

Comprehensive Evaluation of Health, Safety, and Environmental Risks in Railway Construction Project Management

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ABSTRACT

In order to lower the risk of worker injury during a particular activity, an analysis of all risks that were found to be impacting project performance from the railway construction sectors in the Eastern region of Nigeria was carried out. The data obtained from a self-administered questionnaire survey to the construction industries was calculated using Likert scale and the mean index formula following a brief instruction on health, safety, and environmental culture in the industry. Using a matrix analysis table and a qualitative approach of data analysis, the degree of dangers was ascertained. Five categories of dangers, together with their subcategories, were chosen from construction-related projects based on the mentioned literature. To ensure that every company in the research region was equally represented, three firms were chosen at random from each state. Employees in the chosen construction industry received 160 questionnaires in total. 44 did not answer for a variety of reasons, bringing the sample size down to 116. The rate of 72.5% for the respondent was found. Within two months, the distribution and collection were completed. Using the Cronbach's alpha reliability coefficient, which gauges the consistency of items in question replies, reliability tests were run on each hazard's scale. Social, physical, and chemical dangers have the highest level of hazard among the five categories of hazards mentioned. The findings corroborate the literature that shows the most dangerous conditions in the construction sectors within the analyzed locations include insufficient safety performance, lack of job security, dry cement, dust, vibration, and sun.

Keywords: Assessment, Hazard, Railway construction, Risk, Project management

INTRODUCTION

The construction industry is a dangerous profession, with numerous accidents occurring. Safety engineers and managers often conduct sophisticated hazard analyses to identify and reduce hazards to life, environments, and machine functioning. This helps ensure a safe workplace for workers and professionals, allowing for the reduction or elimination of hazards before any harm occurs [1]. Hazard analysis is a crucial technique used in job safety management to identify potential hazards and reduce worker injury risks. It is the core planning process in health, safety, and environmental management [2]. Hazard analysis is a process that identifies unacceptable and various types of hazards [3]. Adherence to hazards is crucial in site planning, as failure to do so can lead to accidents. A lack of forethought in hazard analysis can result in a confused site, reducing health, safety, and environmental standards. During site planning, hazard analysis is essential to ensure safe access for

pedestrians and vehicles, as well as traffic routes. Addressing major hazards such as noise and vibration associated with piling work and crane hazards during lifting operations is also important. The construction industry is known to have a high number of accidents due to poor hazard management [4] [5] [6] [7]. The construction industry is widely regarded as a hazardous profession in contemporary society [8] [9]. A hazard analysis is a crucial process conducted by safety engineers or managers to identify and eliminate potential hazards in the construction industry. This helps professionals and workers understand a safe workplace and reduces or eliminates hazards before any harm occurs. Hazards can be single or combined, leading to functional failure accidents [10]. The primary objective of hazard analysis management is to identify the most effective methods for controlling or eliminating risks.

LITERATURE REVIEW

Hazards refer to potential sources or situations that can cause harm, such as human injury, property damage, or environmental damage. Hazard analysis is a technique used to identify the dangers of specific tasks, aiming to reduce the risk of worker injury or illness [11]. Construction design and management regulations address the main hazards on construction sites, including safe access and egress from the site and individual workplaces. These regulations are crucial for a good health and safety environment, ensuring a safe working environment and preventing accidents [9]. The text emphasizes the importance of the safe use of ladders, scaffolds, gangways, fenced excavations, tidy sites, and proper storage and waste disposal arrangements for all construction sites [8]. Fall from heights is the leading cause of serious injury or death in the construction industry. To prevent personal injury, steps must be taken to prevent falling from a distance liable to cause it, with a maximum unprotected gap of 470mm [12]. The use of intermediate guard rails at heights and a hierarchy of measures should be followed to prevent falls [13]. Construction workers and waste materials should be protected from falling hazards using covered walkways or netting, and waste materials should be brought to ground level using chutes or hoists [10]. Dismantling/Demolition is the most hazardous construction operation, causing the most deaths and injuries. Effective management requires a planning supervisor and a health and safety plan to prevent danger [14]. A competent person must conduct a thorough site investigation before commencing any work to identify potential hazards affecting demolition workers and public members who may pass near the site [15]. Excavation is a crucial construction process that requires proper planning, management, supervision, and execution to prevent accidents and worker health issues, making it a

