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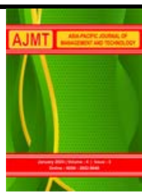

Original Article

Identification of Occupational Hazard in High-Rise Building Construction Projects

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Abstract

Occupational hazards in high-rise building construction projects pose significant threats to the well-being of workers. This research aimed to comprehensively study these hazards, employing a mixed-methods approach for data collection. Primary data were gathered through field observation, questionnaire surveys, and Key Informant Interviews (KII). Convenient sampling was employed to select 75 respondents for the study on occupational hazards in high-rise construction. This method facilitated practical and accessible participant recruitment for data collection. Data analysis for the study was conducted using the statistical tool SPSS. The result revealed that working at height was the major physical hazard, cement and stone dust were the primary chemical hazard, live wires were the major electrical hazard, and continuous overtime work was the predominant physiological hazard. Job dissatisfaction emerged as a major psychological hazard. Additionally, the study highlights the importance of proactive hazard identification and emphasizes the need for preventive measures. Through these insights, the construction sector can strive towards creating a safer and healthier work environment, ultimately reducing accidents and enhancing the overall well-being of workers involved in high-rise building projects.

Keywords: *Construction Projects; Occupational Hazard; Accidents; Preventive Measures*

Introduction

Construction is inherently hazardous, with repetitive activities posing risks. Its growth significantly influences the economy, contributing to a nation's development and overall economic progress (Manzoor, Othman & Waheed, 2022). The Government of Nepal places a high priority on development, focusing on enhancing the country's infrastructure (Rimal *et al*., 2015). Despite the rapid growth of the construction sector, challenges persist in effectively addressing and ensuring construction site safety (Giri, Poudel & Shrestha, 2023). The construction sector is crucial for economic development, influencing national progress significantly (Durdyev & Ismail, 2012). However, the inherent hazards in construction sites, involving heavy machinery, moving vehicles, elevated tasks, diverse environmental conditions, and substantial reliance on temporary and untrained labor, pose considerable risks (Ajith, Sivapragasam & Arumugaprabu, 2019). The expansion in construction activities has led to the neglect of many hazards and unsafe practices, often employing inadequately trained and unskilled workers to expedite project completion (Osei-Asibey *et al*., 2023).

Ensuring occupational safety and health relies on the adept identification and management of workplace hazards through a proficient risk assessment process (Lari, 2024). These hazards encompass a spectrum of elements, including physical, chemical, biological, mechanical, electrical, and psychological

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factors, leading to workplace incidents and injuries that can have implications for organizational productivity and profitability. Effectively addressing and managing hazards that may have gone unnoticed can contribute significantly to the reduction of accident rates (Vredenburgh, 2002). Workplace accidents, also known as occupational accidents, occur in the course of employment. According to statistics from the International Labour Organization (ILO), there are more than 337 million on-site accidents annually, resulting in over 2.3 million deaths attributed to occupational diseases (Memon, Abas & Sohu, 2023).

The process of Hazard Identification and Risk Assessment involves identifying potential events that may result in hazards, analyzing the hazards associated with these events, and typically estimating the scope, scale, and likelihood of adverse effects. Across industries, there is broad consensus regarding the significant contribution of various risk assessment techniques to enhancing safety in intricate operations and with equipment (Tubis, Werbińska-Wojciechowska & Wroblewski, 2020). Health and safety hazards can originate from diverse sources, encompassing substances, materials, processes, and practices capable of causing harm (Mouras & Badri, 2020). High-rise construction witnesses frequent accidents, resulting in injuries, fatalities, and harm, highlighting the inherent risks workers face annually (Manzoor, Othman & Manzoor, 2021). The prevailing trend in construction is the construction of high-rise buildings, driven by their convenience, benefits, architectural appeal, status, and luxury. However, what many may not be aware of is the multitude of safety risks associated with their construction (Boadu, Wang & Sunindijo, 2020). The construction of high-rise buildings introduces complexities in structural design, work intricacies, and potential project risks (Waqar *et al*., 2023). Ensuring safety performance poses a significant challenge in high-rise building construction, primarily due to elevated operations and the excavation of deep foundation pits, leading to notably higher accident rates and more severe injuries compared to moderate and low-rise buildings. Persistent threats include injuries and fatalities resulting from falls and the impact of falling objects (Kayastha, 2023).

