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Assessment of Human Environment Interactions on Health and Safety Behaviour of Construction Workers

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Abstract Construction worksite health and safety in Nigeria has remained a source of concern despite several efforts to addressing the issues. This study therefore examined the perceived level of influence of components of human environment on the construction workers' health and safety behaviour, based on social ecological and social cognitive theories. Data collected through questionnaires and distributed to the construction workers were statistically analysed. The Mean Score Index and standard deviation, and ANOVA of the weighted responses were computed to ascertain the level and significance of influence of components of human environment on the health and safety behaviour of construction workers. On the average, it was found that the perceived level of influence of components of human environment on the health and safety behaviour of construction workers was very high and significant. Individually, Organisational norms (4.8652), National, state and local laws (4.8539), Ethos (4.7266), Work environment (4.6742) and Culture characteristics (4.6067) were found to be the five most influential human environment variables that affect health and safety behaviours of construction workers, while public policy components (4.4095) exert the greatest influence on health and safety behaviours of construction workers when the variables are grouped. This implies that work environment as part of organisation psychology is indispensable in shaping the behavioural pattern of construction workers. Thus, to improve construction workplace health and safety, workers' human environment and personal attributes need to be assessed before engagement.

Keywords Construction Workers, Health and Safety Behaviour, Human Environment Interaction, Social Cognitive Theory, Social Ecological Model

1. Introduction

The construction work environment has been recognised as one of the most hazardous workplaces due to the unique nature of construction products, and complexity of its process in addition to the gamut of network of people working in it. Mohd Saidin et al [1] agree that the construction industry is unique and that construction activities are performed at outdoor under conditions not conducive for safety and health of workers. As a whole, the construction work environment is complex, dynamic and challenging, it comprises a diverse mix of races, socio-economic groups and cultures interfacing and interrelating at all times, which make it to be accident prone. When compared with other labour intensive industries, construction industry has historically experienced a disproportionately high rate of disability injuries and fatalities for its size [2]. The interaction of components of human environment with construction workplace makes the industry more complex. The physical and social environments at which the industry operates are highly unpredictable. Also, Okoye and Okolie [3] observe that workers at construction sites have to face constant changes in the nature of work, work environment, and work with new workers and new technology.

Nonetheless, Huang and Hinze [4] contend that though dramatic improvements have been taken place in recent decades, the safety record in the construction industry continues to be one of the poorest, thereby supporting Alkilani, Jupp and Sawhney's [5] view that the current safety condition in the industry hinders any performance improvement. A closer look also reveals that the construction industry is lagging behind most other industries in terms of safety improvement [6]. Thus, it represents a significant social and economic burden on individuals, employers, and society [7].

The fact that globally, health and safety issues in the industry account for more than 100,000 fatalities annually, which equates approximately to about 30-40% of the world's work related fatal injuries [8, 9] is worrisome. Occupational Safety & Health Administration (OSHA) [10] also reports that every day more than 12 workers die on the job (more than 4,500 a year), and every year, more than 4.1 million workers suffer a serious work-related injury or illness.

Recent study [11] in the Great Britain, shows that annually between 2011/12 and 2014/15 about 69,0000 (3.1%) of workers in the construction sector suffer from an illness that they believe was caused or made worse by their work in the sector. Between 2012/13 and 2014/15 annually, about 65,000 (3%) construction workers also sustained an injury at work. The study also stated that about a quarter of these cases resulted in absence from work of over 7-days and there were about 35 fatal injuries to workers in the construction sector in 2014/15, which was about 20% lower than the five year average for 2010/11-2014/15. This brings the total number of fatal injuries to workers in the sector over the last five years to 217. It [11] further reveals that worker fatal injury rate in the construction sector (1.62 per 100,000 workers) is over 3.5 times the average rate across all industries (0.46 per 100,000 workers). Accordingly, these resulted in the loss of about 1.7 million working days. However, another study [12] reveals that there has been a downward trend in the rate of fatal injury over the last 20-year; and more recently (i.e. since 2008/09), but the trend is less clear.

In the Sub-Saharan Africa, the situation is not better either. For example, Smallwood et al [13] report that construction health and safety is not improving commensurately with the efforts of the industry stakeholders. Smallwood et al [13] supported their claim with the construction health and safety statistics provided by the Department of Labour (DoL) covering the period 2004/05 to 2007/08 in South Africa.

Back home in Nigeria, the situation is even alarming. Unavailability of official and reliable accident data and records on construction site makes the situation more pitiable. According to Hämäläinen et al [14] the annual work-related death rate of Nigeria based on the data available in 2003 stood at about 24 fatalities per 100,000 employees. Relying on the report of the Federal Ministry of Labour and Productivity Inspectorate Division (now the Federal Ministry of Labour and Employment) between 2002 and 2012, Umeokafor et al [15] observe that work-related fatalities are on the increase in Nigeria. Similarly, survey conducted by Abdulahi et al [16] on the artisans working condition in the Nigerian construction industry in some states in northern Nigeria claim that about 76.40% of the artisans have been involved in one form of accidents or the other on construction sites. Even though the reports above are grossly underreported and inaccurate, the available data indicate that construction environment is not safe due to a multiple of factors.

The above conditions have been linked to the fact that most current safety practices in the construction sector are based on the normative approach (i.e. compliance with prescribed safety rules) [17]. They focus on measures to control hazards, and means to control workers' behaviours so that they comply with prescribed safe practices. Notwithstanding the efficacy of these approaches and safety management systems (SMS) in the reduction of incidence of occupational accidents, they still occur. Thus, Talabi et al [18] suggest that the methods mostly address aspects of safety that are not behaviour-related and as a result limited their effectiveness. Also, Fleming and Scott concur that these approaches have been very successful as regards improvements in workplace health and safety but only through improved hardware and design, and through improved safety management systems and procedures.