hazardous exercise [16]. Emergency procedures should be established at the site to prevent or reduce injuries from fires, flooding, or structural collapses. These procedures include locating fire points, providing extinguishers, evacuating the site, contacting emergency services, reporting accidents, and rescuing from excavations and confined spaces [11]. New workers should receive training on noise control procedures, with ongoing training for all workers. Noisy machinery should be fitted with silencers, and noise surveys should be conducted when used in workshops, such as woodworking machines. If noise levels exceed the second action level, ear defenders are mandatory [17]. Construction sites pose health hazards such as vibration, dust, asbestos, cements, solvents, and paints. Regular assessments and updates on hazardous substances are crucial for ensuring safety and compliance with regulations [18]. The assessment and safety data sheet should be kept in the site office for reference after accidents, and the correct personal protective equipment (PE) must be checked [17]. A manual handling assessment should be conducted to minimize the lifting and handling of heavy objects. [13], The initial step in risk assessment is to identify significant hazards that could cause serious harm to people, while ignoring trivial hazards. [19]. The risk assessments team conducts a thorough tour of the area under consideration, consulting with the relevant workforce for effective hazard identification [20]. The identification of an individual can be enhanced by reviewing their accident, incident, and ill-health records. According to [16] 'Workplace hazards can be classified into chemical, physical, biological, social, and mechanical types. Construction site accidents can be caused by various factors [8] .

Table 1: A Holistic outline of the critical hazards & causes of accidents in construction sites

Human	Management	Job Site Conditions	Equipment & Material
-Lack of certain abilities	-Lack of certain knowledge	-Excessive Noise	-Operating equipment without authority
-Lack of certain attitudes such as stubbornness or recklessness	-Lack of awareness of safety regulations	-Slippery and muddy work surface	-Using defective tools or equipment
-Physical and emotional Stress	-Inadequate safety performance	-Poor ventilation	Mechanical failure of machinery
-Excessive overtime work for labor	-Supervisory fault	-Poor illumination	-Unsafe facilities and equipment
-Reluctance to input tools for safety	-Lack of experienced project managers	-Lack of edge protection	-Low tool maintenance
-Lack of teamwork spirits	-Poor inspection program	-Hole and edge	-Lack of protection in material transportation
-Dangerous demolition Work	Poor safety awareness of project managers	-Limitation of working Area	-Lack of protection in material storage
-Misplacing objects	-Lack of innovative technology	Collapse of temporary Structure	Failure to secure materials during hauling/ lifting
-Struck by falling objects, materials and tools	Substandard structure / parts of structure	Ignorance of safety awareness	-Lack of warning system
Inappropriate use of ladders and hoists	Lack of experience and safety regulation	Poor information	Lack of protection
-Improper cleaning and unusable materials	Lack of innovative technology	Lack of safety rules	Failure to secure equipment.
Loss of balance	Supervisory fault	Misinformed	
- Stepping on or striking against objects	Inadequate safety performance.	Lack of warning	

[12]

The study reveals that poor safety awareness, lack of training, reluctance to invest in safety, and reckless operations are the main factors affecting safety performance on a construction site. Other hazards include exposure to infectious microorganisms, toxic substances, job security, saw blades, explosiveness, and unsafe attitudes. Inadequate safety performance,

poor inspection, supervisory fault, and failure to secure materials during hauling or lifting are also identified as critical causes of accidents. Figure 1 is the impact assessment procedure. Table 1 is the holistic outline of the critical hazards and causes of accidents in construction sites.



Figure 1; Safety impact Assessment Procedure

Health and safety refer to the safeguarding of individuals' bodies and minds from illnesses resulting from the materials, processes, or procedures used in the workplace [11]. Safety refers to the protection of individuals from physical harm [15]. Occupational health and safety are crucial across all industries, including construction, and are particularly important in businesses, information technology companies, and offices [17]. Occupational health and safety are crucial for all work aspects, and the construction client is a key agent in promoting improved standards. They should demand a good contractor's health and safety record during the tendering stage and ensure these standards are met on-site [10]. The speaker suggests that proper training for all site workers is crucial, as health is a country's most valuable asset and the foundation for its entire production capacity [7]. The preservation of health in economically active age groups leads to increased labor force productivity and facilitates investment return. [19]. The global industrial revolution has significantly transformed human production from relying on physical forces to utilizing machines and gadgets. [18]. The

mechanization of production processes has led to numerous occupational health hazards, which are industrial-related health problems. [5]. [13], Construction projects often involve actions that disregard safety rules, such as climbing ladders without safety harnesses, using the wrong hands, welding without proper PPE, horseplay, lifting heavy loads without load checks, not obeying signs or signals, entering confined spaces without preliminary gas test, and working without following safety procedures. [18]. The individual was found to be poisoning a crane on unstable ground while moving around a construction site without a hard hat and safety shoes [1], Proper machine handling practices prevent injury and property damage in the workplace, as companies often use equipment and machinery in daily activities. Inadequate management can lead to serious injury and death.[6]. Machinery designers, manufacturers, suppliers, and employers are tasked with identifying and ensuring the safety of machinery by identifying dangerous parts [7]. Employers are obligated to guarantee the safety of both employees and machine operators from potential hazards.

