and behaviour change communication strategies stimulate the most immediate preventive actions among individuals, interpersonal, families, and communities for decreasing accident rates. Advocacy strategies can be used to create new laws or change existing policies to facilitate change. Multilevel approaches that help to change social, cultural, or institutional norms and enable behaviour change are most likely to result in sustained behaviour change over time.

Table 4 presents strategic road map for implementation of safety intervention programmes in the construction industry. It also shows a summary of the C4D approaches, their key features, the usual intended participant groups for each approach and the level of implementation of each strategy. Since the C4D approaches are interrelated, when clinically combined they produce the maximum behavioural change and by extension maximum improvement in the health and safety performance of construction workers. However, it is important to note that different approaches can be applied to different levels of interventions; for example, advocacy approach can also be used at the community or organisational levels [104] and likewise other approaches.

## 5. Conclusions

Questions on why accident has continued to occur increasingly at construction sites despite development of several intervention strategies have been reverberating among construction stakeholders over the years. As argued in this paper, solution lies in identification and application of appropriate implementation strategies that are central to effectiveness of safety interventions in preventing accidents at construction site. Based on this tenet, this study has successfully established that safety intervention programmes are significantly related to the implementation (communication) strategies in the construction industry. The study identified four communication strategies (advocacy, social mobilisation social change communication, and behaviour change communication) based on the UNICEF's communication for development strategy. It then found that these communication strategies can be individually and collectively used in implementation of safety interventions at different levels of intervention but that the greatest effect would be achieved when all the strategies are systematically combined with more efficient use of resources.

It is however clear that this study has both theoretical and practical implications. It has highlighted multiple applications of social ecological theory and practice outside the purview of public health, education, sociology, and psychology. The outcome of this study indicated that the theory can be applied in a complex and dynamic industry like construction. This means that it has added a new dimension in the application of social ecological theory. The relationships established between safety intervention variables and communication strategies indicated that, with good and appropriate safety intervention implementation strategies such as the ones identified and tested in this study, the rate at which accidents occur on construction sites can be greatly minimised. The results of this study have also expanded the existing body of knowledge in this area of research through

Table 4: Road map for multilevel safety intervention implementation strategy in the construction industry.

| C4D approach | Key features | Participant groups | Level of implementation |
|---|---|---|---|
| Advocacy | Focuses on policy environment Seeks to develop or change laws, policies, and administrative practices<br>Works through coalition-building, community mobilisation, and communication of evidence-based justifications for programmes | Policymakers and decision-makers<br>Programme planners<br>Programme implementers<br>Community leaders<br>Government agencies/authorities<br>Regulatory bodies<br>Company's management echelon | Public Policy |
| Social mobilisation | Focuses on uniting partners at the national and community levels for a common purpose<br>Emphasises collective efficacy and empowerment to create an enabling environment<br>Works through dialogue, coalition-building, group/organisational activities | National and community leaders<br>Community groups/organisations<br>Public and private partners<br>Professional associations<br>Construction firms associations | Organisational |
| Social change communication | Focuses on enabling groups of individuals to engage in a participatory process where their needs are defined and their rights demanded in collaboration with the social system<br>Emphasises public and private dialogue to change behaviour on a large scale, including norms and structural inequalities<br>Works through interpersonal communication, community dialogue, mass/social media | Groups of individuals in communities<br>Workers unions<br>Social organisations<br>Peer groups | Community<br>Interpersonal |
| Behaviour change communication | Focuses on individual knowledge, attitudes, motivations, self-efficacy, skills building, and behaviour change<br>Works through interpersonal communication, mass/social media campaigns | Individuals<br>Families/households<br>Small groups<br>Peer groups | Interpersonal<br>Individual |

combination of application of social ecological theory and communication for development principle into improving safety status of the construction industry and construction workers safety performance.

To further unearth its significance, the results of this study have generated some compelling implications for policy readjustment, institutional reawakening, construction cultural practice, and need for future research. The extent of relationships found between safety interventions and communication strategies is particularly striking, given the current workplace realities and several efforts towards improving safety performance at construction sites across Nigeria. The empirical confirmation of these relationships calls for special focus on the direction of implementation of safety interventions through these communication strategies.