Conversely, while the improvements achieved from the above approaches can be acknowledged in terms of low accident rates in the majority of safety critical industries, it does appear that they have reached a plateau and cannot provide further improvement [19]. From the above position, it can be argued that the reason appears to be that these approaches are retrospective, while neglecting the important factors that shape the behavioural pattern of workers. Therefore, Allegrante et al [20] affirm that such a reductionist perspective overlooks the importance of the psychological, environmental, and socio-cultural conditions as contributing factors to injury and its consequences, though injury prevention often is conceptualised as a biomedical construct.

The above arguments are further rooted in the premise that accidents were previously seen from a technical, legal or human factors perspective, but in recent years, cultural and organisational factors have become important additional perspectives included in safety intervention programmes in the workplace [21]. More still, Safe Work Australia [22] has raised concern about the effectiveness of many of the strategies used on a regular basis by work health and safety regulators, (such as introducing regulations, conducting inspections, imposing penalties for non-compliance and running industry campaigns) in achieving the desired policy outcome of reducing work related deaths, injuries and disease. On the same ground, Mitropoulos et al [17] and Farooqui [23] contend that the traditional application of normative approach of health and safety intervention ignores how the characteristics of the individual, team and production system processes influence the work behaviours and affect the possibility of errors and accidents, despite aiming at creating safe work behaviours. They [17,23] agree that it does not account for the production and economic pressures for efficiency, and added that the normative approach does not account for the factors that shape the work environment such as individual commitments, cultural norms, attitudes and perceptions of an individual and group. Accordingly, these factors generate the environment the workers work in, and the crew's ability to continuously and consistently perform safely [17,23].

On the contrary, Agwu [24] argues that despite recent advancements in construction safety management such as the move towards safety culture and behaviour-based safety that have proven to generate better results; these approaches also fail to acknowledge safety as an integral or total process encompassing multiple dimensions, (i.e. person, culture, behaviour and process), which cumulatively determine the true safety performance of a construction company. Thus, Guo and Yiu [25] conclude that it is inappropriate, and even

dangerous, to use safety performance indicators that are selected based on the normative safety management system (SMS) approach as an evaluative tool to identify safety problems, offer solutions and measure safety performance; because managing safety in a proactive manner requires foresights, rather than hindsight. To this effect, Agwu [24] acknowledges that the challenge for researchers and practitioners is to develop total safety systems that are simultaneously highly productive and highly reliable and can function effectively in the dynamic, complex, and competitive conditions that construction projects face.

Therefore it seems likely that the most effective way to reduce workplace injury and accident rates, and further improve hazard management is to address the social and organisational factors that have impacts on safety [26]. The recognition of the importance of organisational and social factors in improving workplace safety is demonstrated by the increased efforts to improve safety leadership, safety culture/climate, and employee safety behaviours [19], and this has formed the thrust of the current study.

1.1. Aim and Objectives of the Study

This study is aimed at examining the workers' perception on the influence of components of human environment interaction on the behavioural pattern of construction workers at site based on the social ecological and social cognitive theories. This aim would be achieved through; the following objectives:

1. Determining the level of influence of components of human environment interaction on workers' health and safety behaviour;
2. Ascertaining the proportion of each component in influencing the health and safety behaviour of workers; and
3. Establishing the significance of the influence of components of human environment on workers' health and safety behaviour based on their perception.

2. Review of Literature

Generally, every human activity is rooted in and can be explain by one theory or the other. Glanz [27] affirms that theories and models help explain behaviour, as well as suggest how to develop more effective ways to influence and change behaviour. Specifically, Glanz [27] is of the view that theories can guide the search to: Understand why people do or do not practice sustainable promoting behaviours; help identify what information is needed to design an effective intervention strategy; and provide insight into how to design an action plan so it is successful.

2.1. The Social Ecological Framework Constructs

The social ecological model (SEM) is defined as a graphic depiction of ecological theory in a given health behaviour or outcome [28]. The model provides a useful framework for achieving a better understanding of the many factors and barriers that impact health behaviours and outcomes. This is because many social, cultural, and economic factors contribute to the development, maintenance, and change of health behaviour patterns [27] and in this case, the health and safety behaviour of construction workers. Furthermore, the social ecological model helps to direct attention to broader political and environmental factors that shape individual and interpersonal characteristics of a person [29]. It is in this regard that Victorian Curriculum and Assessment Authority (VCAA) [30] recognises different versions of the social ecological model, which use slightly different classifications of environmental factors. Elder et al [31] even claim that the components of the social ecological model will remain the same and can be used in a range of populations, but specific examples within each component will vary depending on the population group. For example, Bronfenbrenner's [32] work saw the influences on behaviour as a series of layers, where each layer had a resulting impact on the next level. Using Russian dolls, Bronfenbrenner [32] represented the individual level in the innermost core surrounded by differing levels of environmental influences.

In this regard, human behaviour is difficult to change, especially in an environment that does not support change like construction. In order to increase or improve the health and safety performance of construction workers, Okoye [33] avows that efforts need to be focused not only on the behaviour choices of each individual but also on factors that influence those choices. However, educating people to make healthy choices when environments are not supportive will not be effective in making behavioural change, because, World Health Organisation (WHO) [34] reports that health behaviours, including physical activity participation, are thought to be improved when environments and policies support healthy choices. But VCAA [30] contends that it takes a combination of both individual level and environmental/policy level interventions to achieve substantial changes in health behaviours.

Thus, ecological and social ecological models of human behaviour have evolved over a number of decades in the fields of sociology, psychology, education and health and focus on the nature of human interaction with the environments [30]. The major proponents of social ecological theory according to Glanz et al [35] include; UrieBronfenbrenner's Ecological Systems Theory [36], that focuses on the relationship between the individual and the environment; Kenneth McLeroy's Ecological Model of Health Behaviours [37], that classifies five different levels of influence on health behaviour, excluding the physical environment, which is an essential component of a social-ecological model of physical activity; and Daniel Stokols's Social Ecology Model of Health Promotion [38-40], that identifies core assumptions which underpin the social-ecological model.

