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FACTORS AFFECTING HAZARD RECOGNITION IN CONSTRUCTION SITE OPERATIONS IN NIGERIA

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Abstract

Identifying hazards is necessary for preventing accidents in construction site operations. In light of this assertion, construction professionals must recognise hazards in site operation. However, recognising hazards remains an issue of concern in the construction industry. Invariably, it is expedient that factors affecting hazard recognition be investigated. The study, therefore, aims to examine the factors affecting hazard recognition in construction site operations and test this hypothesis: 'there is no significant difference in factors affecting hazard recognition among construction professionals based on their work experience'. Adopting a quantitative research design and cross-sectional research strategy, a questionnaire with 13 factors adapted from literature was used to elicit information from construction professionals. From the median calculated, the factor with the highest value was "multiple hazards associated with a single source of the task". Furthermore, the study discovered a significant difference in six of the thirteen factors affecting hazard recognition. Because of this, it was concluded that the experience of construction professionals affects their perception of the factors affecting hazard recognition for the six factors. All these issues taken into account, safety experts in construction industry responsible for health and safety training should consider the experiences of construction professionals when developing curriculum on hazard recognition.

1.0 INTRODUCTION

The issue of occupational hazard is quite important, especially in the construction industry. Recognising a situation or circumstance that will lead to potential harm is significant in minimizing accidents in construction operations [1]. However, previous studies reported hazard identification levels to be lower than ideal [2] while significant hazards are usually not recognise leading to sub-optimal hazard awareness level [3]. Over 75% miss was recorded for biological, radiation, chemical and temperature hazards during hazard identification exercise at the pre-intervention phase [1]. At the post-intervention phase, a significant proportion of hazards remain unrecognized [1]. Workers with the least experience were unable to identify hazards in their work areas while those in supervisory positions identified few hazards [4]. At the pre-intervention stage, workers were able to identify an average of 38% hazards [5], which is far below expectation. The above statistics show a dire need to reconsider the issue of hazard recognition in construction operations.

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Hazards are potential sources of harm [6] and unidentified hazards can have adverse consequences such as preventable injuries, emotional distress, productivity loss and wasted resources [3]. It is quite important for construction workers to understand and be able to recognise hazard in the course of executing their task. Additionally, it is important that construction workers are trained to recognise such situations that can lead to risk and subsequently accidents.

Although it is well established that the hazard recognition level is poor and many hazards remain unidentified, uncontrolled and unmanaged especially in the construction industry [2] [5], concerted efforts made in the past to improve hazard recognition focused on different intervention measures. Albert et al. [3] developed a new hazard recognition strategy known as *hazard identification and transmission board*. This strategy incorporated the concepts of retrieval mnemonics for cued hazard recognition during pre-task planning and work execution. The strategy recorded a success rate of 24% at the planning phase and 29% at the execution phase. Albert et al. [5] employed the use of multiple baselines to improve hazard recognition and communication among workers. They discovered a 31% improvement in hazard recognition and communication. Albert et al. [7] developed, implemented and tested an interactive augmented virtuality platform for construction hazard recognition training. The result of the test shows a 27% improvement in hazard recognition and communication of workers. Despite the different intervention programmes, which are experimental, the success rate recorded is far below average. This gives the impression that certain factors still serve as an impediment to recognising hazards. Such factors must be examined to increase the hazard recognition level of workers.

Bahn [4] conducted an action research and discovered that the length of experience did not predetermine the ability of workers to recognise hazards. Some of the longest serving workers and those in supervisory positions identified few hazards. Jeelani et al. [8] adopted an exploratory research to identify downstream workplace factors that act as barrier to hazard recognition. They discovered thirteen factors that can potentially impede hazard recognition. Although Jeelani et al. [8] identified thirteen factors impeding hazard recognition, there is a need to investigate whether there are variations in perception of workers on the factors affecting their ability to recognise hazards. This need is necessary to enable personalized training tailored towards the length of experience of each worker since training can improve hazard recognition level [9] [10]. Hence, it is noteworthy to study the influence of construction workers' experience on factors affecting their hazard recognition pursuant to minimising accidents in construction operations.

The aim of the study, at the risk of sounding repetitive, is to examine the factors affecting hazard recognition by construction professionals so as to minimise the occurrence rate of accidents in construction operations. Specifically, the study examined the differences in the factors affecting hazard recognition among professionals based on their length of experience in construction site operations. Furthermore, the study proposed that there is no difference in the factors affecting hazard recognition among construction professionals based on their length of working experience. The determination of the differences in the factors affecting hazard recognition among construction professionals will assist safety trainers to develop curriculum on the potential factors that can hinder hazard recognition based on different work experience lengths.

