

Assessment of Factors Affecting Workers' Hazard Recognition in Construction

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Abstract

The construction safety management process relies significantly on the hazard recognition of construction workers. This is due to the existence of poor safety practices recorded within the construction industry, which is correlated with construction workers' inability to recognise and manage work hazards effectively. This study, therefore, assesses the factors affecting the hazard recognition ability of construction workers. A questionnaire survey was employed, where questionnaires were distributed to construction workers (both professionals and artisans) in Nigeria. Data was analysed using Mean, Standard Deviation, and a normality test. Kruskal-Wallis H-test was then employed to determine the hazard recognition capability level of the workers based on their various characteristics. 52 out of the 53 identified factors were significant. The study then found significant differences in the hazard recognition ability of the workers based on their years of experience and level of education. On the other hand, job type, designation and profession of the workers do not affect their hazard recognition ability factors. The paper recommends the development of the capacity of construction workers in their experience and education for hazard recognition.

Keywords: Construction workers, hazard recognition, safety management

1. Introduction

The construction industry is notorious for its poor safety records characterised by frequent accidents resulting from multiple hazard sources (Zhou, Goh and Li, 2015). This poor reputation cuts across both advanced and developing countries of the world (Sunindijo and Zou 2012; Patel & Jha, 2014). Efforts have been made to address the problem through safety management and technological approaches (Alruqi et al., 2018; Tam and Fung, 2012; Zhang et al., 2015; Riaz et al., 2014). However, poor hazard recognition limits construction workers' ability to escape from workplace accidents (Goh and Binte Sa'adon, 2015; Namian, Zuluaga, & Albert, 2016).

Hazard recognition capability of workers is a significant enabler for addressing safety challenges on construction sites (Lu et al, 2011). Addressing accidents relies on managing the identified hazards, which result from close interaction of workers, equipment and materials with unsafe conditions (Namian, Zuluaga, et al., 2016; Teizer & Cheng, 2015). These hazards, when not recognised and managed, lead to serious safety incidents. The situation is further compounded as many of the construction workers are unskilled and unlettered, thus unable to recognise safety signs and give proper attention to the safety scenarios at work.

Studies have reported poor ability of construction workers to identify hazards in construction environments (Fu et al., 2024; Carter and Smith, 2006; Perlman et al., 2014). Haslam et al. (2005) observed that 42% of accidents involve inadequate hazard identification and appraisal skills of workers. This was corroborated by Bahn (2013), Zhou et al. (2024) and Albert et al. (2014), who reported the failure of construction workers to recognise an average of 40% to 57% of hazards in different work contexts.

Improving hazard recognition capability of construction workers relies on understanding the factors that aid or hinder the ability of the workers to recognise safety hazards on construction sites (Abubakar et al., 2020; Namian et al., 2016). Once the significant factors are determined, strategies can be developed to strengthen the workers' ability to recognise and manage various work hazards effectively. This will then lead to the desired improvement in the overall safety performance of the construction industry.

2. Hazard Recognition in Construction and Factors Affecting Hazard Recognition Capability

Over time, studies on construction safety management have focused on, among others, hazard identification, accident investigation, and risk assessment. Researchers have documented factors responsible for

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poor safety performance, which manifests in several accidents and fatalities in the construction industry (Mitropoulos et al. 2005; Rajendran and Gambatese 2009; Suraji et al. 2001). According to Abdelhamid and Everett (2000), the root causes of workplace accidents comprise the failure of workers to identify a hazardous condition that occurs before starting an activity or that develops afterwards.

Among the antecedent factors responsible for the poor safety performance, hazard recognition of construction workers has recently received significant attention of researchers (Albert, Hollowell, & Kleiner, 2013; Carter & Smith, 2006; Namian, Zuluaga, & Albert, 2016; Pereira, Ahn, Han, & Abourizk, 2018; Goh and Chua 2009). Hazard is the potential for harm, or an aspect of technology or activity that leads to risks (Bahn, 2013). Hazard recognition is the ability of managers and workers to sense, analyse and extract physical or mental stimuli that indicate the existence of a hazardous situation in a complex and dynamic scenario of construction environments (Albert, Hollowell, & Kleiner, 2014; Namian, Zuluaga, et al., 2016) This may arise from unsafe equipment; unsafe environment; or unsafe work practices” engaged by the workers.