Construction workers face a diverse range of health hazards during their jobs, with exposure varying across different trades, jobs, days, and even hours (Koranyi *et al*., 2018). Typically, exposure to a specific hazard is intermittent and of short duration but has the potential to reoccur. The current state of identifying occupational hazards for various jobs during the construction of high-rise buildings, assigning scores for different risk levels, and implementing necessary prevention and control mechanisms to manage accidents and diseases is subpar and demands significant attention. Safety stands out as a critical performance indicator for project success. Unfortunately, comprehensive and systematic construction job safety procedures for such building construction activities are rare in existing high-rise building projects (Mishra & Aithal, 2021). The implementation of such procedures could prove highly beneficial in controlling accidents, minimizing fatal and non-fatal injuries, and saving both time and significant costs, along with human lives.

The pursuit of enhanced safety performance in Nepalese construction involves multifaceted strategies. Giri (2023) emphasizes measures such as new employee orientation, safety audits, and the provision of Personal Protective Equipment (PPE) to prevent accidents and improve safety management practices. However, Sukamani and Wang (2020) note that safety and health measures in Nepalese construction lack effective implementation and remain informally stated. The inadequacy of safe working environments is linked to a dearth of organizational policies, resources, and effective management within the construction industry in Nepal (Sharma, 2019). To mitigate construction site accidents, fostering a healthy workforce, enhancing work efficiency, and reducing fatalities are vital (Giri, 2023). Additionally, Balkis, Janani, and Gandhi (2021) stress the importance of identifying and addressing root causes to minimize construction risks, emphasizing proactive hazard identification and mitigation strategies. Given this context, the researcher aims to conduct a comprehensive study on safety hazards in high-rise building construction projects in Nepal. The objective is to identify, analyze, and propose effective measures to address safety concerns. By addressing root causes, implementing proactive hazard identification strategies, and fostering a safety-centric work culture, the research endeavors to contribute valuable insights for improving safety practices in Nepalese high-rise construction.

Methodology

Both quantitative and qualitative research methodologies were employed in this study to collect data. The quantitative approach involved systematically gathering numerical data that could be subjected to statistical analysis. This method was implemented using data obtained through questionnaire surveys. On the other hand, qualitative data was acquired through a literature review and KII. The study focused on high-rise building construction projects located in Pokhara Metropolitan City, Kasi District, Nepal. The research encompassed four construction sites, where the total workforce during the survey period was approximately 317 individuals. The sample comprised project managers, site engineers, sub-contractors, supervisors, and workers with over 5 years of work experience in similar building construction projects.

Top of form the creation of questionnaires drew on various literature reviews. These questionnaires were then disseminated to chosen participants in paper form. The distribution of the complete set of questionnaires took place through on-site visits to the construction sites. Within the questionnaire, a 5-point Likert scale was employed, allowing respondents to indicate their level of agreement or disagreement on a symmetric scale concerning a series of statements related to the identification of occupational hazards. To cross-reference the data derived from the questionnaire survey for validity and reliability, KII was conducted. The Project Manager overseeing the selected building projects conducted these interviews. Four experts, each with over five years of experience in the high-rise building construction sector, were chosen for the KII.

Reliability of Research Instrument

The methodology employed for this research was formulated through an extensive literature review and discussions with the guidance of expert supervisors, experienced academicians, and professionals to ensure that the study is genuine and reliable. A thorough research instrument was fabricated and tested before commencing the actual investigation. The questionnaires were developed based on past research of similar scope and input from experts. The compositions were then edited and chosen in light of the study subject. Cronbach's alpha was calculated to confirm the validity and reliability of the study questionnaire. Data from various projects was comprehensively analyzed and consolidated.