Undoubtedly, the aim of this study has been achieved by providing resources for further research actions. The challenges of achieving this are not to be underestimated to avoid the pitfall in previous strategies. The approach calls for higher levels of collaboration between stakeholders providing separate service components than has likely been the case in the past. Communication implementation strategies can be effective in improving knowledge of and perceptions about safety and accidents at construction site in that lack of accurate knowledge can lead to unsafe behaviour. Recommendations in terms of systematic actions by policy makers, construction organisations, and various community groups are required. There is need for collective efforts since maximum safety can only be achieved in the construction industry when safety interventions are implemented across all levels. Multiple approaches should be used when attempting to improve knowledge and perceptions about construction safety among workers.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

## References

[1] K. Mouleeswaran, "Evaluation of safety performance level of construction firms in and around erode zone," *International Journal of Innovative Research in Science, Engineering and Technology*, vol. 3, no. 1, pp. 1586–1594, 2014.

[2] V. Sousa, N. M. Almeida, and L. A. Dias, "Risk-based management of occupational safety and health in the construction

industry—part 1: background knowledge," *Safety Science*, vol. 66, pp. 75–86, 2014.

[3] J. W. Hinze, *Construction Safety*, Prentice Hall, Upper Saddle River, NJ, USA, 1997.

[4] S. Bhattacharjee, S. Ghosh, and D. Young-Corbett, "Safety improvement approaches in construction industry: a review and future directions," in *Proceedings of the 47th ASC Annual International Conference*, Associated Schools of Construction, April 2011.

[5] X. Huang and J. Hinze, "Owner's role in construction safety," *Journal of Construction Engineering and Management*, vol. 132, no. 2, pp. 164–173, 2006.

[6] S. Z. Alkilani, J. Jupp, and A. Sawhney, "Issues of construction health and safety in developing countries: a case of Jordan," *Australasian Journal of Construction Economics and Building*, vol. 13, no. 3, pp. 141–156, 2013.

[7] G. L. Janackovic, S. M. Savic, and M. S. Stankovic, "Selection and ranking of occupational safety indicators based on fuzzy AHP: a case study in road construction companies," *South African Journal of Industrial Engineering*, vol. 24, no. 3, pp. 175–189, 2013.

[8] N. Umeokafor, D. Isaac, K. G. Jones, and B. Umeadi, "Enforcement of occupational safety and health regulations in Nigeria: an exploration," in *Proceedings of the 1st International Scientific Forum*, vol. 3, pp. 92–103, 2013.

[9] J. Dyreborg, H. J. Lipscomb, O. Olsen et al., "Safety interventions for the prevention of accidents at work," ID SW2010-05, The Campbell Collaboration, 2015, https://www.campbellcollaboration.org/.

[10] A. O. Ezenwa, "A study of fatal injuries in Nigerian factories," *Occupational Medicine*, vol. 51, no. 8, pp. 485–489, 2001.

[11] N. Umeokafor, K. Evaggelinos, S. Lundy et al., "The pattern of occupational accidents, injuries, accident causal factors and intervention in Nigerian factories," *Developing Country Studies*, vol. 4, no. 15, pp. 119–127, 2014.

[12] A. N. Nkem, M. H. Hassim, and K. Kidam, "Relationship between unsafe acts/condition and accidents in construction company in Nigeria," *Jurnal Teknologi (Sciences & Engineering)*, vol. 75, no. 6, pp. 73–77, 2015.

[13] DKM Economic Consultants Ltd, "Measuring the impact of health and safety interventions," Report Prepared for the Health and Safety Authority, DKM Economic Consultants Ltd, Dublin, Ireland, 2004.

[14] C. A. Kennedy, B. C. Amick III, J. T. Dennerlein et al., "Systematic review of the role of occupational health and safety interventions in the prevention of upper extremity musculoskeletal symptoms, signs, disorders, injuries, claims and lost time," *Journal of Occupational Rehabilitation*, vol. 20, no. 2, pp. 127–162, 2010.

[15] H. S. Shannon, L. S. Robson, and S. J. Guastello, "Methodological criteria for evaluating occupational safety intervention research," *Safety Science*, vol. 31, no. 2, pp. 161–179, 1999.

[16] P. U. Okoye, "Improving the safety performance of Nigeria construction workers: a social ecological approach," *Universal Journal of Engineering Science*, vol. 4, no. 2, pp. 22–37, 2016.

[17] S. Spangenberg, *Large construction projects and injury prevention [Ph.D. thesis]*, National Research Centre for the Working Environment and Aalborg University, Aalborg, Denmark, 2010.

