

Investigating the Key Factors Influencing Falling Object Incidents at Construction Sites in Batu Pahat, Johor

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Abstract

Building construction refers to the methods and businesses associated with assembling and erecting structures, particularly those designed for residential purposes. The need for a controlled environment to mitigate the effects of climate change was initially purely functional. A construction site presents a wide range of ever-evolving threats, with risks that are often unique to the construction business. Therefore, ensuring that workers are well-trained and aware of these risks is essential for safeguarding themselves and their coworkers from potential harm or even fatalities. This research aims to explore the root causes and consequences of falling object incidents on individuals, assets, and reputation within the construction industry. Thoroughly analyzing the root causes and consequences of incidents informs the development of a targeted intervention plan. This plan aims to reduce severity and address specific issues, such as inadequate safety measures or equipment failures, with the overarching goal of significantly decreasing falling object incidents. This study employs a survey questionnaire as its methodological tool. The procedure includes conducting literature reviews and incorporating sample survey questionnaires from previous researchers. The methodology used to analyze the statistical data was SPSS software via Reliability Tests, One-way ANOVA Tests, and Correlation and Interferential Analysis. The results revealed a strong statistical correlation ($r > 0.5$, $n = 50$, $p < 0.05$) between organizational/departmental roles and responsibilities, the behavioral behavior of construction workers, incidents at work, health/disease problems, and the consequences of the incident. Therefore, to mitigate all the potential consequences, some intervention plans are being proposed, such as the implementation of Toolbox Meeting (TBM) and Toolbox Talk (TBT), a Toolbox Training Program, and the monitoring of physiological conditions for construction workers to maintain the well-being of the workforce and ensure a safe working environment.

1. Introduction

Construction, also referred to as building construction, encompasses the techniques and commercial activities involved in the assembly and erection of structures, primarily residential ones. The first purpose of establishing a controlled environment to counteract climate effects was primarily utilitarian. An effective means by which individuals might acclimatize to many regions and establish themselves as a genuinely worldwide species was

through the utilization of constructed dwellings [1]. Building construction sites often require a significant amount of space around the building to ensure the safety of the surrounding area. However, when constructing a building in a city, there may be limitations on the available space, which can pose risks to the safety of surrounding individuals, property, or assets. The project entailed constructing a skyscraper, an office building, a school, and various other structures, involving the installation of steel pipelines, beams, and other essential structural components. As reported by the Ministry of Economy and Department of Statistics Malaysia in 2021 [2], the primary cause of occupational injuries in 2021 was being struck against or struck by things, particularly falling objects, as shown in Figure 1. Haslinda Abas [3] conducted a 2020 study that revealed several factors contributing to the occurrence of occupational injuries. The study identified a deficiency in training as the main contributing factor. Falling objects pose a significant threat to people's safety. Through a thorough examination of these occurrences, researchers can ascertain the fundamental causes and influential factors, as well as devise tactics to mitigate or avert such incidents. An accident is an unforeseen and unregulated event in which an object, substance, individual, or radiation behaves or responds in a manner that heightens the likelihood of bodily harm [4]. In addition, H. W. Heinrich [5] described an accident as an unforeseen, inevitable, accidental occurrence that arises from the interplay of host, agent, and environmental elements in situations involving risk-taking and perception of danger. According to the accident causation theory, an accident is considered the fourth domino in the chain of events, as depicted in Figure 2. Figure 2 illustrates the chronological progression of events that lead to accidents. It demonstrates that a worker's social environment and lineage have a role in their responsibility, which in turn leads to a dangerous action that creates an accident. The consequence of this accident is an injury [6].

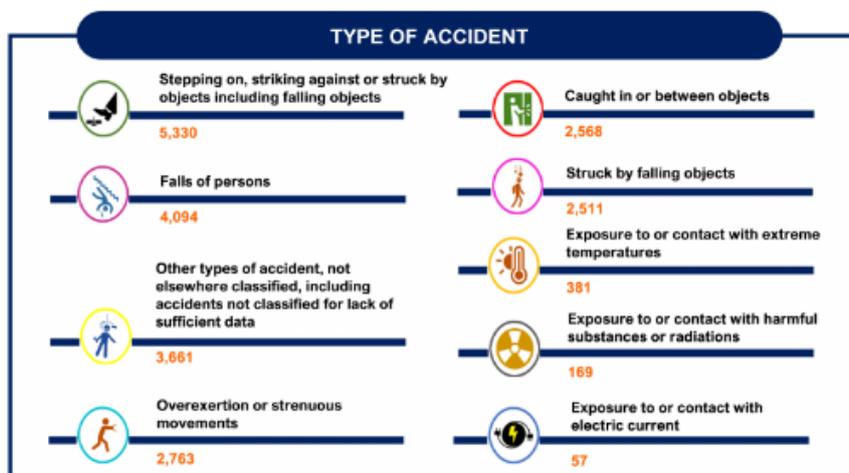


Fig. 1 Number of occupational injuries by type of accident and cause of accident [2]