The social ecological model is helpful in understanding factors affecting behaviour and also providing guidance for developing successful programs through social

environments [27,41]. Furthermore, the model emphasises multiple levels of influence (such as individual, interpersonal, organisational, community, and public policy) and the idea that behaviours both shape and are shaped by the social environment [37,42]. However, it is worthy to note that the underlying principles of social ecological models are consistent with Social Cognitive Theory concepts [43-45], which suggest that creating an environment conducive to change is important to facilitate adoption of healthy behaviours [27].

Meanwhile, the social ecological paradigm is rooted in four core principles and concerns the interrelations among environmental conditions and human behaviour and wellbeing [30,39,46]. The principles are as follows.

Multiple factors influence behaviours: This means that there are multiple factors influencing the health behaviours, at the intrapersonal, interpersonal, organisational, community, and public policy levels [46]. This suggests that efforts to change human behaviour should be targeted at understanding of the interrelationship between the various levels of the social ecology.

Environments are multidimensional and complex: Social or physical environments in which humans live and interact contain a variety of features or attributes, such as the size, temperature, facilities and safety [39]. Sallis et al [46] opine that influences on behaviours interact across these different levels. Environments can also be described in terms of their actual or perceived qualities. However the variable nature of environments has a direct implication on the health and safety behavioural pattern.

Human environment interactions can be described at varying levels of organisation: Human interactions with the environment can occur at individual, small group, organisational, community or population levels. The social ecological model does not just focus on the individual but includes multiple levels of human interaction with environments [30]. Ecological models therefore should be behaviour-specific; thereby identifying the most relevant potential influences at each level of interaction [47].

The interrelationships between people and their environment are dynamic: There is a reciprocal relationship between people and their environments. Thus, the social, physical and policy environments influence the behaviour of the individual, while at the same time behaviour of the individual, group or organisation also impact on the wellbeing of their environments. The environment can control or set limits to the behaviour that occurs within it and making a change in the environment can result in a modification of behaviour [38,48].

Based on the above scenario, Max et al [49] affirm that the social ecological model demonstrates that knowledge, values, and attitudes of individual as well as social influences are the result of behaviour, including people who are associated with it, the organisations to which they belong, and the communities in which they live. Hence, the model highlights the notion that individual knowledge is not sufficient for behaviour change, but increasing knowledge, training skills and creating a supportive environment are all important components of behaviour change [50].

In the context of construction health and safety, Okoye [33] argues that though rules, regulations and managements systems have their role to play in improving safety performance, on their own they are inadequate to bring about further major improvements in safety performance which are required in the construction industry. In this regard, Okoye [33] developed a social ecological model of safety performance improvement (SEM-SPI) framework and outlined four strategic steps through which safety behaviour can be influence. However, the study did not examine the perception of workers on how the components of human environment influence the safety behavioural patterns of construction workers. Thus, in an effort to fully explore the climate within which construction workers work; there is need to examine the influence of personal attributes, social and physical environmental on the behaviour of construction workers. Therefore, viewing the problem of health and safety on construction site through a social ecological perspective allows for understanding of the systems in which a construction worker makes health and safety behaviour choice.

Figure 1. Social Ecological Model [37]

The Social Ecological Model's five levels (figure 1) of behavioural influence can be used to determine primary influencing factors specific to construction worker health and safety behaviour. In this case, the influence of these factors is observed on the construction workers safety behaviours. For example, an individual's social environment of family, friends and workplace are embedded within the physical environment of geography and community facilities, which in turn embedded within the policy environment of different levels of government or governing bodies [31]. This is to say that all factors of social ecological model impact on the behaviour of the individual [39, 51]. The conceptual

model of social ecological theory is shown in figure 1 and represented as a series of overlapping circles, with each circle representing a different layer or component of the model.

This study is therefore adopting the McLeroy's five levels of SEM [37] which will be transformed to suit the context of the study. This is because the model is wide-ranging and can be apply in the construction industry scenery. In the context of this study, the components of human environment are conceptualised within the framework of social ecological model which are briefly discussed thus:

2.1.1. Individual (Intrapersonal) Components

This is first layer of the SEM. It represents the central core where all interactions are directed to. Lakhan and Ekúndayò [52] describe this as the central level of the social ecological model which encloses the individual. It involves the biological make-ups and personal attributes of a person that increase the likelihood of influencing the person's behaviour. This component can include knowledge, attitudes, and behaviours taking risks in addition to age, and gender [53]. Strategies that bring about behavioural change at the individual level tend to focus on changing the individual's knowledge, attitudes, behaviour and skills [51].

Allegrante et al [20] added that intrapersonal factors involve the characteristics of the individual, which include knowledge, skills, life experience, attitudes, and behaviours as they interface with the environment and society. Lakhan and Ekúndayò [52] are of the view that the person interacts with objects and people in their intimate and immediate world [52]. This is to say that at the personal level, individuals construct meaning and develop behaviours in relation to others and to larger collective ideals, shared symbols, and beliefs [54]. However, as the levels move away from the centre, they tend to become less of a direct influence on health behaviour and begin to have a more indirect influence [55].

2.1.2. Interpersonal Components

The interpersonal components include the immediate physical environment and social networks in which an individual lives and interacts. These include the family, friends, peers, local facilities and services, and colleagues and co-workers [20,52]. In this case, the system may include institutions, formal and informal bodies, religious institution (church, temple, mosque etc), school, club, office, work, union, informal support group, and volunteer organisation etc, with which the person is in close contact[51,52].

According to VCAA [30], the strategies which bring change at the social environment level and promote positive community attitudes include community education, support groups, peer programs, workplace incentives and social marketing campaigns. However, Fleury and Lee [56] support the current social ecological frameworks which recognise the multiple levels influence on human behaviour rather than the traditional approach that focus only on intrapersonal factors.