Hazard recognition is central to addressing the safety challenges of construction sites (Lee and Hasanzadeh, 2024). Safety management efforts are always designed to manage the identified hazards, which occur in various forms. When hazards are not recognised and managed, the likelihood of calamitous and sudden injuries increases. Studies have reported that more than 42% of injuries in construction occur because of inadequate hazard recognition and evaluation (Carter & Smith, 2006; Haslam et al., 2005; Perlman, Sacks, & Barak, 2014). Bahn (2013) reported that workers failed to recognise an average of 57% of hazards in occupational environments in Australia. In a study of several projects across the United States of America, Albert, Hollowell, and Kleiner (2014) discovered that more than 40% of hazards were not recognised at the time of pre-job safety meetings. These problems have been aggravated by the inherent characteristics of the industry, such as frequent rotation and interaction of teams, constantly changing weather and environmental conditions, a higher proportion of unskilled labourers, and high labour turnover, among other factors.

Literature on construction safety has reported the importance of hazard recognition to any safety management initiative. The persistence of poor safety records of the construction industry has been linked to the inability of workers to recognise and manage work hazards (Namian et al., 2016; Chen et al., 2024; Uddin et al., 2023) This is undoubtedly among the primary reasons for the growing research interests on the improvement of hazard recognition performance of construction workers. To avert the negative consequences of poor hazard recognition of workers, it

is inevitable to understand the factors that influence their hazard recognition capabilities (Abubakar et al., 2020). This will enable the development of appropriate strategies to improve the level of hazards recognised and managed by the workers, thereby achieving the desired improvement in the general safety performance of the construction industry.

Previous studies have documented the factors contributing to the inability of workers in construction and allied sectors to recognise hazards at workplaces. Notable among them is the work of Namian et al. (2016) and Chen et al. (2024), in which they established factors that influence hazard recognition performance of construction workers. The factors were identified through a literature review and interviews with construction managers and safety professionals. They assembled the factors into five categories: personal, organisational, social, situational, industry-related, and miscellaneous factors (Jeelani et al., 2017). Other researchers further expanded these to cater for omissions and other contextual factors related to geography or inherent characteristics of workers (Abubakar et al., 2020). Many other studies considered the factors and their influence on different aspects of hazard recognition. Assessing the specific influence of these factors and their relative importance will help industry practitioners to devise effective strategies for dealing with them in improving the hazard recognition capability of construction workers.

3. Research design and approach

This study employed a quantitative approach to evaluate the hazard recognition capability of construction workers. This is appropriate given the nature of the quantitative data and the analytical tools involved.

The research identified a series of factors related to hazard recognition capability from existing literature (Abubakar et al., 2020), which were subsequently used to construct a semi-structured questionnaire, with closed-ended questions aimed at evaluating 53 factors related to hazard recognition capability. Two types of questionnaires were designed to address different respondent groups: tradesmen (workers) and professionals (construction managers, safety managers, and site supervisors). The questionnaire was structured in two sections: Part A and Part B. The information solicited in Part A varied slightly between the two questionnaire types to effectively capture the pertinent demographics for each respondent category. For tradesmen, inquiries included their specific trade, years of experience, educational background (including any formal schooling), and the nature of the jobs undertaken by their organisations.

The demographic data solicited from the professionals encompassed details regarding the types of projects

they are involved in, their job titles, years of experience in the field, and their educational backgrounds. Both parts of the questionnaires contained identical information. A Likert scale ranging from 1 to 5, with 1 being the lowest and 5 being the highest, was utilised to assess the perceived impact of various factors on the hazard recognition capabilities of the construction workers. The questionnaires were disseminated both in person and online, with a total of 1,200 questionnaires distributed across Nigeria. Six hundred five completed questionnaires were returned, representing a response rate of 50.42%. Out of these, 561 questionnaires (46.75%) were deemed suitable for analysis.