[18] Safe Work Australia, *The Effectiveness of Work Health and Safety Interventions by Regulators: A Literature Review*, Research and Evaluation, Safe Work Australia, 2013, http://www.safeworkaustralia.gov.au.

[19] R. U. Farooqui, *Achieving zero accidents-a strategic framework for continuous safety improvement in the construction industry [FIU Electronic Theses and Dissertations]*, Florida International University, Miami, Fla, USA, Paper 392, 2011, http://digitalcommons.fiu.edu/etd/392.

[20] R. Olson, A. Varga, A. Cannon, J. Jones, I. Gilbert-Jones, and E. Zoller, "Toolbox talks to prevent construction fatalities: empirical development and evaluation," *Safety Science*, vol. 86, pp. 122–131, 2016.

[21] Construction Owners Association of Alberta (COAA), *Best Practice for Behaviour Based Safety*, H:\Web Updates\COAA\Nov 13\COAA Behaviour Based Safety Best Practice.doc, 2013.

[22] Occupational Safety and Health Administration (OSHA), "Injury and illness prevention programmes," White Paper, 2012, http://www.osha.gov/dsg/topics/safetyhealth/OSHAwhite-paper-january2012sm.pdf.

[23] J. McKenzie, A. G. F. Gibb, and N. M. Bouchlaghem, "Communication of health and safety in design phase: implementation of safety and health on construction sites," in *Proceedings of the 2nd International Conference of International Council for Research and Innovation in Building and Construction (CIB)*, Working Commission W99, pp. 419–426, Honolulu, Hawaii, USA, 1999.

[24] C. R. Che Hassan, O. J. Basha, and W. H. Wan Hanafi, "Perception of building construction workers towards safety, health and environment," *Journal of Engineering Science and Technology*, vol. 2, no. 3, pp. 271–279, 2007.

[25] Health and Safety Executive (HSE), "Statistics on fatal injuries in the workplace in Great Britain," 2015: Full-Year Details and Technical Notes, 2015, http://www.hse.gov.uk/statistics/fatals.htm.

[26] Health and Safety Executive, "Health and safety in construction sector in Great Britain 2014/2015," 2015, http://www.hse.gov.uk/statistics/industry/construction/construction.pdf.

[27] L. H. Siang and A. Tan, "Singapore's framework for reporting occupational accidents, injuries and diseases," *African Newsletter on Occupational Health and Safety*, vol. 20, no. 3, pp. 57–60, 2010.

[28] W. A. Asanka and M. Ranasinghe, "Study on the impact of accidents on construction projects," in *Proceedings of the 6th International Conference on Structural Engineering and Construction Management*, pp. 58–67, Kandy, Sri Lanka, December 2015.

[29] General Organisation for Social Insurance (GOSI), "Annual statistical report 1435H," 2015, http://www.gosi.gov.sa/portal/web/guest/statistics/view-statistic?StatisticsId=1379226.

[30] A. Pinto, I. L. Nunes, and R. A. Ribeiro, "Occupational risk assessment in construction industry—overview and reflection," *Safety Science*, vol. 49, no. 5, pp. 616–624, 2011.

[31] P. Wadick, "Safety culture among subcontractors in the domestic housing construction industry," *Structural Survey*, vol. 28, no. 2, pp. 108–120, 2010.

[32] A. Al-Wreidat, "The national occupational safety and health profile of the Hashemite Kingdom of Jordan," The Report of Ministry of Labour, Directorate of Occupational Safety and Health in Collaboration with International Labour Organisation, International Labour Organization, Amman, Jordan, 2006.

[33] A. K. Somasundaraswaran, T. Brammananda, J. A. Akeel, and G. Rajakumar, "Evaluation of safety level at construction sites in Sri Lanka," in *Proceedings of the 3rd Academic Sessions*, pp. 148–153, 2005.

[34] H. Y. Chong and T. S. Low, "Accidents in Malaysian construction industry: statistical data and court cases," *International Journal of Occupational Safety and Ergonomics*, vol. 20, no. 3, pp. 503–513, 2014.

[35] A. Soltanzadeh, I. Mohammadfam, A. Moghimbeigi, and R. Ghiasvand, "Key factors contributing to accident severity rate in construction industry in Iran: a regression modelling approach," *Arhiv za Higijenu Rada i Toksikologiju*, vol. 67, no. 1, pp. 47–53, 2016.