Relative Important Index (RII)

The Relative Importance Index (RII) is a non-parametric tool that is widely used by researchers in construction and facilities management to look at structured questionnaire responses, especially when the data includes an ordinal measure of attitudes. In this section of the questionnaire, a five-point Likert scale ranging from 1 to 5 was utilized. Where 1 = Strongly Disagree and 5 = Strongly Agree. The formula for calculating the RII for each sustainable criterion is as follows:

$$\text{RII} = \frac{\sum \text{W}}{\text{A} \times \text{N}} = \frac{5n5 + 4n4 + 3n3 + 2n2 + n1}{5(\text{n+n2+n3+n4+n5})}$$

Where, W = weighting that is assigned to each variable by the respondent, A = highest weight, and N = total number of respondents. The RII value ranges from 0 to 1 with 0 not inclusive. It shows that the higher the value of RII, the more important the sustainable criteria and vice versa (Sakhare & Chougule, 2019).

Results and Discussion

Table 1 provides a comprehensive snapshot of the demographic profile of respondents involved in the study. The age distribution reveals a significant portion, 49.3%, falls within the 31-40 age range, followed closely by 44.0% in the 41-50 age bracket. Gender-wise, the majority, 88.0%, are male. Marital status indicates that 88.0% of respondents are married. The educational background shows a diverse range, with 41.3% having completed SLC, and 33.3% falling into the "Others" category. Experience levels are balanced, with 45.3% having 5 to 10 years of experience and 54.7% having more than 10 years. The office designation breakdown includes 42.7% as Skilled Labor, and other roles such as Engineers, Supervisors, Contractors/Subcontractors, and Unskilled Labor are also represented. This detailed demographic analysis provides a foundation for understanding the composition of the respondents participating in the study.

Table 1: Demographic profile of respondents.

Demographic Characteristics	Frequency	Percentage (%)
Age		
31-40	37	49.3
41-50	33	44.0
50-60	5	6.7
Gender		
Male	66	88.0
Female	9	12.0
Marital Status		
Single	9	12.0
Married	66	88.0
Education Level		
SLC	31	41.3
Higher Secondary (+2)/Diploma	9	12.0
Bachelor	8	10.7
Masters or above	2	2.7
Others	25	33.3
Experience		
5 to 10 years	34	45.3
More than 10 years	41	54.7
Sector of Wording Experience		
Engineer	9	12.0
Supervisor	10	13.3
Contractors/Subcontractor	4	5.3
Skilled Labour	32	42.7
Unskilled Labour	20	26.7

Source: Field Survey, 2023

Reliability of Questionnaires

Cronbach's Alpha serves as a metric to assess the internal consistency of a questionnaire or survey, ranging from 0 to 1, where higher values indicate greater reliability. The categorization of Cronbach's Alpha values is as follows: An excellent level is attributed to values ranging from 0.9 to 1, a good level falls between 0.8 and 0.9, an acceptable range is from 0.7 to 0.8, the internal consistency is considered questionable when the value is between 0.6 and 0.7, poor internal consistency is associated with values between 0.5 and 0.6, and an Alpha value less than 0.5 is deemed unacceptable (Saidi & Siew, 2019).

Table 2 presents the assessment of internal consistency using Cronbach's Alpha for various types of hazards. For physical hazards, the calculated Cronbach's Alpha value is 0.858, falling within the "Good" range, indicating a reliable and internally consistent measurement of this category of hazards. Chemical hazards exhibit an Alpha value of 0.798, categorized as "Acceptable," suggesting moderate internal consistency. Similarly, electrical hazards, physiological hazards, and psychological hazards all demonstrate Cronbach's Alpha values ranging from 0.784 to 0.793, falling within the "Acceptable" range. These results collectively suggest that the survey or questionnaire effectively captures and measures the different hazards, with varying degrees of internal consistency across the distinct hazard categories.