2.1.3. Organisational Components

Organisational components involve commercial organisations, social institutions, associations, clubs, and other structures that have rules and regulations enabling them to have direct influence over the physical and social environments maintained within their organisation [20]. Organisational influences on health behaviour include formal and informal organisations as well as social institutions [37]. However, they also include specific social structures and organisations that do not contain individual, but affects an individual's immediate environment and their micro system. Richards et al observe that people spend a majority of their lives in organisational settings such as education and occupation and these settings can have a strong impact on health related behaviours [57]. In view of this, McLeroy et al [37] state organisational characteristics such as the use of incentives, management and supervisor support changes in benefits, and changes in the structure of work may all be used to support behavioural changes.

2.1.4. Community Components

Within the context of human environment, a community can be defined in several viewpoints. It can be located within geographical or political boundaries and may share demographic, cultural, ethnic, religious, or social characteristics, with its members having a sense of identity and belonging, shared values, norms, communication and helping patterns [20]. Components of human environment interact and influence the health behaviour. Community factors involve collectives of people identified by common values and mutual concern for the development and well-being of their group or geographic area (villages, neighbourhoods) [58].

2.1.5. Public Policy Components

These are larger systems, often defined along political boundaries, possessing the means to distribute resources and control the lives and development of their constituent communities [20]. This system considers cumulative experiences on a person, what they experience over the course of their lifetime [52]. These experiences include environmental events, as well as major transitions in life. It involves formal and informal rules (local, state and national laws and regulations). Policies, rules and regulations, political parties in action impact the individual and their micro system [52].

Policy may include; urban planning policies, construction policies, active transport policies, health and safety policies, environmental policies, workplace policies and funding policies. However, Katzmarzyk et al [59] aver that aligning the policy with priorities together with strong political will increases the success rate of implementing any policy. Therefore, policy factors involve larger systems possessing the means to control several aspects of the lives and development of their constituent subsystems (provinces, states, countries) [52].

2.2. Application of the Social Ecological Model

Max et al [49] believe that one of the intensive ways to apply the social ecological approach is to expand partnership with other sectors. In applying social ecological theory to health and safety performance of construction workers therefore, it should be understood that behaviours are shaped through a complex interplay of determinants at different levels [33]. For example, safety behaviour activity is influenced by self-efficacy at the individual level, social support from family and friends at the interpersonal level, and perceptions of safety at the organisation and community levels, and relevant safety regulations at local, state and federal levels. Therefore, ecological models suggest that these multiple levels of influence interact across levels. For example, social support for welfare and health and safety facilities from co-workers and organisation may interact with the availability of such facilities at the worksite to lead to improve health and safety behaviour. The effectiveness of the social ecological model in solving the health and safety challenges in the construction work environment is relied on the fact that construction activities are embodiment of physical and human environment interactions. This is in line with the position of DiClemente et al [48] who posit that interactions are most effective when they target multiple levels to support behaviour change.

2.3. Application of the Social Cognitive Theory (SCT)

Social cognitive theory [43] explains psychological functioning in terms of triadic reciprocal causation. Conceptually, this means that social cognitive theory explains behaviour in terms of reciprocal causation among individuals, their environments, and their behaviours (see figure 2) [43,60,61].

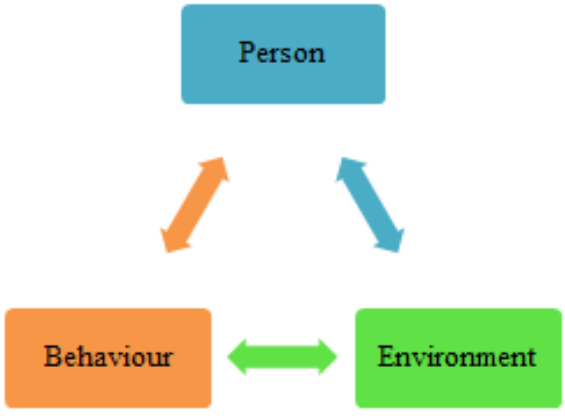

Figure 2. A Reciprocal Determinism of Behaviours, Cognition and Environment [43]

The social cognitive theory explains how people acquire and maintain certain behavioural patterns, while also providing the basis for intervention strategies [62]. It is proposed that our thoughts and actions originate in the social world but it is essential to note that human beings have capacity for self-regulation and engage in active cognitive processes [63]. Evaluating behavioural change then depends on these factors; environment, people and behaviour. Within the social cognitive perspective, social factors play an influential role in cognitive development and there are many motivators of the pursuit of competence [64].

Human behaviour has often been explained in terms of one-sided determinism [61]. In the causal model, behaviour, cognitive and other personal factors and environmental events all operate as interacting determinants that influence each other bi-directionally [43]. In such modes of unidirectional causation, behaviour is depicted as being shaped and controlled by environmental influences or driven by internal dispositions [61]. The three factors environment, people and behaviour are constantly influencing each other. Behaviour is not simply the result of the environment and the person, just as the environment is not simply the result of the person and behaviour [65].

Environment refers to the factors that can affect a person's behaviour. There are social and physical environments. Social environment include family members, friends and colleagues. Physical environment is the size of a room, the ambient temperature or worksite. Environment and situation provide the framework for understanding behaviour [66]. The situation refers to the cognitive or mental representations of the environment that may affect a person's behaviour. The situation is a person's perception of the lace, time, physical features and activity [65]. The triadic causal mechanism is mediated by symbolising capabilities that transform sensory experiences into cognitive models that guide actions. The human capacity for vicarious learning allows individuals to acquire rules for conduct without physically enacting the behaviour but rather, by observing others. Direct experience with enacting behaviour also affects these perceptions and that is called enactive learning. Individuals use their capacity for forethought to plan actions, set goals, and anticipate potential behavioural consequences. Through evaluations of personal experiences and self-assessments of their thought processes, they employ a self-reflective capability that helps them better understand themselves, their environments, and variations in situational demands [43,44].