METHODOLOGY

Books, magazines, journals, papers, documents, the internet, and textbooks are a few of the materials used in literature reviews. When it comes to routine and sporadic duties, new processes, operational changes, and service improvements, a literature review is employed. The information gained from the literature research was used to build the survey questionnaire. The case study for the research is the construction and restoration of railroad tracks in the

eastern part of Nigeria. For this reason, the companies that construct and renovate highway and railroad tracks are selected for this study. The process of dissecting data using the mean index formula to determine each component. This study of the data is quantitative. Each interviewee had spent between two and 10 years working on research projects. A brief safety and health lecture was given throughout project construction to ensure the most

accurate answers to the self-administered questionnaire. Everyone involved in a project, including the contractor, site engineer, supervisors, safety authorities, storekeepers, foremen (skilled and unskilled labor), etc., is the targeted group. The relative simplicity of obtaining standard data appropriate for achieving the study's objectives served as a proxy for the success of the questionnaire dissemination. Based on the literature study, five types of hazards and their subcategories were selected from construction-related projects. The respondents were asked to rate their answers on five-point rating scales. The case study region consists of five states in eastern Nigeria: Abia State, Imo, Anambra, Ebonyi, and Enugu. The study concentrated on three companies from each state to guarantee that every company was fairly represented. Each state's enterprises were chosen at random to guarantee that the whole case study region was covered. The firms have fully registered with the Federal Ministry of Works and Transportation. One hundred and sixty staff members of the selected contractors were given questionnaires in total. Due to withdrawals from the study, 14 participants could no longer participate, leaving 116 in the final sample.

For the respondent, a rate of 89.23% was obtained. The distribution and collection were finished in two months. The reliability tests were performed on each hazard's scale using Cronbach's α . To evaluate the coherence of responses to questions meant to depict a notion, Cronbach's α is calculated.

According to [21] the equation Cronbach's $\alpha = \frac{rk}{[1 + (k - 1)r]}$ (1)

Where:

K= is the number of items considered and

r = is the mean of the inter-item correlations.

The construct permits the deletion of negative α and the acceptance of positive α in the range of 0 to 1.2. According to [21], a dependable scale would have a coefficient greater than 0.7. The scale's consistency with the sample size and the strongly linked data are shown by the derived alpha score of 1.1. The mean inter-item correlations and the total number of items on the scale both affect the alpha's magnitude. The likelihood and the impact of the risk factors and hazards analysis are the two types of variables used in the research:

The mean of the scores will be determined using the data gathered from the surveys. The mean index formula is as follows:

$$\text{Mean index} = \frac{\sum a_i x_i}{N} \dots\dots\dots(2)$$

Where:

a_i = Constant expressing the weight to each enquire (1 to 5).

X_i = frequency of response.

N = total number of inquiries made.

The results were then used to assign the scores of likelihoods and consequences into hazardous assessment. The grading of the results to be assigned in the matrix analysis is as follows;

- (i) 1.0 - < 1.5; Rare.
- (ii) 1.5 - < 2.5; Minor.
- (iii) 2.5 - < 3.5; moderate
- (iv) 3.5 - < 4.5; major
- (v) 4.5 - < 5.0; Catastrophic.

Hazards matrix will be used to provide an indicative level of hazards to reflect the degree of hazards in each category. The matrix table is shown in table 2.

Level of consequence	Description
1	Insignificant
2	Minor
3	Moderate
4	Major
5	Catestrophic

X

Level of frequency	Description
1	Rare
2	Unlikely
3	Possible
4	Likely
5	Almost Certain

=

Probability	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5

Table 2: Matrix Table

Level of Hazards:

- (E) – Extreme = Detailed action required
- (H) – High = needs senior management attention
- (M) – Moderate = specify management responsibility
- (L) – Low = manage by routine procedure.

RESULTS, ANALYSIS AND DISCUSSION

Table 3 below reveals the demographic data of respondents and Table 4 is the year of working experience for the respondents.

Table 3 Professions of Respondents.

<i>PROFESSION OF RESPONDENTS</i>	No	%age	Cumm %age
At least degree certificate holder in related fields	22	18.97	18.97
Diploma or equivalent certificates	38	32.76	51.73
Tradesmen and below	56	48.28	100

Table 4: Years of Working Experiences

<i>YEARS OF WORKING EXPERIENCES</i>	No	%age	Cumm %age
1 – 3	61	52.59	52.59
3 - 6	36	31.03	83.62
Above 6	19	16.38	100

This shows that although 51.73% of respondents are usually well educated and have a wealth of experience in the construction industry, 48.28% of respondents are technical trainees. Research indicates that those with over six years of experience had a smaller percentage. The Chemical Hazards

evaluations made during project construction are shown in Table 5. Top management needs to be well aware of high-risk scenarios, and specific management tasks need to be taken care of in moderate-risk situations. In Figure 2, the chemical dangers are presented based on effect order.