Table 2: Coefficient of Cronbach's Alpha.

Different Hazards	Cronbach's Alpha
Physical hazards	0.858
Chemical hazards	0.798
Electrical hazards	0.793
Physiological hazards	0.793
Psychological hazards	0.784

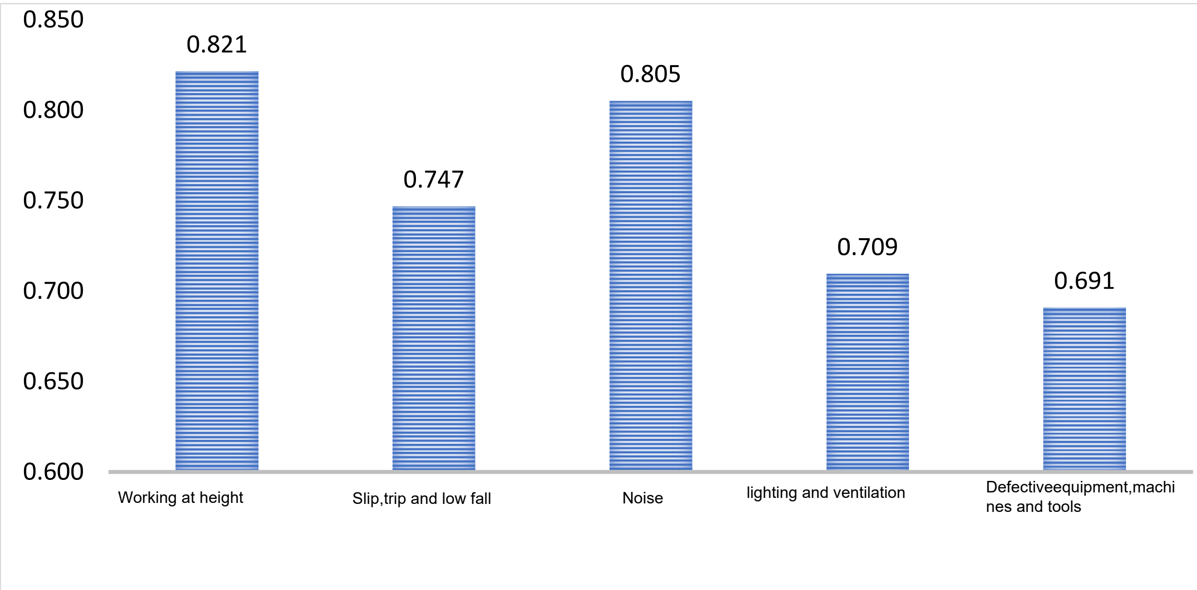
Source: Field Survey, 2023

Identification of Occupational Hazards in Construction Projects

Various hazards were surveyed among construction project stakeholders, including engineers, developers, and representatives from contractors and sub-contractors. The collected data underwent analysis using statistical tools such as SPSS and RII. This method allowed for a comprehensive examination of diverse hazard types and provided valuable insights into the risk perceptions within the construction industry.

Physical Hazards in Construction Projects

Figure 1 illustrates the predominant physical hazards in construction projects based on responses from a questionnaire survey. Working at height emerges as the foremost concern, garnering the highest RII value of 0.821, as indicated by respondents. Following closely, noise ranks as the second major hazard with an RII of 0.805, while slip trips and low falls secure the third position at 0.747. Poor lighting and ventilation, along with defective equipment, machines, and tools, claim the fourth and fifth spots, respectively, with RII values of 0.709 and 0.691. KII, which emphasizes the significance of addressing hazards related to working at height in construction projects, further supports this consensus.