There are also internal, self-reactive incentives resulting from comparisons of personal actions with standards for behaviour. The objective magnitude of incentives does not matter as much as perceptions of how incentives are contingent on a particular course of action. Humans also possess a self-regulatory capability that provides the basis for purposive action through the sub functions of self-monitoring, judgmental process, and self-reaction [43,65]. Self-monitoring is the observation of one's own actions to provide diagnostic information about the impact of behaviour on the self, others, and the environment [67]. The judgmental process compares self-observations of behaviour to personal standards, personal or social norms, and the

valuation of the activity, particularly when the locus of control for the behaviour resides in the individual. The self-reactive function supplies the behavioural incentive through the satisfaction derived from accomplishing an activity that meets desired standards. Dysfunctional forms of self-regulation may also affect behaviour. Addictions mark the failure of self-regulatory functions [61]. Self-slighting of one's accomplishments is another form of dysfunctional self-monitoring that reduces the self-reactive incentive to persist, and self-disparagement of one's capabilities can also inhibit performance [43].

Another important determinant of behaviour is self-efficacy, or belief in one's capability to organise and execute a particular course of action [62]. Those who perceive themselves to be highly efficacious with reference to a particular task will invest sufficient levels of effort to achieve successful outcomes, whereas those with low levels of self-efficacy will not persist. People are neither deterministically controlled by their environments nor entirely self-determining. Instead they exist in a state of reciprocal determinism with their environments whereby they and their environments influence one another in a perpetual dynamic interplay [68].

Key constructs of social cognitive theory that are relevant to health and safety behaviour change interventions include: Observational learning; Reinforcement; Self-control; and Self-efficacy [43,44]. Some elements of behaviour modification based on SCT constructs of self-control, reinforcement, and self-efficacy include goal-setting, self-monitoring and behavioural contracting. Goal-setting and self-monitoring seem to be particularly useful components of effective interventions. Self-efficacy, or a person's confidence in his or her ability to take action and to persist in that action despite obstacles or challenges, is especially important for influencing health and safety behaviour change efforts. The key Social Cognitive Theory construct of reciprocal determinism means that a person can be both an agent for change and a responder to change. Thus, changes in the environment, the examples of role models, and reinforcements can be used to promote safety behaviour towards the use of construction resources and prevent accidents on site because human competency requires not only skills, but also self-belief in one's capability to use those skills well [44].

In the case of construction practice, viewing from social cognitive perspective, interactions with the environment (the social environment, in this case) influence construction workers by continually reforming expectations about the likely outcomes of future construction practice (behaviour). Seemingly, this represents the same process that describes the relationship between the components of human environment and construction site health and safety practice. Recognising this parallel link, we next examine social cognitive theory as a source of further insight into the interrelationship between the components of human environment and construction site health and safety practices by seeking the opinion of workers. Applying social cognitive theory in the context of this study, expectations about the positive outcomes of construction site safety should be an increase in a particular behaviour change. Each type of incentive (i.e., sensory, monetary, social, status, activity, and self-reactive) may make unique contributions. Likewise, expected negative outcomes, such as accidents, injuries, delay, wastages and increase cost, etc., should discourage a particular unsafe behaviour through safety consciousness. Thus, SCT synthesises concepts and processes from cognitive, behaviouristic, and emotional models of behaviour change, so it can be readily applied to planning, use and management of construction resources and waste prevention as a preventive strategy for construction site accidents. A basic premise of SCT is that people learn not only through their own experiences, but also by observing the actions of others and the results of those actions [27].

2.4. Human-Environment Interaction

The importance of re-thinking the relationships between the humans and their environment have been adequately acknowledged [69,70]. Similarly, the influence of working environment, which is mostly composed of physical, social and psychological factors, has been extensively examined. In a number of studies [71-74], employees' motivation, job satisfaction, job involvement, job performance, and health have been found to be markedly influenced by psycho-social environment of work organisation.

To understand various aspects of this interaction it would be useful to understand various types of environment which we encounter. A brief description of major types of environment is given below [70].

2.4.1. Physical environment

It includes both physical reality and social-cultural phenomenon that surround us. The noise, the temperature, the quality of air and water, and various objects and things constitute the physical world around us.

2.4.2. The social and cultural environment

It includes the aspects of social interaction including its products such as beliefs, attitudes, stereotypes, etc. The material and non-material aspects of environment are included in it.

2.4.3. Psychological Environment

It includes the perceptions and experiences pertaining to any environmental setting. Some environments may be stimulating and exciting while others may be dull and boring. Expression of psychological is often used in the organisational context. Environment is a theme relevant to many other disciplines, such as geography architecture, urban planning, etc. It is indeed multidisciplinary in nature. It is labelled as Environmental Science.

The description above shows that human social systems

and ecosystems are complex adaptive systems [75]; because ecosystems and human social systems have many parts and many connections between these parts and they have feedback structures that promote survival in a constantly changing environment [76]. Therefore, human environment interaction is an overarching theme in the study of geography that concerns the many relationships, both positive and negative, between people and their surroundings. This examination includes how people depend on and modify the environment and how people adapt behaviourally and physically in response to the environment [76,77]. The study of human environment interaction focuses more on groups of people or cultures rather than on individuals. Therefore, human environment interaction looks at the interplay between human social systems and larger ecosystems [76,77].

In order to analyse human environmental interactions it is important to be aware of specific characteristics of the human social system. Impacts on ecosystems are of direct importance to human society, because ecosystems provide services that sustain and fulfil human life [78]. The ecosystem services form the vital links within the coupled human-environment system [79]. The type of society strongly influences peoples' attitude towards nature, their behaviour and therefore their impact on ecosystems. Important characteristics of human social systems are population size, social organisation, values, technology, wealth, education, knowledge and many more. Especially values and knowledge strongly influence peoples "view of life" and consequently define the way people act. The choice of possible actions is then limited by the available technology [76,77]. Thus, human environment interaction refers to the ways people change their environment and how the environment changes them. According to Lill [76] there is a never-ending process of mutual adjustment (adaptation) and change betweenhuman social systems and the environment. Consequently, the human-environment interaction is categorised into five major components. These components are briefly described below [70]:

Physical Environment: It includes aspect of natural environment such as climate, terrain, temperature, rainfall, flora, fauna, etc.