Table 5: The identified chemical hazards in construction site

NO	Hazards	Probability	Impact	Level of hazards
1	Fumes	2.2	2	Moderate
2	Gases	2.5	2.6	Moderate
3	Pesticides	2.2	2.4	Moderate
4	Organic solvent.	2	2.3	Moderate
5	Adhesives	2	2.1	Moderate
6	Dry cement	3.6	3.2	High
7	Tar.	2.2	2.5	Moderate
8	Dust	4	3.7	High

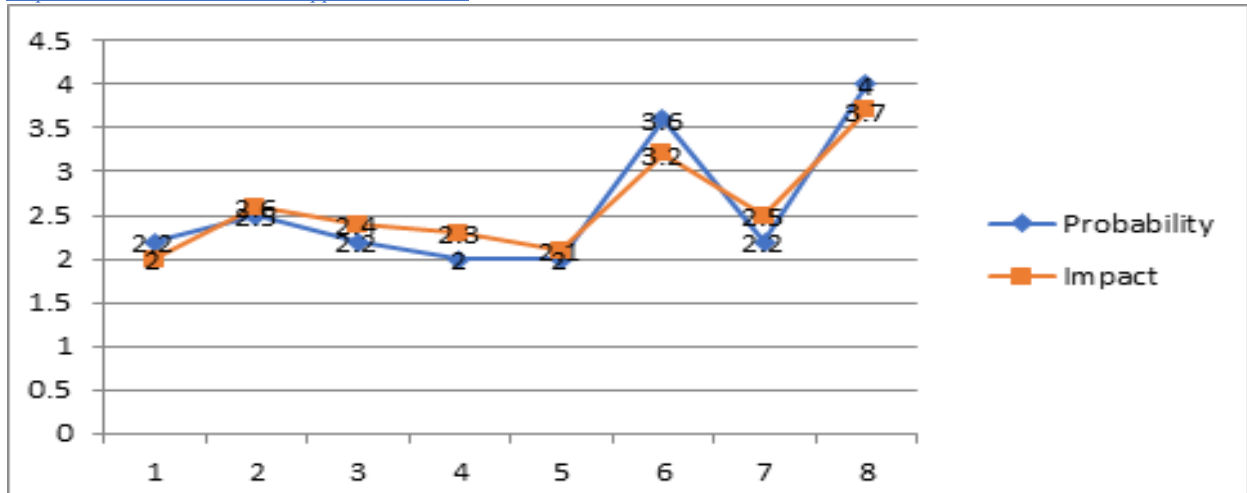


Figure 2: The graph of chemical hazards indicating the probability and impact
Physical hazards are shown in table 6 and the graph is shown in figure 3.

Table 6: Physical hazards

No	Hazards	Probability	Impact	Level of hazards
1	Noise	3.6	3.2	High
2	Heat	4	2.2	Moderate
3	Fire	2.5	2.6	Moderate
4	Cold	2.3	2.4	Moderate
5	Radiation	2.5	2.5	Moderate
6	Welding spark.	3.3	2.9	Moderate
7	Fire and other emergencies	2.3	2.8	Moderate
8	Vibration	3.6	3	High
9	Sun	3.3	3.4	Moderate
10	Snow	1.7	1.8	Moderate
11	Explosion	2	2.4	Moderate