A range of statistical analyses was performed to assess the reliability and appropriateness of the data analysis methods for the research. The Statistical Package for the Social Sciences (SPSS v.25) was utilised for the various analyses. The internal consistency reliability of the survey instrument was evaluated, employing Cronbach's Alpha, which ranges from 0 to 1. A higher Alpha value, approaching 1, indicates greater reliability of the dataset. Tavakol and Dennick (2011) suggest that a minimum acceptable Alpha score is 0.7. The reliability of the dataset was assessed, yielding a Cronbach's Alpha of 0.802, which signifies a robust internal consistency. To ascertain the suitability of parametric versus non-parametric statistical methods for data analysis, an assessment of the dataset's normality was conducted. The Shapiro-Wilk test was employed similarly to the study of Dandago et al. (2025). The results of the Shapiro-Wilk test indicated P-values below 0.05 for all factors (see Table 1 in Appendix 1), implying that the dataset does not follow a normal distribution. Consequently, this finding advocates for the application of non-parametric statistical methods to evaluate the appropriateness of the dataset for factor analysis. In light of this result, the Kruskal-Wallis H-Test, which is a non-parametric technique based on ordinal data, was utilised to investigate whether the responses from experts across different professions exhibited significant differences (as in Dandago et al., 2025).

4. Data analysis and results

Respondents' background information

Results from the analysis of the background information of the respondents (Table 2) show that the majority of the respondents have years of experience ranging from 0 to 10 years, with 69%. The result also shows that 67% of the respondents have a diploma or a bachelor's degree. The respondents also comprise tradesmen and professionals from various fields, contributing a diverse and well-rounded expertise essential for assessing the factors influencing hazard recognition capabilities, with 54% workers and 46% professionals handling different types of jobs, primarily including building and civil engineering construction. This shows that the respondents have the requisite

knowledge and skills to provide reliable responses for the study.

4.1 Significant hazard recognition factors of construction projects

The significant hazard recognition factors of construction workers in construction projects were assessed via mean score analysis. A mean score of 3 or higher on the 5-point Likert scale utilised in this study indicates that a hazard recognition factor is significant. The findings related to the mean score of hazard recognition factors are presented in Table 1. The mean score analysis reveals that only one of the 53 hazard recognition factors was insignificant. The expert deemed 'Race and ethnicity' with a mean score of 2.86 to be an insignificant hazard recognition factor. The respondents, however, considered 'Level of experience in the job', 'Knowledge of the job', 'Good visual ability', 'Prior knowledge of the hazards', and 'Safety training to recognise hazards' with respective mean scores of 3.92, 3.90, 3.85, 3.73 and 3.71 to be the top 5 significant hazard recognition factors. Consequently, investors, contractors, and project managers must focus on these factors, warranting a more in-depth examination.

4.2 Hazard recognition factors of construction projects based on the respondents' attributes

This section evaluates the differences in the hazard recognition capability of the workers based on their demographic attributes. The Kruskal-Wallis H-test was employed to determine whether significant differences exist in the hazard recognition capability of the workers, taking into account variables such as the Years of Experience, Educational Qualification, Job Type Handled by Firms, Designation, and Profession of the workers.

As illustrated in Table 3 (in Appendix 1), based on the Years of Existence of the workers, the hazard recognition capability of the workers shows significant differences in 33 of the factors, while responses on 20 factors show no significant differences. This shows that there is a significant overall difference in the hazard recognition capability of the workers based on their years of experience. This can be attributed to the findings of Zhou et al. (2024), who opined that novices have better hazard recognition performance than experienced workers because they are more sensitive to hazards. This may result in novice and experienced workers having different understandings of what significant hazard recognition factors are, depending on their experience.