1.1 Factors Affecting Hazard Recognition

There is a wide range of definitions of 'hazard' but HASPA [11] concluded that the different definitions are useful based on the context of an occupational health and safety activity. A hazard refers to a circumstance or object that possesses the capacity to cause harm to an individual [6]. It is the potential for harm [12]. Potential hazards in a work environment can encompass a range of factors such as loud machinery, a mobile forklift, chemical substances, electrical hazards, working at elevated heights, monotonous tasks, instances of bullying and violence, an inadequately designed workplace, and insufficient management systems (e.g., absence of safety protocols for task execution) [11]. Thus, it is essential that workers recognise the factors that lead to hazard in construction operations in order to prevent injuries, illness and accidents.

Different authors identified different factors affecting hazard recognition in construction site operations [8, 9, 13]. While some authors categorised the factors [13], others simply listed the factors [8, 9]. Naiman et al. [13] identified the factors affecting hazard recognition performance by construction workers as personal factors, organizational factors, social factors, situational and industry factors and miscellaneous factors. Each of the factors has sub variables. For example, physical factors consist of cognitive and visual ability, safety complacency, knowledge and

experience, etc. Jeelani et al. [8] and Jeelani et al. [9] identified the factors as Operational unfamiliarity with construction tools and equipment", "Hazards that are secondary or unassociated with the primary task", "Hazards perceived to impose low levels of safety risk", "Premature termination of hazard recognition", "Low prevalence or unexpected hazards", etc.

2.0 MATERIALS AND METHOD

To achieve the objectives in this study, a cross-sectional survey research strategy was adopted, specifically a descriptive research. The rationale for the choice of research design was that a one-time observation of independent (experience of construction professionals) and dependent (factors affecting hazard recognition) variables were conducted [14].

The research approach adopted was quantitative research approach, which involved empirical testing [15]. Since this study involved the testing of independent and dependent variables, a quantitative approach was thus adopted. Questionnaire was used in eliciting information from construction professionals who are the population for this study. The construction professionals include architects, builders, quantity surveyors and civil engineers. The construction professionals were grouped into three categories based on their length of work experience. The first group, termed "*low experience group*", consists of professionals with work experience of 10 years and below. The second group, termed "*medium experience group*", consists of professionals with work experience between 11- 20 years, while the last group, "*high experience group*', comprises professionals with 20 years and above work experience.

The questionnaires were distributed using purposive sampling techniques. Purposive sampling technique is a non-probability sampling technique where respondents are deliberately made a part of the sample due to their position, knowledge or any other criteria [16]. Due to the position of the respondents as construction professionals and due to their knowledge of hazard in construction sites operations, a purposive sampling technique was adopted.

2.1 Measures of Variables

The variables which measured the factors affecting hazard recognition by construction professionals in this study were adapted from the works of [8] [17]. Thirteen factors in statement forms were listed and construction professionals were asked to tick their level of agreement on whether the listed factors affect their hazard burden recognition in construction operations. The level of agreement was measured on a five-point Likert scale of 1= Strongly disagree, 2 = Disagree, 3 = Moderately agree, 4 = Agree and 5 = Strongly Agree.

To determine the level of agreement of professionals on factors affecting hazard recognition in construction site operations, the median value of each variable was calculated and interpreted. Furthermore, a Kruskal-Wallis test was conducted to determine whether there are differences in factors affecting hazard recognition among construction professionals based on their work experience.

2.2 Demographic Details of Respondents

Table 1 depicts the profile of 100 construction professionals that participated in the survey. Based on their experience in construction industry, more than half of them have experience that is 10 years and below (Low experience) while the remaining two-thirds have medium and high experience. The high number of low experience construction professionals suggests that most early career construction professionals worked mostly on construction sites and as they advanced, they moved to the managerial level. However, the percentages of the three groups of construction professionals indicate that all the groups are well represented. More than half of the respondents are male. The construction industry is male-dominated because of the nature of work on construction sites and since the study is site-based, it is unsurprising to have more male respondents than female respondents.

In terms of their professional background, 64% are architects, 24% builders and 6% are the combination of quantity surveyors and mechanical engineers. This percentage representation shows that the respondents are construction professionals; on the strength of this percentage representation, the respondents can give reliable information about hazard burden in construction site operations. Majority of the respondents are within the age bracket of 20-39 years. This shows that the respondents are young and agile, therefore they can relate well to the issue of hazard in construction site operations.