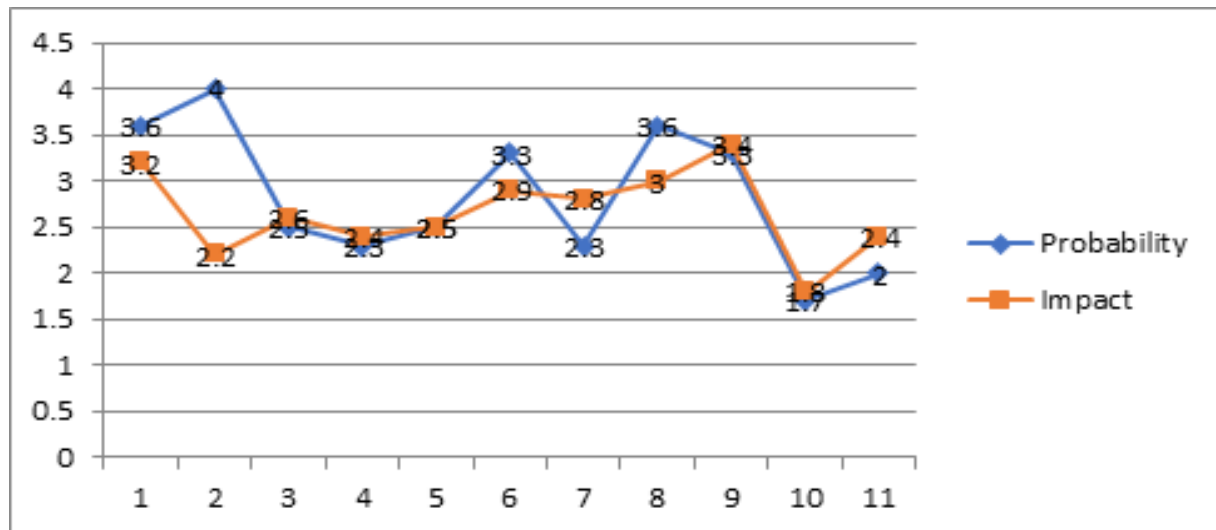


Figure 3: Representation of probability and impact of physical hazards

Figure 4 is the graph of the biological hazards in their order of impact and table 7 is showing the biological hazards.

The table 7 is showing the biological Hazards in project construction

No	Hazards	Probability	Impact	Level of hazard
1	Exposure to infectious micro organism	2.7	3	Moderate
2	Exposure to toxic substance of biological origin	2.5	2.6	Moderate
3	Exposure to animal attack	2.5	2.5	Moderate
4	Excavation Collapse	3	3.3	Moderate
5	Attack by animals	2.8	2.7	Moderate
6	Wood dust	2.5	2.1	Moderate

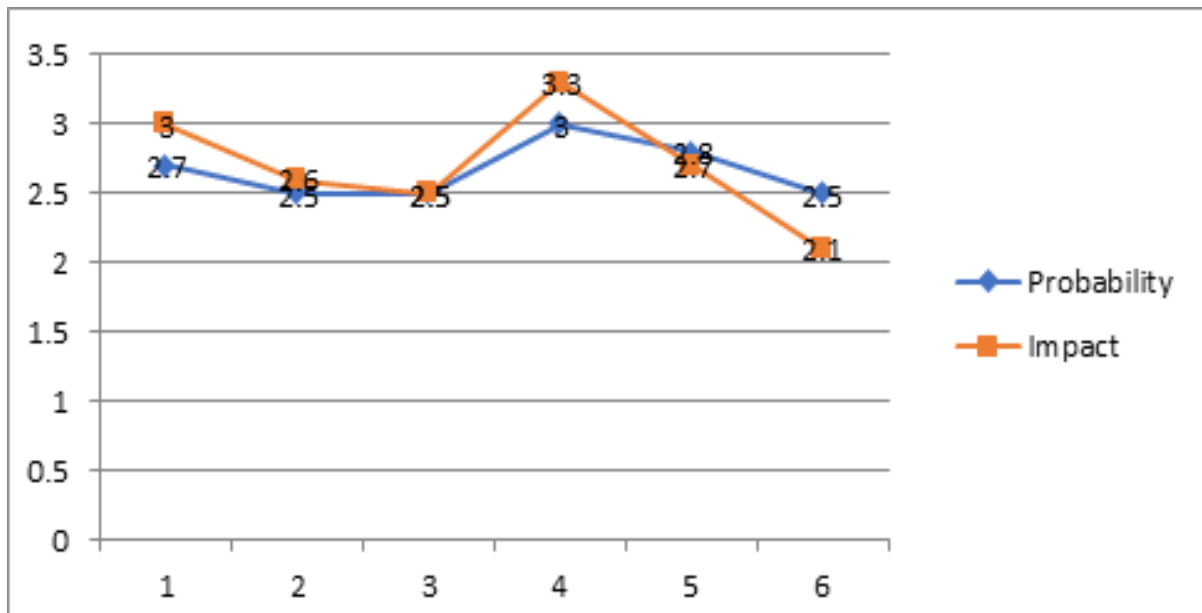


Figure 4: Representation of probability and impact of biological hazards

Table 8 is showing social hazards in project construction Figure 5 is the graph of the social hazards in their order of impact

Table 8: Social hazards in Eastern part of Nigeria.

No	Hazards	Probability	Impact	Level of hazards
1	Lack of job security	3.6	3.3	High
2	Lack of protection against falling object	2.5	2.9	Moderate
3	Un satisfactory working environment	3.2	3.3	Moderate
4	work overload / pressure	3.4	3.5	High
5	Job stress	3.5	3.5	High
6	Unsafe place of work	3.2	3.1	Moderate
7	Lack of stable and dependable network of soil support.	2.5	2.6	Moderate
8	Intense pressure to complete the work	3.2	2.4	Moderate
9	Repetitiveness	2.3	2.3	Moderate