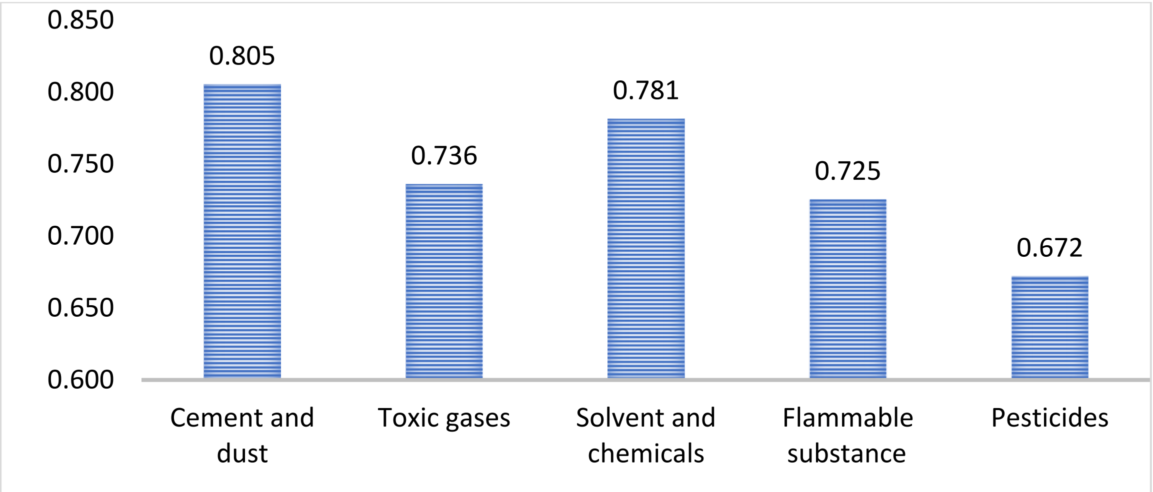
Source: Field Survey, 2023

Figure 1: Source of physical hazards in construction projects.

Working at height was observed as the major physical hazard, as there was different work that should be performed in building construction work, such as installing steel frames, concrete pouring, window installation, and facade work, often requiring workers to operate on scaffolds, platforms, and narrow ledges. The potential for slips, trips, and missteps is heightened, and the consequences of falling from significant heights are far more severe compared to ground-level accidents.

Chemical Hazards in Construction Projects

In Figure 2, respondents in a construction project questionnaire survey highlight cement and stone dust as primary chemical hazards, securing the highest RII at 0.805. Toxic gases come in third on the site (RII 0.736), after solvents and chemicals (RII 0.781). Flammable substances and pesticides are placed fourth and fifth, with RII values of 0.725 and 0.672, respectively. Corroborated by KII, the findings underscore cement and stone dust as the main chemical hazards, emphasizing the need for robust safety measures to address these specific risks in construction projects.