Table 1: Characteristics of Respondents

Respondent Profile	Frequency	%
Experience		
10 years & Below	73	73
11-20 years	17	17
20 years & above	10	10
Total	**100**	**100**
Gender		
Male	68	68
Female	32	32
Total	**100**	**100**

Profession		
Builder	24	24
Architect	64	64
Civil Engineer	6	6
Quantity Surveyor	6	6
Total	**100**	**100**
Age Bracket		
Below 20 years	2	2
20-29 years	53	53
30-39 years	28	28
40-49nyears	10	10
50-59 years	7	7
Total	**100**	**100**

3.0 RESULTS AND DISCUSSIONS

3.1 Results

3.1.1 Factors affecting hazard recognition in construction site operations

Table 2 depicts the results of factors affecting hazard recognition in construction site operations. 13 statements described the factors affecting hazard recognition in construction site operations. Construction professionals moderately agree that 6 of the factors affect their hazard recognition, while they agree that another 6 factors affect hazard recognition in site operations. Finally, they strongly agree that only one factor, "multiple hazards associated with single source of task", affects hazard recognition. See details of the factors in Table 2.

3.1.2 Difference in factors affecting hazard recognition in site operations

Table 3 shows the result of the Kruskal Wallis test conducted to determine whether there is a significant difference in the factors affecting hazard recognition by construction professionals based on their experience. When 13 items were tested, six items were significant; thus, the test rejects the hypothesis for the six variables. For example, there was a significant difference in the factors "operational unfamiliarity with construction tools and equipment (2) X^2 = 12. 242, p = < 0.05 with mean rank of 56.23 (median 4) for construction professionals with low experience, 35 (median = 3) for construction professionals with medium experience and 35 (median = 3) for construction professionals with high experience. Table 3 gives the details of the other significant variables.

7 factors were not significant; on that score, the test fails to reject the hypothesis for the seven variables. For example, there was no significant difference in the variable "premature termination of hazard recognition". The 3 groups of construction professionals have the same median value of 4. Table 3 shows the result of the remaining non-significant variables.

Table 2: Factors Affecting Hazard Recognition in Construction Site Operations

S/N	Factors	1	2	3	4	5	Total	Mdn	Remark
1	Operational unfamiliarity with construction tools and equipment	6	4	49	25	16	100	3	Moderately Agree
2	Hazards that are secondary or unassociated with the primary task	10	30	19	20	21	100	3	Moderately Agree
3	Hazards perceived to impose low levels of safety risk	4	6	45	21	24	100	3	Moderately Agree
4	Premature termination of hazard recognition	4	7	23	31	35	100	4	Agree
5	Low prevalence or unexpected hazards	5	10	39	23	23	100	3	Moderately Agree
6	Visually unperceivable / Obscure hazards	9	21	23	29	18	100	3	Moderately Agree
7	Unexpected and unknown potential hazard set	6	17	42	25	10	100	3	Moderately Agree
8	Selective attention or Inattention	4	6	32	41	17	100	4	Agree
9	Multiple hazards associated with single source or task	9	3	17	18	53	100	5	Strongly Agree
10	Task unfamiliarity	4	11	33	20	32	100	4	Agree
11	Latent or stored energy hazards	3	11	17	52	17	100	4	Agree
12	Hazard source detection failure	4	9	19	35	33	100	4	Agree
13	Hazards without immediate outcome onset	4	6	32	41	17	100	4	Agree

Note: 1= Strongly Disagree, 2= Disagree, 3= Moderately Agree, 4= Agree, 5= Strongly Agree, Mdn. = Median

Table 3: Kruskal Wallis Test of Difference in Factors affecting Hazard Recognition in Site Operation

S/N	Factors	Low Experience		Medium Experience		High Experience		Kruskal Wallis				
		Mean Rank	Median	Mean Rank	Median	Mean Rank	Median	X2	df	p-value	Sig	Decision
1	Operational unfamiliarity with construction tools and equipment	56.23	4	35	3	35	3	12.242	2	0.002	SS	Reject
2	Hazards that are secondary or unassociated with the primary task	55.05	4	31.26	2	50	3	9.779	2	0.008	SS	Reject
3	Hazards perceived to impose low levels of safety risk	56.97	4	33	3	33	3	15.196	2	0.001	SS	Reject
4	Premature termination of hazard recognition	53.27	4	38.88	4	50	4	3.713	2	0.156	NS	Accept
5	Low prevalence or unexpected hazards	56.23	4	35	3	35	3	11.534	2	0.003	SS	Reject
6	Visually unperceivable / Obscure hazards	46.62	3	56.88	4	68	4	6.088	2	0.048	SS	Reject
7	Unexpected and unknown potential hazard set	51.8	3	44.5	3	51.2	3	0.973	2	0.615	NS	Accept
8	Selective attention or Inattention	50.38	4	43.68	3	63	4	3.133	2	0.209	NS	Accept
9	Multiple hazards associated with single source or task	41.81	4	74	5	74	5	28.901	2	0	SS	Reject
10	Task unfamiliarity	53.75	4	47.44	3	32	3	5.607	2	0.061	NS	Accept

11	Latent or stored energy hazards	49.24	4	57.5	4	47.8	4	1.431	2	0.489	NS	Accept
12	Hazard source detection failure	52.53	4	42.06	4	50	4	1.971	2	0.373	NS	Accept
13	Hazards without immediate outcome onset	50.38	4	43.68	3	63	4	3.133	2	0.209	NS	Accept