Regarding the educational qualification, the responses of the workers indicate significant differences in 30 hazard recognition capability factors, while 23 factors exhibited no statistically significant differences. This shows a statistically significant overall difference in the respondents' hazard recognition capabilities. Although

Table 2: Respondents' background information

Characteristics	Classification	Frequency	%
Years of Experience	01-05 years	190	34
	06-10 years	194	35
	11-15 years	82	15
	16-20	54	10
	21-25	26	5
	26-30	10	2
	Above 30 years	5	1
	Total	561	100
Educational Qualification	SSCE and below	130	23
	National Diploma	131	23
	Higher National Diploma	85	15
	Bachelors	164	29
	Masters	43	8
	Doctorate	8	1
	Total	561	100
Job Type Handled by their Firms	Building Construction	264	47
	Civil Engineering Construction	74	13
	Both Building and Civil Engineering	221	39
	Others	2	0
	Total	561	100
Designation	Safety Manager	32	6
	Construction Manager	226	40
	Workers	303	54
	Total	561	100
Profession	Roof Work	177	32
	Steel Work	62	11
	Excavation work	65	12
	Professionals	257	46
	Total	561	100

a large portion of the respondents possess at least a diploma, the approach to education in promoting safety practices is deficient. The educational approach has been noted to be reliant on lectures (Albert et al., 2020), with researchers calling for a more self-directed, active approach (Bhandari and Hallowell, 2017). Uddin et al. (2023) suggested tapping the potential of advanced technologies like large language models, specifically ChatGPT, to support hazard recognition education and training.

The study also analysed the differences in the types of jobs handled by the respondents. The study found only

six hazard recognition factors to be significantly different, whereas 47 factors had no significant difference. This indicates that the types of jobs handled by the respondents do not influence their hazard recognition capability. This is supported by the fact that the analysis revealed, overall, no significant differences in the hazard recognition capability of the respondents based on their jobs. However, on designation of the respondents, all 53 factors show no significant difference. This is an indication that the hazard recognition capability of tradesmen and professionals can be treated as a whole.

Based on the profession of the respondents, 25 factors show a statistically significant difference in the hazard recognition capability of the respondents. On the other hand, 28 factors show no significant difference. This shows that the overall hazard recognition capability of the respondents across various professions is not significantly different.

5. Conclusion

This study assessed the hazard recognition factors of construction workers in construction projects. The mean score analysis revealed that 52 of 53 analysed hazard recognition factors are significant. The study found 'Level of experience in the job', 'Knowledge of the job', and 'Good visual ability' to be the leading factors in the hazard recognition capability of construction workers. The study further used inferential statistics, specifically the Kruskal-Wallis H-test, to analyse differences in the responses of the workers based on their demographic attributes. The analysis found that there is a significant overall difference in the hazard recognition capability of the respondents based on their years of experience and educational

qualifications. However, the study found no significant differences in the hazard recognition capabilities of the respondents based on their job type, designation and various professions. The paper recommends the development of the capacity of construction workers in their experience and education for hazard recognition. The study also recommends leveraging advanced technologies to enhance hazard recognition education and training efforts and improve construction safety. Nevertheless, it is essential to recognise certain limitations of this study. The hazard recognition factors analysed were derived from empirical studies documented in the existing literature. Researchers, practitioners, and stakeholders must be aware of the sensitivity of these hazard recognition factors to various project types, geographical locations, objectives, and national contexts.