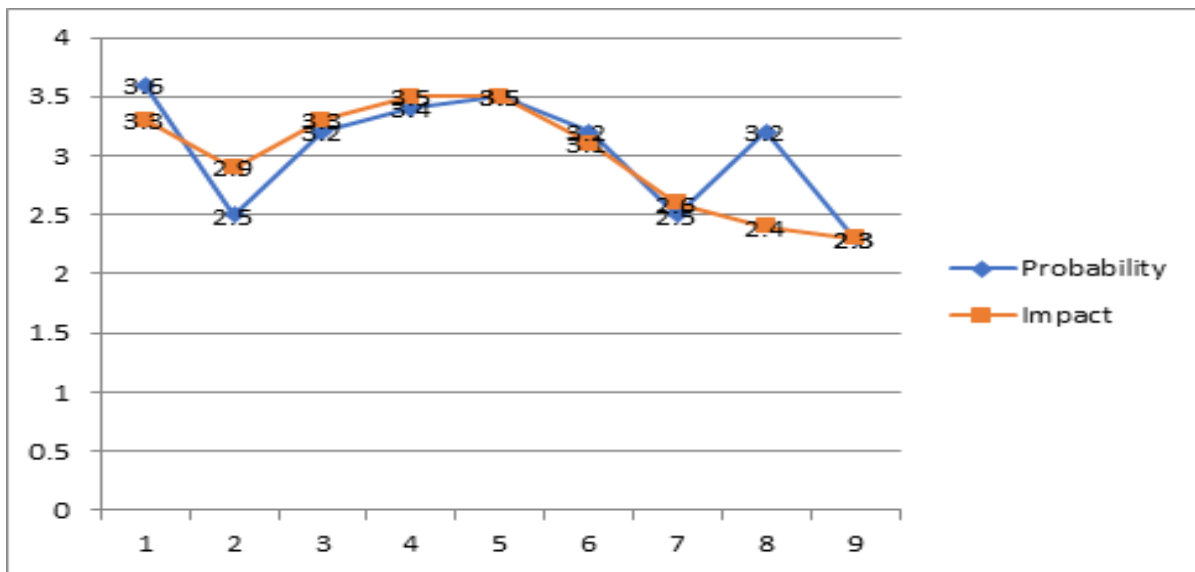


Figure 5: Representation of probability and impact of social hazards

Table 9 is the mechanical hazards in project construction and Figure 6 is the graph of the mechanical hazards in their order of impact

Table 9 Mechanical hazards in Eastern part of Nigeria.

No	Hazards	Probability	Impact	Level of hazards
1	Saw blades	2.7	2.6	Moderate
2	Air compressor	2.3	2.8	Moderate
3	crane	3	3	Moderate
4	Pneumatic hammer	2.6	2.7	Moderate
5	Power Saw	2.7	2.9	Moderate
6	Explosiveness	2.3	2.4	Moderate
7	Vehicle and traffic route	2.9	2.8	Moderate
8	Nail gun	2.3	2.4	Moderate

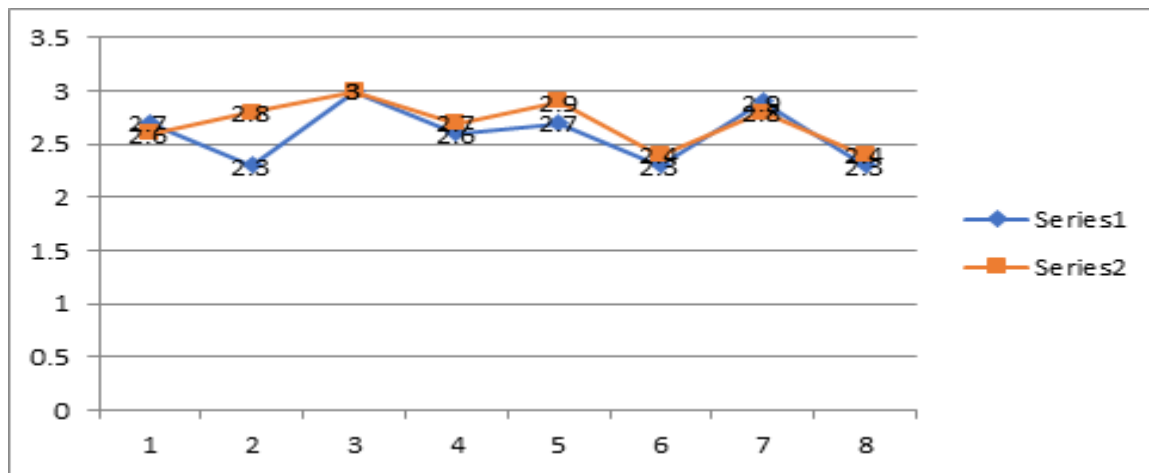


Figure 6: Representation of probability and impact of mechanical hazards

Discussion and Summary on types, classification and level of hazards

There are five distinct kinds of dangers that might occur throughout the course of a project, according to the statistics. These encompass hazards that are mechanical, chemical, physical, biological, and social. The table presents many dangers for every category, as per the analysis matrix table. The data makes it clear that social risk and social hazards make up the bulk of high-level risks for which senior management prepares and takes action in collaboration [22, 23, 24]. It is evident that, when it comes to the hazard variables taken into account at the project level, social risks rank highest. This is not surprising given the subpar safety record and disregard for safety requirements. As a result, many companies disregarded maintaining their tools and equipment in top condition and failed to provide the personal protection equipment that their workers