Social –Cultural Environment: It includes all aspects of cultural environment such as norms, customs, process of socialisation, etc. It includes all the aspects dealing with other people and their creations.

Environmental Orientations: It refers to the beliefs that people hold about their environment. For example, some people hold environment equivalent to God and therefore they perceive all its aspects with respect and reverence and try to maintain it in a perfect form and do not degrade it.

Environmental Behaviour: It refers to the use of environment by people in the course of social interactions. For example, considering the environment as personal space, where the individual identifies himself with it.

Products of Behaviour: These include the outcomes of people's actions such as homes, cities, dams, schools, etc. That is, these are products or outcomes dealing with the environment.

All the above aspects of environment depict the important constituents of the study of interaction between environment and the human beings [70].

3. Methodology

The study is a site-based survey research that made use of structured questionnaire administered randomly to the selected construction workers across some selected States in Nigeria. According to Sekaran [80], the questionnaire is an efficient data collection mechanism when the researcher knows exactly what is required and how to measure the variables of interest. The selection and distribution of the questionnaires followed the paths of earlier works of Okoye [33], but in this case, only site workers were considered. The questionnaire was divided and structured into two parts. Part 1 to 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 five (45) items of social ecological factors which are broadly grouped based on the five levels social ecological model and measuring the influence of components of human environment on the health and safety behaviours on construction worksite.

The respondents comprised site-based construction workers such as site managers/supervisions, craftsmen/skilled labourers and unskilled labourers. The respondents were asked to indicate the level of influence of the selected variables on the health and safety behaviour construction workers on a five point Likert-type scale, where 1 = very low, and 5 = very high.

Solimun [81] states that (a) size of sample recommended for multivariate analysis is in range of 100 to 200; (b) equal to 5 to 10 times of number of manifest variables (indicators) or the parameters in the model. Based on the research model developed, then the approach employed here is multivariate analysis, with 5 latent variables and 45 indicators. Thus, the sample size used in this study was 400 construction workers.

Ten states of Nigeria were selected with at least one from each of the six geo-political zones of the country. Parts of the consideration for the selection of state and site include; the state's infrastructural development statues; geographical location; the site location; and size. In each of the selected state, the researchers engaged a helper who accompanied them and helped in the administering and retrieving of the questionnaires. Written consent/permission was first sought and obtained from each of the site manager whose site was selected, while the objectives of the study were clearly explained to participants and they were made to know that participation was voluntary. The questionnaires were administered to 400 construction workers in the selected sites and states. Out of this, a total 267 questionnaires were

retrieved and used for analysis. This represents a response rate of 66.75% which is very good for this kind of study. Subsequently, the data generated through the questionnaire survey were subjected to descriptive and quantitative analysis using tables and computing Mean Score Index (MSI) and standard deviation.

However, the questionnaires contents were tested for their validity and reliability. A variable is said to be valid if it has a correlation coefficient (r) of ≥ 0.30, while a research instrument is said to be reliable if it has Cronbach Alpha coefficient (α) ≥ 0.60 to 0.95 [72,82-84]. Streiner [85] recommends a maximum alpha value of 0.90. According to Tavakol and Dennick [84], a low value of alpha could be due to a low number of questions, poor interrelatedness between items or heterogeneous constructs, while a very high alpha (> 0.90) may suggest that some items are redundant as they are testing the same question but in a different guise. However, a more feasible method for testing the consistency or reliability of questionnaires is the split-half method [84,86,87].The preferable statistic to calculate the split-half reliability is coefficient alpha (otherwise called Cronbach's alpha). Likewise the Pearson correlation coefficients of the variables are computed so as to determine the validity of the variables [78,84].

To establish if the components of human environment significantly influence the health and safety behaviours of construction workers, a one-way analysis of variance (ANOVA) was used to cast inference on the calculated mean scores and standard deviations based on the perceived opinions of workers. In this case, the test statistic has an F sampling distribution with df_1 and df_2 degrees of freedom and a significant level (α) of 0.05 (5%). Meanwhile, all the computation was made using SPSS 16.0.

Decision: Reject H_0 if $F_{calculated} > F_{critical}$ (df_1, df_2, α), otherwise accept H_0 and conclude.

4. Results

4.1. Hypothesis

H_0: The components of human environment do not significantly influence the health and safety behaviours of construction workers.

H_1: The components of human environment do significantly influence the health and safety behaviours of construction workers.

The result of table 1 shows that the correlation coefficient for all the variables in the questionnaire is > 0.3, so also the Cronbach's Alpha value is >0.6 for all the components. Thus, research instruments are valid and reliable, so they can be used as instrument for data collection. This also implies that in measurement model analysis both test of variable validity and test of construct reliability have been satisfied. It further implies the adequacy and suitability of the research instruments and its contents. This shows that the results therefore that can be obtained from these instruments can be relied upon to the level of its error margin.