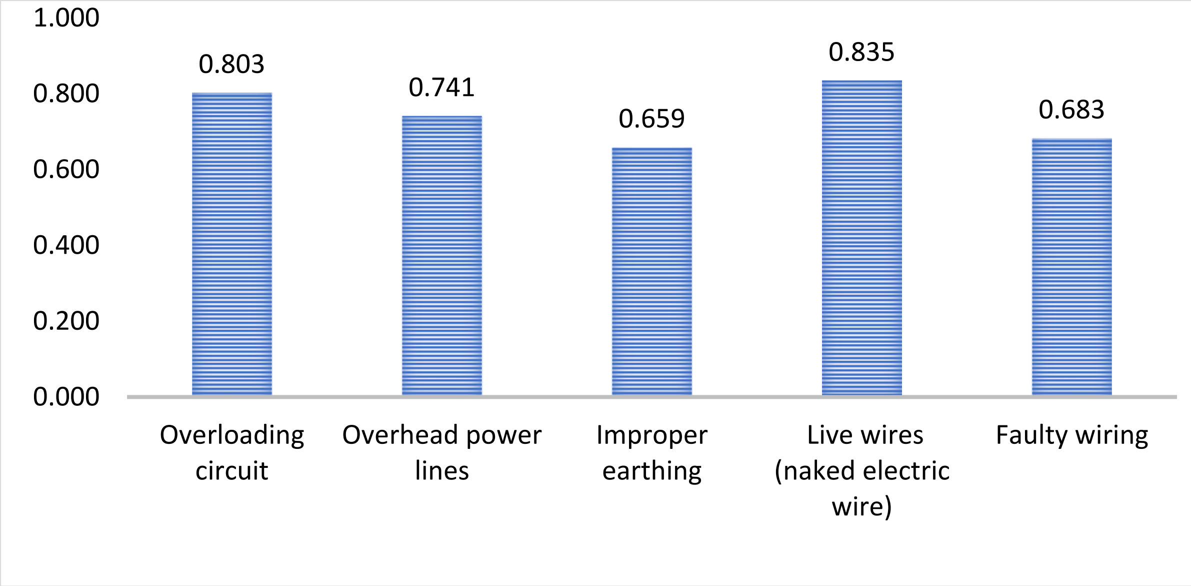
Source: Field Survey, 2023

Figure 2: Source of chemical hazards in construction projects

Dust and chemicals emitted from cement and stone pose health risks to both workers and nearby individuals. These substances may contain harmful elements, leading to lung issues, skin-related diseases, eye irritation, and other health concerns. Despite the use of ready-mix concrete with a hydraulic concrete distributor boom for extensive concreting, manual mixing of cement is noted for specific tasks like mortar, tiles, marble, and stone work. Recognized as significant chemical hazards on construction sites, cement and stone dust necessitate precautionary measures such as wearing masks and implementing proper handling systems to mitigate dust exposure and safeguard the health of workers and those in the construction site vicinity.

Electrical Hazards in Construction Projects

In Figure 3, respondents in a construction project questionnaire survey identify live wire (naked electric wire) as the foremost electrical hazard, holding the highest RII at 0.835. Overloading circuits come in second place (RII 0.803), with overhead powerlines coming in third (RII 0.747). Additionally, faulty wiring and improper earthing are noted as the fourth and fifth electrical hazards, with RII values of 0.683 and 0.659, respectively. The findings, which are consistent with KII, highlight live wire as the main electrical hazard and emphasize the need for increased attention to electrical safety measures in construction projects.



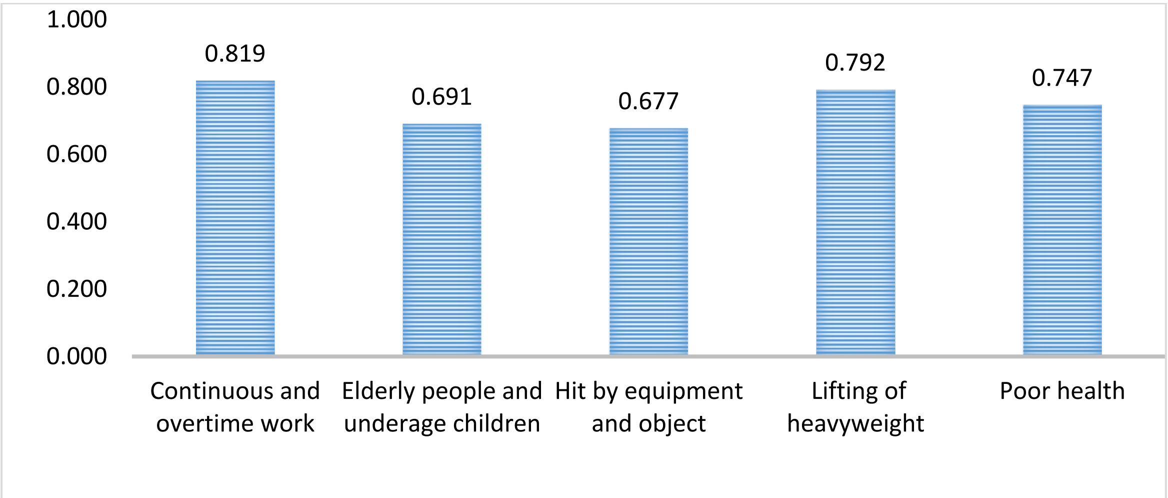
Source: Field Survey, 2023

Figure 3: Source of electrical hazard in construction projects.