3.2 Discussion

The study examined the factors inhibiting the recognition of hazard by construction professionals. 13 factors were considered and the median of each factor was used to determine the level of agreement of construction professionals on the factors. The result in Table 2 indicates that construction professionals agreed that all the 13 factors listed inhibit construction professionals from recognizing hazard in construction site operations, although with varying levels of agreement. Construction professionals moderately agree that 'operational unfamiliarity with construction tools and equipment' affects their hazard recognizing skills. This implies that they agree to some certain extent that when workers are not familiar with the operations and the operational features of the equipment or tool, they find it difficult to recognize the associated safety hazard. This finding confirms that of [8] in which operational unfamiliarity was considered as a factor affecting hazard recognition. Once the hazard cannot be recognised, then it can lead to risk and subsequently to accidents in construction site operations. Memon et al. [18] identified operation procedures as a major factor affecting hazard recognition in the construction industry. Operational unfamiliarity with construction tools and equipment can be categorised under operational procedures; due to this contention, it is important that professionals are familiar with the operation of tools and equipment to recognise hazards in construction site operations.

Construction professionals strongly agree with this factor: "multiple hazards associated with single source or task is a factor affecting hazard recognition in construction site operations". This type of barrier occurs when workers thought they had already identified the hazards associated with the task but it turned out that the task was associated with other hazards as well [8] [17]. Construction professionals agree that when they are not familiar with a task, they are prevented from recognizing the potential hazard associated with it. This is in line with [2] in which knowledge and information barriers are key barriers to identifying hazard. Thus, unfamiliarity with a task implies lack of knowledge. Reference [4] suggests that training on potential hazard before undertaking a task will assist workers in recognizing potential hazard.

The study further tested this hypothesis: 'there is no significant difference in factors affecting hazard recognition among construction professionals based on their working experience'. The result shows that 6 out of the 13 factors were significant. Hence, there is the recognition that the experience of construction professionals affects the factors affecting the hazard recognition skills in site operations. This recognition supports the findings of [19, 20] in which safety experience of workers affects their hazard recognition rates. The median value of construction professionals with low length of work experience is higher compared with the medium and high experience professionals. This suggests that professionals with low experience perceived that the following factors – "Operational unfamiliarity with construction tools and equipment", "Hazards that are secondary or unassociated with the primary task", "Hazards perceived to impose low levels of safety risk", "Low prevalence or unexpected hazards" – hinder their hazard recognition skills more than the medium and high experience group.

The implication for the first factor, "Operational unfamiliarity with construction tools and equipment", is that there was a significant difference among the three groups of construction professionals. Thus, the experience of professionals affects the factors hindering hazard recognition. The low-experience group agrees that operational unfamiliarity with construction tools and equipment hinders their hazard recognition skills compared with the other two groups who moderately agree. This is quite correct given the fact that the low-experience group has limited experience in the use of construction tools and equipment; on that account, they perceived that it hinders their hazard recognition skills.

The median value for "visually unperceivable/ obscure hazards" and "multiple hazards associated with single source or task" was higher for construction professionals with medium and high length of work experience compared with the low-experience professionals. While, the low-experience group felt hazard that is not visually perceivable (hot surfaces) moderately hinders their hazard recognition skills, the medium and high group agreed that it hinders their hazard recognition skills. This may be due to their higher level of experience. The higher their experience, the more they experience some of the factors, compared to the low-experience group.

4.0 CONCLUSION

Identifying the factors that hinder hazard recognition skills and understanding the differences in the factors

among construction professionals of low, medium and high length of work experience is important for developing curriculum that addresses the needs of each group of construction professionals. That being the case, the study investigated the differences in factors affecting hazard recognition skills among professionals in construction site operations. The study discovered a significant difference in the following factors, namely, "Operational unfamiliarity with construction tools and equipment", "Hazards that are secondary or unassociated with the primary task", "Hazards perceived to impose low levels of safety risk", "Low prevalence or unexpected hazards", "visually unperceivable / Obscure hazards" and "multiple hazards associated with single source or task", and concluded that the experience of construction professionals affects their perception on some factors hindering hazard recognition.

Based on this, safety experts that are responsible for health and safety training in the construction industry should consider the experiences of construction professionals when developing curriculum on hazard recognition. This consideration will make the curriculum individual and specific, rather than a general one. Health and safety managers should consider the experienced professionals when planning their health and safety training so that the training will address the needs of individuals based on personal factors.

The study employed quantitative research design; future studies should combine both the quantitative and qualitative research designs so as to validate the result of the quantitative analysis. Furthermore, the study also considered professionals as the population; future research should consider non-professionals working on construction sites.

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