need for their safety, in agreement with [25,26,27]. Construction hazards were a major emphasis since there are many elements that affect building operations and require careful attention. The project could need to be stopped if negligence on the part of any party causes equipment failure or damage while it is being built. Social risks are undoubtedly the category with the greatest number of hazards, even though there are one or two other categories with high degrees of danger as well. Meanwhile. In conclusion, the results are in line with the literature, which demonstrates that inadequate safety performance, a lack of job security, work overload, and misunderstanding of safety standards are the most hazardous components of establishing a project between the places under investigation.

CONCLUSION AND RECOMMENDATION

This research uses a matrix approach to look at safety risks in the building industries in eastern Nigeria. The frequency or seriousness of recognized hazards

did not significantly differ between employers and construction workers, according to the study. The investigation also showed that there are no safety

regulations in place when building projects are underway. The study's objectives are to identify crucial construction project operational components and increase public knowledge of safety laws. It designates occupations that have a significant risk of diseases or accidents, such as running machinery without permission, using defective tools, creating a lot of noise, working on slick surfaces, lacking edge protection, collapsing temporary constructions, and carrying out hazardous demolition. Dry cement, dust, noise, vibration, lack of job security, work overload, stress, attitudes, ignorance of safety regulations, subpar performance, refusal to use safety devices, shifts in political power, inflation, and equipment failure or damage during construction are examples of high-level hazards. Through the dissemination of questionnaires and mini-training sessions, the research sought to identify possible risks to customers, suppliers, and the general public. Raising workers' attention, identifying operational components, removing incomplete information, and educating participants about event patterns were the objectives. The second and third goals were to define, assess, and analyze the extent to which hazards take into account the people who are in danger. Each hazard's relative chance of happening as well as its effect will be assessed. The results will be tabulated according to the categories of hazards, with a list of all the risks and their corresponding subheadings. Every hazard will have its impact and likelihood calculated, and a qualitative method will be used to assess each hazard's degree. The hazards

Through the identification of current and prospective dangers before work commencing or new projects, the research seeks to promote a good health, safety, and environmental culture within the construction sector. It attempts to decrease accidents and risky practices by making risks a top priority in the

are included in the table along with their subheadings, and the kind, intensity, and classification of the threats are shown. The researcher contends that encouraging higher health and safety standards is a major responsibility of building clients. To guarantee that health and safety regulations are followed on site, they should request proof of a contractor's excellent performance and health and safety record throughout the tendering process. For site workers, proper training is also crucial. Contractors should prioritize managing hazards in their projects such that the most serious risks receive the most attention to avoid catastrophic outcomes. To satisfy customers and end users and guarantee timely, cost-effective, and high-quality project delivery, other risks should also be controlled. The study's conclusions highlight the significance of giving risks top priority to avoid catastrophic consequences for the project. Contractors need to understand how important risk management is for their projects and that there are preventable or controlled construction dangers. Wearing weather-resistant clothes and other personal protection equipment (PPE) is advised for dangers and hazards that are too great to handle. Because PPE shields employees from hazards to their health and safety, it should be used as a "last resort" when implementing control measures. When thinking about control methods, contractors should weigh the advantages of controlling construction hazards and reserve the use of personal protective equipment (PPE).

CONTRIBUTION TO KNOWLEDGE

building industry of Eastern Nigeria. Additionally, the research attempts to inspire employees to apply acquired skills to attain and sustain excellent safety performance in their specialized fields. Reducing the likelihood of accidents and enhancing overall safety performance is the ultimate objective.

REFERENCES

1. H. J. Joshi, "Construction Site Safety," in *Advances in Civil Engineering*, vol. 2017, Article ID 3462831, 6 pages, 2017. <https://doi.org/10.1155/2017/3462831>.
2. G. Mehta, P. Nambiar, and S. Mehta, "Job Safety Analysis as an Effective Tool for Hazard Identification and Risk Assessment in the Construction Industry," *Journal of Construction Engineering and Management*, vol. 140, no. 7, 2014. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000864](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000864).
3. "OSHA Hazard Identification Training" [Online]. Available: <https://www.osha.gov/training/library/hazard-identification>.
4. A. Dehghan et al., "Identification and Evaluation of Hazards in Construction Industry by Brainstorming and Quality Function Deployment Techniques," *Journal of Safety Research*, vol. 45, 2013, pp. 33-41. <https://doi.org/10.1016/j.jsr.2012.12.005>.
5. A. H. Choudhry and F. S. Hussain, "Critical Factors Causing Cost Overruns in Large Construction Projects in Pakistan," *Journal of Construction Engineering and Management*, vol. 139, no. 6, 2013. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000656](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000656).
6. A. F. Elmir et al., "Occupational Safety and Health and Its Impact on the Environment in UAE," *Journal of Construction Engineering and Management*, vol. 139, no. 3, 2013. [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0000627](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000627).
7. B. Hasnan et al., "Safety Management in Construction Sites: Literature Review," *Journal of Engineering and Applied Sciences*, vol. 11, no. 6, 2016, pp. 1250-1255.