[36] J. Smallwood, T. Haupt, and W. Shakantu, "Construction health & safety in South Africa," Research Report Undertaken by Construction Research Education and Training Enterprises (CREATE), Construction Industry Development Board (CIDB), 2010, http://www.cidb.org.za.

[37] R. Irumba, *Modelling of construction safety performance and housing markets in Kampala City, Uganda [Doctoral Thesis Building and Real Estate Economics]*, Department of Real Estate and Construction Management, KTH Royal Institute of Technology, Stockholm, Sweden, 2015.

[38] U. Abubakar, "An overview of the occupational safety and health systems of Nigeria, UK, USA, Australia and China: Nigeria being the reference case study," *American Journal of Educational Research*, vol. 3, no. 11, pp. 1350–1358, 2015.

[39] P. Hämäläinen, K. Leena Saarela, and J. Takala, "Global trend according to estimated number of occupational accidents and fatal work-related diseases at region and country level," *Journal of Safety Research*, vol. 40, no. 2, pp. 125–139, 2009.

[40] U. Abdulahi, I. Anum, A. M. Adole, and F. N. Williams, "Artisans working conditions in the Nigerian construction industry: a case study of some states in Northern Nigeria," *ATBU Journal of Environmental Technology*, vol. 8, no. 1, pp. 16–25, 2015.

[41] A. A. Akinwale and O. A. Olusanya, "Implications of occupational health and safety intelligence in Nigeria," *Journal of Global Health Care Systems*, vol. 6, no. 1, 2016.

[42] S. A. Oyewole and J. M. Haight, "Making the business case: assessment of safety intervention and resource allocation and optimization," in *Proceedings of the Safety Conference and Exposition Organized by the American Society of Safety Engineers (ASSE '09)*, San Antonio, Tex, USA, June-July 2009.

[43] A. Celis, "Principles of evaluation of safety interventions for motorcycle injuries," in *Proceedings of the WHO-RTIRN Regional Workshop on Public Health Research on Road Traffic Injuries*, October 2011, http://www.rtirn.net.

[44] A. O. Ajayeoba, K. A. Adebiyi, O. O. Akinyemi, and A. L. Akintan, "Evaluation of effectiveness of manufacturing safety intervention; a key to successful safety planning and management," *Industrial Engineering Letters*, vol. 5, no. 8, pp. 34–40, 2015.

[45] E. MacEachen, C. Breslin, N. Kyle et al., *Effectiveness and Implementation of Health and Safety Programmes in Small Enterprises: A Systematic Review of Qualitative and Quantitative Literature*, Institute for Work & Health, Toronto, Canada, 2008.

[46] D. Mohan, G. Tiwari, M. Khayesi, and F. M. Nafukho, *Road Traffic Injury Prevention Training Manual*, World Health Organization, Geneva, Switzerland, 2006, http://apps.who.int/iris/bitstream/10665/43271/1/9241546751_eng.pdf.

[47] H. F. van der Molen, M. M. Molen, J. Lappalainen et al., "Interventions to prevent injuries in construction workers," *Cochrane Database of Systematic Reviews*, vol. 12, 2012.

[48] M. Peden, R. Scurfield, D. Sleet et al., Eds., *World Report on Road Traffic Injury Prevention*, World Health Organisation, Geneva, Switzerland, 2004.

[49] L. S. Robson, J. A. Clarke, K. Cullen et al., "The effectiveness of occupational health and safety management system interventions: a systematic review," *Safety Science*, vol. 45, no. 3, pp. 329–353, 2007.

[50] S. J. Guastello, "Do we really know how well our occupational accident prevention programs work?" *Safety Science*, vol. 16, no. 3-4, pp. 445–463, 1993.

[51] J. Lund and L. E. Aarø, "Accident prevention. Presentation of a model placing emphasis on human, structural and cultural factors," *Safety Science*, vol. 42, no. 4, pp. 271–324, 2004.

[52] D. M. DeJoy, "Behavior change versus culture change: divergent approaches to managing workplace safety," *Safety Science*, vol. 43, no. 2, pp. 105–129, 2005.

[53] Z. Whysall, C. Haslam, and R. Haslam, "Implementing health and safety interventions in the workplace: an exploratory study," *International Journal of Industrial Ergonomics*, vol. 36, no. 9, pp. 809–818, 2006.