Table 1. Results of validity and reliability testing of research instruments

Components of Human Environment (Variables)	Correlation Coefficient (r)	Validity	Cronbach's Alpha Coefficient (α) (Reliability)
Individual Components			0.766 (Reliable)
Knowledge	0.352	Valid	
Attitudes	0.330	Valid	
Age	0.465	Valid	
Gender	0.313	Valid	
Belief	0.521	Valid	
Perception	0.535	Valid	
Skills	0.457	Valid	
Level of education	0.509	Valid	
Socioeconomic status	0.383	Valid	
Self-efficacy	0.368	Valid	
Life experience	0.353	Valid	
Interpersonal Components			0.837 (Reliable)
Friends	0.598	Valid	
Support groups	0.538	Valid	
Peers	0.619	Valid	
Local facilities and services	0.506	Valid	
Colleagues and co-workers	0.686	Valid	
Religious institutions	0.403	Valid	
Unions	0.588	Valid	
Family	0.604	Valid	
Organisational Components			0.843 (Reliable)
Organisational norms	0.525	Valid	
Organisational structure and pattern	0.497	Valid	
Social institutions	0.696	Valid	
Commercial organisations	0.681	Valid	
Associations	0.672	Valid	
Clubs	0.616	Valid	
Social structure	0.602	Valid	
Ethos	0.435	Valid	
Work environment	0.360	Valid	
Community Components			0.879 (Reliable)
Demography	0.540	Valid	
Culture characteristics	0.665	Valid	
Ethnicity	0.626	Valid	
Religion	0.713	Valid	
Shared values and norms	0.748	Valid	
Communication pattern	0.668	Valid	
Community organisations	0.574	Valid	
Institutional attachment	0.602	Valid	
Neighbourhoods	0.593	Valid	
Community network	0.364	Valid	
Public Policy Components			0.836 (Reliable)
Formal and informal rules and regulations	0.682	Valid	
Government policies and programmes	0.602	Valid	
Political systems	0.620	Valid	
Government control and interference	0.638	Valid	
System of governance	0.648	Valid	
National, state and local laws	0.562	Valid	

Table 2. Perception on the level of influence of components of human environment on the health and safety behaviours of construction workers

Components of Human Environment	N	Mean Score	Standard Deviation	Group Mean	Group Ranking
Individual Components				4.3990	2
Knowledge	267	4.5169	0.61520		
Attitudes	267	4.4944	0.65103		
Age	267	4.4719	0.68425		
Gender	267	4.3895	0.59285		
Belief	267	4.3858	0.65828		
Perception	267	4.3895	0.62975		
Skills	267	4.5843	0.65135		
Level of education	267	4.3858	0.65828		
Socioeconomic status	267	4.2959	0.73481		
Self-efficacy	267	4.0337	0.81503		
Life experience	267	4.4419	0.63082		
Interpersonal Components				4.2374	4
Friends	267	4.2734	0.75354		
Support groups	267	4.1648	0.88587		
Peers	267	4.2772	0.77433		
Local facilities and services	267	4.0899	0.70402		
Colleagues and co-workers	267	4.1573	0.75939		
Religious institutions	267	4.4232	0.50996		
Unions	267	4.3596	0.79822		
Family	267	4.1536	0.80577		
Organisational Components				4.3408	3
Organisational norms	267	4.8652	0.34218		
Organisational structure and pattern	267	4.5318	0.60225		
Social institutions	267	4.1948	0.75062		
Commercial organisations	267	4.2097	0.73642		
Associations	267	4.3970	0.79452		
Clubs	267	3.5543	0.83162		
Social structure	267	3.9139	0.80183		
Ethos	267	4.7266	0.44655		
Work environment	267	4.6742	0.47751		
Community Components				4.1996	5
Demography	267	4.1910	0.87844		
Culture characteristics	267	4.6067	0.64804		
Ethnicity	267	3.6030	0.87126		
Religion	267	4.4794	0.65648		
Shared values and norms	267	4.3783	0.71186		
Communication pattern	267	4.2772	0.81224		
Community organisations	267	4.0375	0.75000		
Institutional attachment	267	4.1049	0.82958		
Neighbourhoods	267	3.8352	0.67931		
Community network	267	4.4831	0.50811		
Public Policy Components				4.4095	1
Formal and informal rules and regulations	267	4.5618	0.65960		
Government policies and programmes	267	4.3333	0.74927		
Political systems	267	4.3371	0.71415		
Government control and interference	267	4.2472	0.82189		
System of governance	267	4.1236	0.80160		
National, state and local laws	267	4.8539	0.39405		

Table 2 shows the perceived level of influence of components of human environment on the health and safety behaviours of construction workers on worksite based on the average mean score index. It shows that all the identified components based on the social ecological model have a very high influence on the health and safety behaviours of workers on site. When considered individually irrespective of the variables grouping, Organisational norms (4.8652), National, state and local laws (4.8539), Ethos (4.7266), Work environment (4.6742) and Culture characteristics (4.6067) are the five most influential human environment variables on the health and safety behaviours of construction workers respectively. However, in the major component grouping, the average means score index ranges from 4.1996 for community components to 4.4095 for public policy components respectively. From the table 2 also, it shows that individually, all the components have very high influence on the health and safety behaviours of construction workers based on the mean score values of the workers' perception. By implication, it means that the components of human environment influence to a greater extent the pattern of health and safety behaviours of construction workers on site.

However, it is not enough to conclude that the components of human environment influence the health and safety behaviours of construction workers on site. There is need to determine the significance of the influence of components of human environment on construction workers health and safety behaviours based on the mean scores and standard deviations.. The results of these are presented in tables 3-7.

Table 3 shows the result of the ANOVA for influence of the individual components of human environment on construction workers health and safety behaviours. It shows that F calculated (16.214) is greater than the critical value (2.557). Thus, since F cal. (16.214) > critical value (2.557), and p (0.00001920) < α (0.05), H_0 is rejected. This implies that the individual components of human environment significantly influence the health and safety behaviours of construction workers.

Table 4 shows the result of the ANOVA for influence of the interpersonal components of human environment on construction workers health and safety behaviours. It shows that F calculated (10.178) is greater than the critical value (3.247). Thus, since F cal. (10.178) > critical value (3.247), and p (0.00161336) < α (0.05), H_0 is rejected. This implies that the interpersonal components of human environment significantly influence the health and safety behaviours of construction workers.