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Appendix 1**Table 1:** Mean score ranking of the hazard recognition factors for construction projects

Factors	Mean	SD	Rank	Shapiro-Wilk
Level of experience in the job	3.92	0.963	1	0.000
Knowledge of the job	3.90	1.041	2	0.000
Good visual ability	3.85	0.960	3	0.000
Prior knowledge of the hazards	3.73	1.037	4	0.000
Safety training to recognise hazards	3.71	1.121	5	0.000
Organisational safety policy	3.69	1.101	6	0.000
Sound auditory ability	3.68	1.021	7	0.000
Attitude towards safety	3.68	0.982	7	0.000
Project characteristics (size, scope, materials, height, etc)	3.68	0.990	7	0.000
Hazardous nature/tendencies of equipment used in projects	3.65	1.036	10	0.000
Supervisory environment	3.65	1.009	10	0.000
The layout plan of the construction site	3.64	0.985	12	0.000
Safety Training Programs in the organisation	3.63	1.104	13	0.000
The productivity and delivery pressure of the project	3.63	1.021	13	0.000
Hazard recognition practices employed in the project	3.61	2.384	15	0.000
Job-specific safety training was provided for workers in the project	3.61	1.087	15	0.000
The site condition (e.g. elements of weather)	3.60	1.015	17	0.000
Employee involvement in hazard recognition and safety planning	3.59	1.026	18	0.000
Organisational campaign to promote hazard recognition	3.59	1.057	18	0.000
The site configuration (e.g. topography, soil condition, access, space, etc.)	3.59	1.004	18	0.000
Organisational communication system for managing hazard info. at work	3.57	1.122	21	0.000
The use of mechanical plants and equipment in the project	3.57	1.005	21	0.000
Project scope and schedule change	3.56	0.964	23	0.000
Hazard recognition method/tool adopted	3.56	1.123	23	0.000
Safety complacency	3.55	1.036	25	0.000
A large number of construction tasks on site	3.55	1.010	25	0.000
The size and composition of the work crew	3.55	0.925	25	0.000
Organisational structure with responsibilities for HR and management	3.55	1.096	25	0.000
The project site's house-keeping practices	3.55	1.010	25	0.000
Co-workers' hazard recognition and safety practices	3.53	0.998	30	0.000
Supportive environment for hazard recognition and management	3.53	1.011	30	0.000
Project safety climate	3.52	1.023	32	0.000
Hazard recognition ability and motivation of peers	3.51	1.020	33	0.000
Noise level at the project site	3.50	1.089	34	0.000
Work group norms	3.48	0.978	35	0.000
Use of incentive programs to motivate employees for HR	3.47	1.103	36	0.000
Use of hazard (both manual and automated) identification techniques	3.47	1.108	36	0.000

Appreciation of the risks associated with the job	3.46	1.015	38	0.000
Traffic on the project site	3.46	1.040	38	0.000
Knowledge of risks (consequences) associated with a hazard	3.45	1.056	40	0.000
Co-workers' and superiors' support for hazard recognition at work	3.45	1.024	40	0.000
Experience in using hazard recognition techniques	3.44	1.041	42	0.000
Stable emotional disposition	3.44	1.002	42	0.000
Hazard recognition ability of peers at work	3.44	1.011	42	0.000
Organisational policy on the use of psychoactive substances by workers	3.43	1.126	45	0.000
Risk-taking ability	3.39	1.059	46	0.000
Location of hazards	3.38	1.047	47	0.000
The project owner and community support for HR and management	3.38	1.102	47	0.000
Involvement in a previous construction accident	3.36	1.144	49	0.000
Fatigue and depletion	3.32	1.120	50	0.000
Belief system	3.20	1.194	51	0.000
Use of Substances (like drugs, alcohol and so on) at work	3.00	1.486	52	0.000
Race and ethnicity	2.86	1.233	53	0.000

Table 3: Kruskal-Wallis test in the hazard recognition capability of the workers based on their demographic attributes