[54] M. Peden, K. Oyegbite, J. Ozanne-Smith et al., Eds., *World Report on Child Injury Prevention*, World Health Organisation, Geneva, Switzerland, 2008.

[55] P. Kines, D. Andersen, L. P. Andersen, K. Nielsen, and L. Pedersen, "Improving safety in small enterprises through an integrated safety management intervention," *Journal of Safety Research*, vol. 44, no. 1, pp. 87–95, 2013.

[56] K. A. Adebiyi and A. O. Ajayeoba, "Integrated modelling of manufacturing safety interventions planning and management," in *Proceedings of the International Conference on Aeronautical and Manufacturing Engineering (ICAAME '15)*, pp. 46–50, Dubai, UAE, March 2015.

[57] K. A. Adebiyi, "A combinatorial approach to planning manufacturing safety programme," *World Academic of Science, Engineering and Technology*, vol. 74, pp. 285–290, 2013.

[58] H. J. Lipscomb, L. Li, and J. Dement, "Work-related falls among union carpenters in Washington State before and after the Vertical Fall Arrest Standard," *American Journal of Industrial Medicine*, vol. 44, no. 2, pp. 157–165, 2003.

[59] M. M. Lehtola, H. F. van der Molen, J. Lappalainen et al., "The effectiveness of interventions for preventing injuries in the construction industry. A systematic review," *American Journal of Preventive Medicine*, vol. 35, no. 1, pp. 77–85, 2008.

[60] T. R. Krause, K. J. Seymour, and K. C. M. Sloat, "Long-term evaluation of a behavior-based method for improving safety performance: a meta-analysis of 73 interrupted time-series replications," *Safety Science*, vol. 32, no. 1, pp. 1–18, 1999.

[61] B. Sulzer-Azaroff and J. Austin, "Does BBS work? Behaviour-based safety and injury reduction: a survey of the evidence," *Professional Safety*, vol. 45, no. 7, pp. 19–24, 2000.

[62] S. Tuncel, H. Lotlikar, S. Salem, and N. Daraiseh, "Effectiveness of behaviour based safety interventions to reduce accidents and injuries in workplaces: critical appraisal and meta-analysis," *Theoretical Issues in Ergonomics Science*, vol. 7, no. 3, pp. 191–209, 2006.

[63] Health and Safety Authority (HSA), "Behaviour based safety guide," HSA 0392, 2013, http://www.hsa.ie/eng/Publications_and_Forms/Publications/Safety_and_Health_Management/behaviour_based_safety_guide.pdf.

[64] H. C. Lingard, T. Cooke, and N. Blismas, "Designing for construction workers' occupational health and safety: a case study

of socio-material complexity," *Construction Management and Economics*, vol. 30, no. 5, pp. 367–382, 2012.

[65] E. S. Geller, "Psychological science and safety: large-scale success at preventing occupational injuries and fatalities," *Current Directions in Psychological Science*, vol. 20, no. 2, pp. 109–114, 2011.

[66] P. Kines, L. P. S. Andersen, S. Spangenberg, K. L. Mikkelsen, J. Dyreborg, and D. Zohar, "Improving construction site safety through leader-based verbal safety communication," *Journal of Safety Research*, vol. 41, no. 5, pp. 399–406, 2010.

[67] F. W. Guldenmund, *Understanding and exploring safety culture [Ph.D. thesis]*, Uitgeverij Boxpress, Oisterwijk, The Netherlands, 2010.

[68] A. R. Hale, F. W. Guldenmund, P. L. C. H. van Loenhout, and J. I. H. Oh, "Evaluating safety management and culture interventions to improve safety: effective intervention strategies," *Safety Science*, vol. 48, no. 8, pp. 1026–1035, 2010.

[69] K. J. Nielsen, "Improving safety culture through the health and safety organization: a case study," *Journal of Safety Research*, vol. 48, pp. 7–17, 2014.

[70] P. Kines, *Improving Construction Site Safety through Safety Communication of Foremen*, EU-OSHA European Agency for Safety and Health at Work, 2012, https://osha.europa.eu/en/tools-and-publications/publications/improving-construction-site-safety-through-safety-communication-of-foremen.

[71] B. F. Oldenburg and A. M. Brodie, "Trends and challenges in intervention research methods," in *Handbook of Injury and Violence Prevention*, L. S. Doll, S. E. Bonzo, D. A. Sleet and, and J. A. Mercy, Eds., pp. 359–380, 2007.