The complexity of high-rise construction projects involves a lot of electrical work, including wiring for lighting, power outlets, and equipment. This abundance of electrical installations increases the likelihood of exposed live wires. When a worker accidentally comes into contact with a live wire, electricity can flow through their body, causing severe injuries or even fatalities. Live wires can easily come into contact with water or wet surfaces, such as rain or puddles, on construction sites. When electricity meets water, it can create a dangerous situation where the water acts as a conductor, increasing the likelihood of electrical accidents.

Physiological Hazards in Construction Projects

In Figure 4, respondents in a construction project questionnaire survey highlight continuous and overtime work as the predominant physiological hazard, with the highest RII at 0.819. Poor health is third on the site (RII 0.747), lifting heavy weights is second (RII 0.792). The survey places hitting by equipment and objects as the least dangerous physiological hazard (RII 0.677), while elderly people and children under the age of 18 rank fourth (RII 0.691). The findings, which have the support of KII, emphasize the importance of addressing continuous and overtime work for the wellbeing of construction workers.



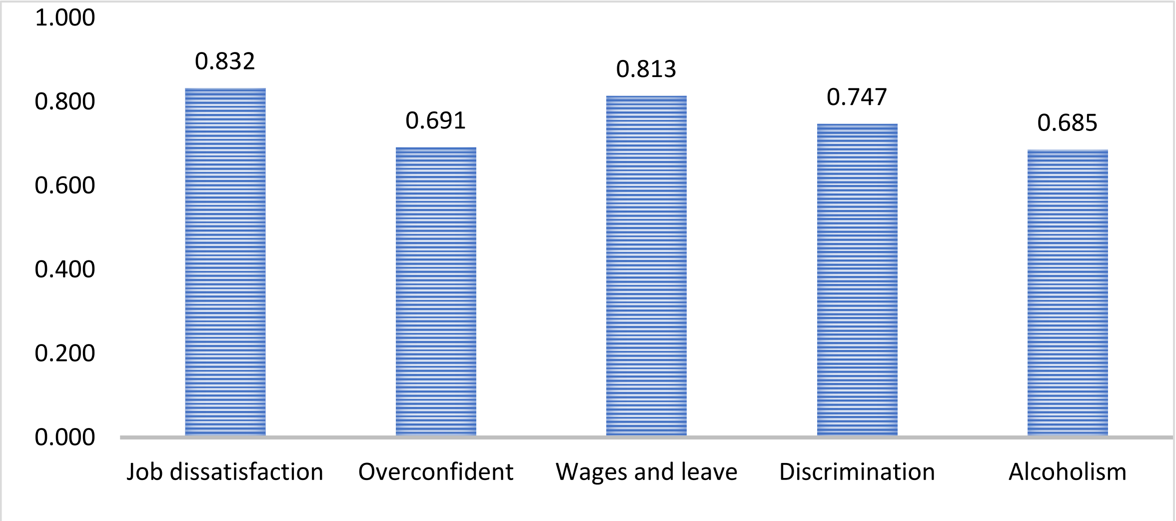
Source: Field Survey, 2023

Figure 4: Source of physiological hazard in construction projects

The demanding nature of construction work, characterized by extended hours and overtime, leads to mental and physical exhaustion, causing fatigue and muscle strain. Recognized as a major physiological hazard, continuous and overtime work poses serious health risks to construction workers, elevating the potential for accidents and injuries. To safeguard workers' well-being, construction companies must strategically manage work schedules and ensure sufficient rest periods, mitigating the adverse effects associated with prolonged and strenuous work conditions.