Factors	Exp	Educ	Job	Design	Profession
Level of experience in the job	0.000	0.002	0.138	0.599	0.000
Knowledge of the job	0.006	0.081	0.197	0.519	0.000
Good visual ability	0.349	0.998	0.882	0.235	0.000
Prior knowledge of the hazards	0.002	0.000	0.287	0.757	0.114
Safety training to recognise hazards	0.002	0.003	0.373	0.246	0.979
Organisational safety policy	0.084	0.001	0.276	0.867	0.000
Sound auditory ability	0.066	0.005	0.057	0.881	0.105
Attitude towards safety	0.218	0.364	0.202	0.126	0.348
Project characteristics (e.g. size, scope, materials, height, etc)	0.034	0.015	0.430	0.401	0.001
Hazardous nature/tendencies of equipment used in projects	0.307	0.041	0.010	0.913	0.000
Supervisory environment	0.005	0.077	0.642	0.088	0.570
The layout plan of the construction site	0.216	0.003	0.131	0.901	0.012
Safety Training Programs in the organisation	0.000	0.000	0.868	0.890	0.157
The productivity and delivery pressure of the project	0.010	0.413	0.083	0.640	0.125
Hazard recognition practices employed in the project	0.001	0.003	0.152	0.470	0.194
Job-specific safety training was provided for workers in the project	0.000	0.001	0.322	0.753	0.001
The site condition (e.g. elements of weather)	0.054	0.156	0.032	0.080	0.001
Employee involvement in hazard recognition and safety planning	0.000	0.228	0.313	0.962	0.105
Organisational campaign to promote hazard recognition	0.012	0.368	0.023	0.965	0.000
The site configuration (e.g. topography, soil condition, access, space, etc.)	0.050	0.071	0.170	0.842	0.001

Organisational communication system for managing hazard info. at work	0.007	0.000	0.090	0.916	0.000
The use of mechanical plants and equipment in the project	0.108	0.099	0.257	0.087	0.021
Project scope and schedule change	0.009	0.070	0.138	0.664	0.015
Hazard recognition method/tool adopted	0.000	0.006	0.158	0.180	0.002
Safety complacency	0.024	0.889	0.119	0.837	0.022
A large number of construction tasks on site	0.012	0.272	0.297	0.346	0.203
The size and composition of the work crew	0.125	0.004	0.786	0.121	0.215
Organisational structure with responsibilities for HR and management	0.186	0.013	0.630	0.240	0.100
The project site's house-keeping practices	0.000	0.000	0.926	0.171	0.189
Co-workers' hazard recognition and safety practices	0.219	0.023	0.052	0.210	0.350
Supportive environment for hazard recognition and management	0.186	0.005	0.043	0.646	0.824
Project safety climate	0.000	0.000	0.417	0.766	0.476
Hazard recognition ability and motivation of peers	0.136	0.003	0.609	0.663	0.492
Noise level at the project site	0.034	0.156	0.220	0.976	0.004
Work group norms	0.221	0.046	0.146	0.127	0.693
Use of incentive programs to motivate employees for HR	0.000	0.006	0.331	0.797	0.006
Use of hazard (both manual and automated) identification techniques	0.006	0.152	0.146	0.653	0.004
Appreciation of the risks associated with the job	0.395	0.081	0.129	0.687	0.266
Traffic on the project site	0.018	0.056	0.203	0.567	0.100
Knowledge of risks (consequences) associated with a hazard	0.000	0.000	0.133	0.979	0.404
Co-workers' and superiors' support for hazard recognition at work	0.013	0.015	0.348	0.780	0.027
Experience in using hazard recognition techniques	0.004	0.143	0.119	0.358	0.459
Stable emotional disposition	0.000	0.025	0.388	0.481	0.758
Hazard recognition ability of peers at work	0.023	0.115	0.519	0.069	0.410
Organisational policy on the use of psychoactive substances by workers	0.297	0.000	0.002	0.818	0.002
Risk-taking ability	0.136	0.053	0.335	0.514	0.321
Location of hazards	0.000	0.547	0.940	0.778	0.060
The project owner and community support for HR and management	0.055	0.019	0.429	0.358	0.002
Involvement in a previous construction accident	0.002	0.534	0.807	0.435	0.000
Fatigue and depletion	0.048	0.030	0.016	0.480	0.003
Belief system	0.005	0.090	0.096	0.272	0.451
Use of Substances (like drugs, alcohol and so on) at work	0.139	0.004	0.887	0.057	0.000
Race and ethnicity	0.165	0.028	0.481	0.102	0.054