[72] R. A. Haslam, S. A. Hide, A. G. F. Gibb et al., "Contributing factors in construction accidents," *Applied Ergonomics*, vol. 36, no. 4, pp. 401–415, 2005.

[73] J. Dyreborg, ""Safety matters have become too important for management to leave it up to the workers"—The Nordic OSH model between implicit and explicit frameworks," *Nordic Journal of Working Life Studies*, vol. 1, no. 1, pp. 135–160, 2011.

[74] M. Fleming and R. Lardner, "Promoting best practice in behaviour-based safety," *IChemE Symposium Series*, no. 148, pp. 473–486, 2001.

[75] F. A. Zulkefli, N. Md Ulang, and F. Baharum, "Construction health and safety: effectiveness of safety incentive programme," *SHS Web of Conferences*, vol. 11, Article ID 01012, 6 pages, 2014.

[76] K. Glanz and D. B. Bishop, "The role of behavioral science theory in development and implementation of public health interventions," *Annual Review of Public Health*, vol. 31, no. 1, pp. 399–418, 2010.

[77] C. S. Fabrizio, M. van Liere, and G. Pelto, "Identifying determinants of effective complementary feeding behaviour change interventions in developing countries," *Maternal and Child Nutrition*, vol. 10, no. 4, pp. 575–592, 2014.

[78] R. Finkelstein, "Safety misinformation and misknowledge: the outcome of a free market model," in *Health Communication and Change and HIV/AIDS Working Groups. Abstracts Accepted for Presentation at IAMCR 2015 in Montreal, Canada*, ID 9256, 2015.

[79] R. E. Glasgow and L. A. Linnan, "Evaluation of theory-based interventions," in *Health Behaviour and Health Education: Theory, Research, and Practice*, K. Glanz, B. K. Rimer, and K. Viswanath, Eds., Theory, Research, and Practice (Google eBook), pp. 487–508, Jossey-Bass, San Francisco, Calif, USA, 4th edition, 2008.

[80] United States Agency for International Development (USAID), "Strengthening behaviour change communication for prevention," Technical Brief under the Leader with Associates Cooperative Agreement GPO-A-00-05-00024-00, 2012.

[81] J. F. Sallis, N. Owen, and E. B. Fisher, "Ecological models of health behaviour," in *Health Behaviour and Health Education: Theory, Research, and Practice*, K. Glanz, B. K. Rimer, and K. Viswanath, Eds., Theory, Research, and Practice (Google eBook), pp. 465–485, Jossey-Bass, San Francisco, Calif, USA, 4th edition, 2008.

[82] K. R. McLeroy, D. Bibeau, A. Steckler, and K. Glanz, "An ecological perspective on health promotion programs," *Health Education & Behavior*, vol. 15, no. 4, pp. 351–377, 1988.

[83] National Cancer Institute, *Theory at a Glance: A Guide for Health Promotion and Practice*, US Department of Health and Human Services, National Institutes of Health, Bethesda, Md, USA, 2nd edition, 2003.

[84] Infant & Young Child Nutrition (IYCN), *IYCN Social and Behaviour Change Communication Approach*, USAID's Infant & Young Child Nutrition Project, 2011, http://www.iycn.org/.

[85] A. C. Gielen, E. M. Mcdonald, T. L. Gary, and L. R. Bone, "Using the precede-proceed model to apply health behaviour theories," in *Health Behaviour and Health Education: Theory, Research, and Practice*, K. Glanz, B. K. Rimer, and K. Viswanath, Eds., Theory, Research, and Practice (Google eBook), pp. 406–433, Jossey-Bass, San Francisco, Calif, USA, 4th edition, 2008.

[86] Victorian Curriculum and Assessment Authority (VCAA), *Social Ecological Model*, VCE Physical Education (2011–2014), Unit 3, 2010.

[87] K. Callahan-Myrick, *Assessing the social and ecological factors that influence childhood overweight and obesity [Ph.D. thesis]*, Faculty of the College of Public Health, East Tennessee State University, 2014.

[88] K. Glanz, "Social and behavioural theories," Behavioural & Social Science Research, e-Source, 2010.

[89] J.-L. D. Langille and W. M. Rodgers, "Exploring the influence of a social ecological model on school-based physical activity," *Health Education and Behavior*, vol. 37, no. 6, pp. 879–894, 2010.