Psychological Hazards in Construction Projects

Figure 5 illustrates the collective views of respondents on the sources of psychological hazards in construction projects, derived from a questionnaire survey. Job dissatisfaction emerges as a significant concern, ranking highest with an RII value of 0.832. Wages and leaves follow closely as the second psychological hazard at 0.813, while discrimination on-site ranks third with an RII value of 0.747. The survey, corroborated by Key Informant Interviews, identifies job dissatisfaction as the primary psychological hazard in construction projects.



Source: Field Survey, 2023

Figure 5: Source of psychological hazard in construction projects

The Occupational Safety and Health Administration (OSHA) of the United States classifies falls, object strikes, electrocutions, and caught-in/caught-between incidents as major hazards in construction. Notably, slip, trip, and fall occurrences emerge as the primary contributors to fatalities in the construction industry (Satapathy, 2022). Rani *et al*. (2022) emphasize crucial factors influencing the well-being of construction site workers, encompassing aspects such as salary packages, working hours, workers' welfare, working environment, monitoring, communication, and collaborative project leadership. In high-rise building construction projects, Raamkumar and Indhu (2022) highlight significant risk factors, including physical aspects of work, a safe working environment, safety behavior, and protective measures. Additionally, a study by Samanta and Gochhayat (2023) in India identifies significant safety issues affecting construction sites. These challenges include inadequate communication, non-use of personal protective equipment, incorrect work postures, a lack of training, psychological stress, an absence of safety orientation and culture, and issues related to compliance with legislation. Enhancing the health and safety of construction workers necessitates the crucial implementation of effective training and awareness programs on construction sites (Giri, 2020).

Construction jobs entail demanding physical labor, exposure to harsh weather, and safety risks, causing both physical and mental stress. The temporary nature of many roles adds uncertainty about employment, benefits, and career growth. These challenges contribute to job dissatisfaction, identified as a significant hazard. Addressing this issue is crucial for enhancing working conditions and safeguarding the overall well-being of construction workers.

Conclusion

Occupational hazards encompass potential sources, conditions, or situations at a workplace that pose risks to employees' well-being. Hazard identification involves recognizing potential dangers at a job site, anticipating possible harm, and implementing measures to enhance safety for all involved in construction. Research focuses on high-rise building construction hazards, aiming to understand and address occupational risks for worker health and safety. To achieve the research objective, primary data were gathered through questionnaire surveys involving engineers, supervisors, sub-contractors, and workers. KII, along with project managers and on-site field observations, assessed risks. Additionally, secondary data from journals, reports, and construction site documents, obtained from various sources, supplemented the comprehensive analysis of occupational hazards in high-rise building projects.

This study employed a comprehensive methodology to identify and assess potential hazards during high-rise building construction in Pokhara Metropolitan City, Nepal. Risk assessment was conducted by evaluating the likelihood and severity of identified hazards using SPSS for data analysis. In the study involving 75 respondents, key occupational hazards in high-rise building construction were identified through the RII. Working at height was the predominant physical hazard (RII 0.821), while chemical risks were notable with cement and stone dust (RII 0.805). Live wires (RII 0.835), physiological risks from continuous and overtime work (RII 0.819), and psychological issues related to job dissatisfaction (RII 0.832) were the three main electrical hazards. These insights underscore the multifaceted nature of occupational risks in construction. The findings emphasize the importance of recognizing and addressing occupational hazards, offering insights for preventive measures. The study advocates for the implementation of strategies to reduce or eliminate identified hazards, promoting a safer workplace environment for construction workers. By prioritizing preventive measures, the construction sector can mitigate potential accidents, enhance worker well-being, and contribute to an overall healthier and safer work environment in high-rise building projects.

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Conflict of Interest

The authors declare no financial conflicts or personal relationships influencing the reported work, ensuring research integrity and unbiased findings in this paper.

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