- <https://doi.org/10.3923/jeasci.2016.1250.1255>.
8. S. B. Barnes, "Rethinking Construction: The Hazards of Construction Work," *Journal of Industrial Relations*, vol. 43, no. 4, 2001, pp. 471-486. <https://doi.org/10.1111/1472-9296.00224>.
 9. N. M. Rees, "Occupational Health and Safety in the Construction Industry," *Journal of Civil Engineering and Management*, vol. 10, no. 4, 2004, pp. 283-291. <https://doi.org/10.3846/13923730.2004.9636341>.
 10. C. R. Meyer, "Probabilistic Hazard Analysis Methods in Civil Engineering: A Review," *Structural Safety*, vol. 48, 2014, pp. 53-66. <https://doi.org/10.1016/j.strusafe.2013.10.003>.
 11. Joint Professional Training and Support (2011). Onshore offshore health safety and Environments, supervision course level I & II handbook.
 12. O.O Ugwu and J.C Agunwamba (2011). *Civil Engineering Practice and Entrepreneurship*.
 13. Ozulu.S (2010). *Project Management Risk in Construction. Risk and hazards in Construction. Health, Safety and Environmental Management Risk Evaluation Strategy*: Harlow: Longman (co-published with chartered institute of Building. Great Britain..
 14. Phil.Hughes (2011). *Handbook professionals and Students on National Examination Board in Occupational Safety and Health*.
 15. Samaneh Zolfagharian, Aziruddin Ressang, Jevier Irizarry, and Mehdi Nourbakhsh, Rosli Mohamad (2011). *Risk Assessment of Common Construction Hazards among Different Countries*.
 16. *Construction (Design and Management) Regulations 2015*. (2015). Legislation.gov.uk. <https://www.legislation.gov.uk/uksi/2015/51/contents/made>
 17. *Health and Safety at Work etc. Act 1974*. (1974). Legislation.gov.uk. <https://www.legislation.gov.uk/ukpga/1974/37>
 18. Health and Safety Executive. (n.d.). *Construction Phase Plan (CDM 2015)*. <https://www.hse.gov.uk/construction/cdm/plan.htm>
 19. Jeong K.-S., Lee K.-W., Lim H.-K. (2010). Risk assessment on hazards for decommissioning safety of a nuclear facility. *Annals of Nuclear Energy* 37:1751-1762.
 20. Nnadi Ejiofor, Alintah-Abel Uchechi, and Iheama Ndidi (2018) Impact of Sustainable Construction on Environmental and Health Risk in Nigerian construction industry, *Journal of Civil, Construction and Environmental Engineering (JCCEE)*. Vol. 3. No 4. Pp 99- 105
 21. Pallant J. (2001) *SPSS Survival Manual. A step-by-step guide to data analysis using SPSS for Windows (Version 10-11)* Open University Press, Buckingham.
 22. E.O.E Nnadi, E.C. Enebe and O.O. Ugwu (2018) Evaluating the awareness level of risk management amongst construction stakeholders in Nigeria, *International Journal of Construction Engineering and Management* 2018, 7(1): 47-
 23. Zohar, D. (2010). Thirty years of safety climate research: Reflections and future directions. *Accident Analysis & Prevention*, 42(5), 1517-1522.
 24. Amarachi, B. N., Ezekiel, N., & Eze, V. H. U. (2024). Evaluating Public Procurement's Challenges in Nigeria's Construction Industry. *International Journal of Recent Technology and Applied Science*, 6(1), 25–36. <https://doi.org/10.36079/lamintang.ijortas-0601.621>
 25. Hinze, J., & Thurman, S. (2014). Leading indicators of construction safety performance. *Safety Science*, 64, 120-130.
 26. Nwamgbowo, P., Ezekiel, N., Eze, V. H. U., & Nathan, K. (2023). Quantification of Earth Material for Sustainable Road Works in Southeast Nigeria. *Journal of Engineering, Technology & Applied Science*, 5(3), 99–109. <https://doi.org/10.36079/lamintang.jetas-0503.59>
 27. Hinze, J., & Gambatese, J. A. (2003). Factors that influence safety performance of specialty contractors. *Journal of Construction Engineering and Management*, 129(2), 159-164.

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