[90] J. P. Elder, L. Lytle, J. F. Sallis et al., "A description of the social-ecological framework used in the trial of activity for adolescent girls (TAAG)," *Health Education Research*, vol. 22, no. 2, pp. 155–165, 2007.

[91] Y. Khosravi, H. Asilian-Mahabadi, E. Hajizadeh, N. Hassanzadeh-Rangi, and A. H. Behzadan, "Structural modeling of safety performance in construction industry," *Iranian Journal of Public Health*, vol. 43, no. 8, pp. 1099–1106, 2014.

[92] J. R. Finnegan Jr. and K. Viswanath, "Communication theory and health behaviour change: the media studies framework," in *Health Behaviour and Health Education: Theory, Research, and Practice*, K. Glanz, B. K. Rimer, and K. Viswanath, Eds., Theory, Research, and Practice (Google eBook), pp. 363–387, Jossey-Bass, San Francisco, Calif, USA, 4th edition, 2008.

[93] S. Brandrick, *HSE Construction Division Communications Strategy*, Construction Industry Advisory Committee (CONIAC), Health and Safety Executive, 2011.

[94] The Manoff Group, "Defining social and behaviour change communication (SBCC) and other essential health communication terms," Technical Brief, 2012, http://www.manoffgroup.com/documents/DefiningSBCC.pdf.

[95] P. C. Liao, L. X. Jiang, B. S. Liu et al., "A cognitive perspective on the safety communication factors that affect worker behavior,"

*Journal of Building Construction and Planning Research*, vol. 2, no. 3, pp. 183–197, 2014.

[96] L. B. Hammer, D. M. Truxillo, T. Bodner, J. Rineer, A. C. Pytlovany, and A. Richman, "Effects of a workplace intervention targeting psychosocial risk factors on safety and health outcomes," *BioMed Research International*, vol. 2015, Article ID 836967, 12 pages, 2015.

[97] A. Dainty, D. Moore, and M. Murray, *Communication in Construction: Theory and Practice*, Taylor & Francis, London, UK, 2006.

[98] V. H. Perumal and A. H. Abu Bakar, "The needs for standardisation of documents towards an efficient communication in the construction industry," *World Applied Science Journal*, vol. 13, no. 9, pp. 1988–1995, 2011.

[99] R. M. Salem, J. Bernstein, and T. M. Sullivan, "Tools for behaviour change communication," INFO Reports of Centre for Communication Programmes no. 16, Johns Hopkins Bloomberg School of Public Health, 2008, https://www.k4health.org/sites/default/files/BCCTools.pdf.

[100] Y. S. Aidoo, *Internal communication strategies in the construction industry: a case study of African Concrete Products (ACP) Limited [Commonwealth Executive Master of Business Administration Degree thesis]*, Institute of Distance Learning, Kwame Nkrumah University of Science and Technology, 2012.

[101] S. Lamstein, T. Stillman, P. Koniz-Booher et al., *Evidence of Effective Approaches to Social and Behaviour Change Communication for Preventing and Reducing Stunting and Anemia: Report from a Systematic Literature Review*, USAID/ Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) Project, Arlington, Va, USA, 2014.

[102] The World Congress on Communication for Development (WCCD), *Communication for Development: A Major Pillar for Development and Change*, Final Version, The Rome Consensus, 2007, http://siteresources.worldbank.org/EXTDEVCOMMENG/Resources/RomeConsensus07.pdf.

[103] L. Raftree and K. Bachan, *Integrating Information and Communication Technologies into Communication for Development Strategies to Support and Empower Marginalised Adolescent Girls*, C4D Section Programme Division, United Nations Children's Fund (UNICEF), 2013, https://www.unicef.org/cbsc/files/ICTPaper_Web.pdf.

[104] UNICEF, "C4D realising strategic shifts and accelerating results for children: policy and practice," Position Paper, UNICEF, New York, NY, USA, 2009, http://www.unicef.org/cbsc/files/C4D-Position-Paper.doc.

[105] UNICEF, *What are the Social Ecological Model (SEM), Communication for Development (C4D)? A Global Communication Strategy Development Guide for Maternal, Newborn, and Child Health Programmes, Communication for Development Section, MODULE 1*, 2013, http://www.unicefiec.org/documents/download/3634.