Table 3. ANOVA for influence of individual components on construction workers health and safety behaviours

ANOVA						
Sources		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**
Between People		390.681	266	1.469	16.214	.00001920
Within People	Between Items	55.823	10	5.582		
	Residual	915.813	2660	.344		
	Total	971.636	2670	.364		
Total		1362.317	2936	.464		
Grand Mean = 4.3990						

Table 4. ANOVA for influence of interpersonal components on construction workers health and safety behaviours

ANOVA						
Sources		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**
Between People		568.284	266	2.136	10.178	.00161336
Within People	Between Items	24.779	7	3.540		
	Residual	647.596	1862	.348		
	Total	672.375	1869	.360		
Total		1240.659	2135	.581		
Grand Mean = 4.2374						

Table 5. ANOVA for influence of organisational components on construction workers health and safety behaviours

ANOVA						
Sources		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**
Between People		469.865	266	1.766	170.644	.00000001
Within People	Between Items	377.521	8	47.190		
	Residual	588.479	2128	.277		
	Total	966.000	2136	.452		
Total		1435.865	2402	.598		
Grand Mean = 4.3408						

Table 6. ANOVA for influence of community components on construction workers health and safety behaviours

ANOVA						
Sources		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**
Between People		702.700	266	2.642	82.274	.00000004
Within People	Between Items	236.682	9	26.298		
	Residual	765.218	2394	.320		
	Total	1001.900	2403	.417		
Total		1704.600	2669	.639		
Grand Mean = 4.1996						

Table 7. ANOVA for influence of public policy components on construction workers health and safety behaviours

ANOVA						
Sources		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig**
Between People		435.709	266	1.638	67.623	.00007807
Within People	Between Items	90.739	5	18.148		
	Residual	356.928	1330	.268		
	Total	447.667	1335	.335		
Total		883.376	1601	.552		
Grand Mean = 4.4095						

Table 5 shows the result of the ANOVA for influence of the organisational components of human environment on construction workers health and safety behaviours. It shows that F calculated (170.644) is greater than the critical value (2.945). Thus, since F cal. (170.644) > critical value (2.945), and p (0. 00000001) < α (0.05), H_0 is rejected. This implies that the organisational components of human environment significantly influence the health and safety behaviours of construction workers.

Table 6 shows the result of the ANOVA for influence of the community components of human environment on construction workers health and safety behaviours. It shows that F calculated (82.274) is greater than the critical value (2.725). Thus, since F cal. (82.274) > critical value (2.725), and p (0. 00000004) < α (0.05), H_0 is rejected. This implies that the community components of human environment significantly influence the health and safety behaviours of construction workers.

Table 7 shows the result of the ANOVA for influence of the public policy components of human environment on construction workers health and safety behaviours. It shows that F calculated (67.623) is greater than the critical value (4.380). Thus, since F cal. (67.623) > critical value (4.380), and p (0. 00007807) < α (0.05), H_0 is rejected. This implies that the public policy components of human environment significantly influence the health and safety behaviours of construction workers.

5. Discussion

The results of this study indicate that components of human environment significantly influence the health and safety behaviours of construction workers. Although all identified components are very influential in shaping the health and safety behaviours of construction workers in the construction work environment (for instance, the workers belief, state of mind, co-workers, organisational policy, rules and regulations, culture, etc), the result of the average mean score indicates that public policy components are the most

influential components, followed by the individual components and the organisational components. This might be as a result of the high powers of the government in issues relating to laws, rules, regulations and policies and programmes. The ability of the person's personal characters also manifested itself together with the organisation's position in issues relating to workers' health and safety behaviours. That is to say that issues bordering on personality, the prevailing laws and work environment shape ones behavioural pattern and this is reflected on the way construction workers behave while working at site.

The result further implies that workers psychology of safety is greatly influence by their personal characteristics and the surrounding environment. This study has established that social factors acting in triadic perspectives have a commanding influence on the pattern of construction workers. The fact that the components of human environment have influence on the health and safety behaviours of construction workers requires that such components need to be considered and evaluated before a worker is engaged to work at site so as to prevent accidents which might occur as a result of unsafe acts which invariability could undermine the success of the project.

Based on this, the study averred that both individual personality characteristics and objectives and subjective features of the individual's behaviour are indispensible elements of health and safety indices and how individual behaviours affect their safety performance. From the content of this study, this study is rooted in the social ecological theory which holds that both person and environment factors shape individual behaviours. It is also in tandem with the social cognitive theory which explains how people acquire and maintain certain behavioural patterns, while also providing basis for intervention strategies [43-45]. More interestingly, this study aligned with other studies [41,88-90] which believed that theory-based health behaviour change programmes are more effective than those that do not use theory, and should be considered when designing health and safety interventions.

6. Conclusions

Efforts have been made over the years to improve the health and safety image of construction industry without significant improvement to stem down the rate of accidents on sites. Earlier study had suggested that improving the health and safety performance of construction workplace requires a multi-level approach [33]. Thus, this study has examined the interaction of human environment in the shaping of the health and safety behaviours of construction workers in Nigeria with a view to establishing the importance and influence of the components of human environment on the behavioural patterns of construction workers.

The study established that the components of human environment significantly influence the health and safety behaviours of construction workers. The study believed that with the combination of components of human environment, which connect individual and environment, construction work environment would be safe and devoid of serious dangers. This is because personality characteristics and surrounding environment hold great influence on person's behavioural pattern.

Undoubtedly, finding of this study has highlighted a number of theoretical and practical implications for social ecological and social cognitive theories and practice. It has also widened the scope of application of these frameworks to construction industry. This means that it has added a new dimension to the application of social ecological theory in combination with social cognitive theory. It has demonstrated the powers of salient components of the environment such as culture, beliefs, perceptions, peer groups, religious, social characteristics, sense of identity and belonging, social structures, policies, abilities, disabilities or injuries, age, sex, level of education, socioeconomic status, employment status and self-efficacy in changing the health and safety behaviours of construction workers.

Generally, it is perceived that behaviour change towards safety on construction site would be achieved through the interplay between the physical and human environments. Thus, it is the workers view that improving knowledge and perceptions of construction workers on health and safety and accident on construction site would influence the behaviour of workers. To improve the health and safety of construction workplace, workers personal, social and ecological attributes need to be evaluated before engagement. Having seen the influencing powers of personal character and socio-ecological factors in modelling the behaviour of an individual, minimisation or prevention of construction site accidents cannot be separately tackled, but requires a systematic action from the policy makers; construction organisations and community groups.

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