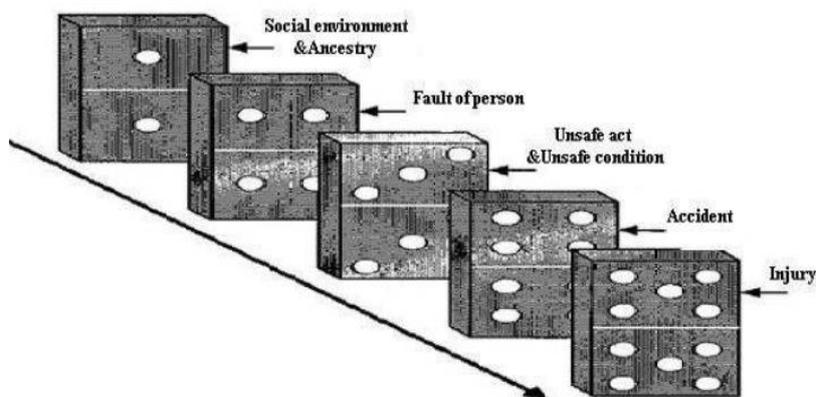


Fig. 2 Heinrich Domino Theory [6]

2. Methodology

2.1 Research Design

This study will employ both qualitative and quantitative approaches to accomplish its aims. The qualitative technique is employed to ascertain the underlying causes, opinions, and motives, providing insights into the issue or assisting in the formulation of concepts or hypotheses for potential quantitative research. Quantitative research

involves the use of numerical data or data that may be transformed into statistics in order to measure and quantify the topic at hand. By not depending on information provided by informants, this approach might offer a more comprehensive depiction of the research problem.

2.2 Operational Framework

Collecting data and information is an essential aspect of this scientific endeavor. Diverse sources, including books, journals, articles, websites, interviews, questionnaires, surveys, case studies, and more, can be utilized to collect information. To bolster this research problem statement, data gathering endeavors might also capitalize on the parallel challenges acknowledged within the organization and department. The repercussions of a falling object occurrence can serve as evidence to gather data for further investigation into that particular health concern. The complete approach will facilitate the investigation by quantifying the notable diseases or fatalities caused by a descending object.

2.3 Questionnaires

The process of performing literature studies and the inclusion of sample survey questions by previous researchers serve as a source of inspiration for the development of a survey questionnaire. We use conversations with construction workers about accidents related to objects falling at the construction site as additional sources of information to support earlier studies. Queries are formulated with precision, ensuring that they are comprehensible and unambiguous to the individuals being asked. The researcher must also consider the appropriate selection of language. Avoiding complex questions is necessary to ensure that respondents understand and provide correct answers. The questionnaires will be partitioned into two distinct sections: Section (A) and Section (B). Section A compiles all pertinent background information about the respondent. Section B has been subdivided into five subsections, encompassing management or departmental roles in addressing construction-related issues within organizations, worker behavior, workplace incidents and the factors that contribute to them, health concerns and diseases among construction workers, and the consequences of such incidents.

2.4 Data Analysis

The raw data analysis technique from the survey questionnaire session has been analyzed using the Statistical Package for Social Science (SPSS) computer program. SPSS is capable of efficiently managing intricate data processing and analysis tasks with minimal training. It is designed for both interactive and non-interactive users. This program facilitates the analysis process, resulting in enhanced precision in the outcome. This study utilizes Pearson's Correlation, One-way ANOVA, Descriptive testing, and Reliability testing to assess the data.

3. Result and Discussion

3.1 Respondent Data

A total of 50 survey questionnaires ($N = 50$) were distributed and then collected in their entirety for statistical analysis. Table 1 presents the results of an analysis conducted on 50 samples and 23 survey questionnaires. The Cronbach's Alpha value obtained was 0.738. Hence, the collection of data is suitable for further examination and discourse with the objective of identifying the primary factors influencing accidents related to falling objects at building sites.

Table 1 Cronbach's Alpha value for the survey questionnaires

Cronbach's Alpha	N of Items
0.738	23

Figure 3 depicts the distribution of respondents' population according to many characteristics, including age, position, years of service, and educational background. The age category with the highest representation is between 36 and 45 years old, accounting for 34% of the total. In contrast, the age category between 36 and 45 years represents only 12% of the total. In addition, individuals aged between 26 and 35 make up 26% of the population, while those under the age of 25 comprise 28%. The general worker category is the most prevalent, accounting for 78% of the positions. The remaining 22% is divided between executives/engineers (18%) and managers (4%). 40% of the population has reported receiving services for 16 to 25 years, while 10% has recorded having services for more than 26 years. The percentages for the remaining 6 to 15 years and fewer than 5 years are 32% and 18%, respectively. The data shows that the Diploma/STPM/SPM category has the largest proportion,

accounting for 64%, whereas both Master's Degree and Bachelor's Degree account for only 14% and 22%, respectively.

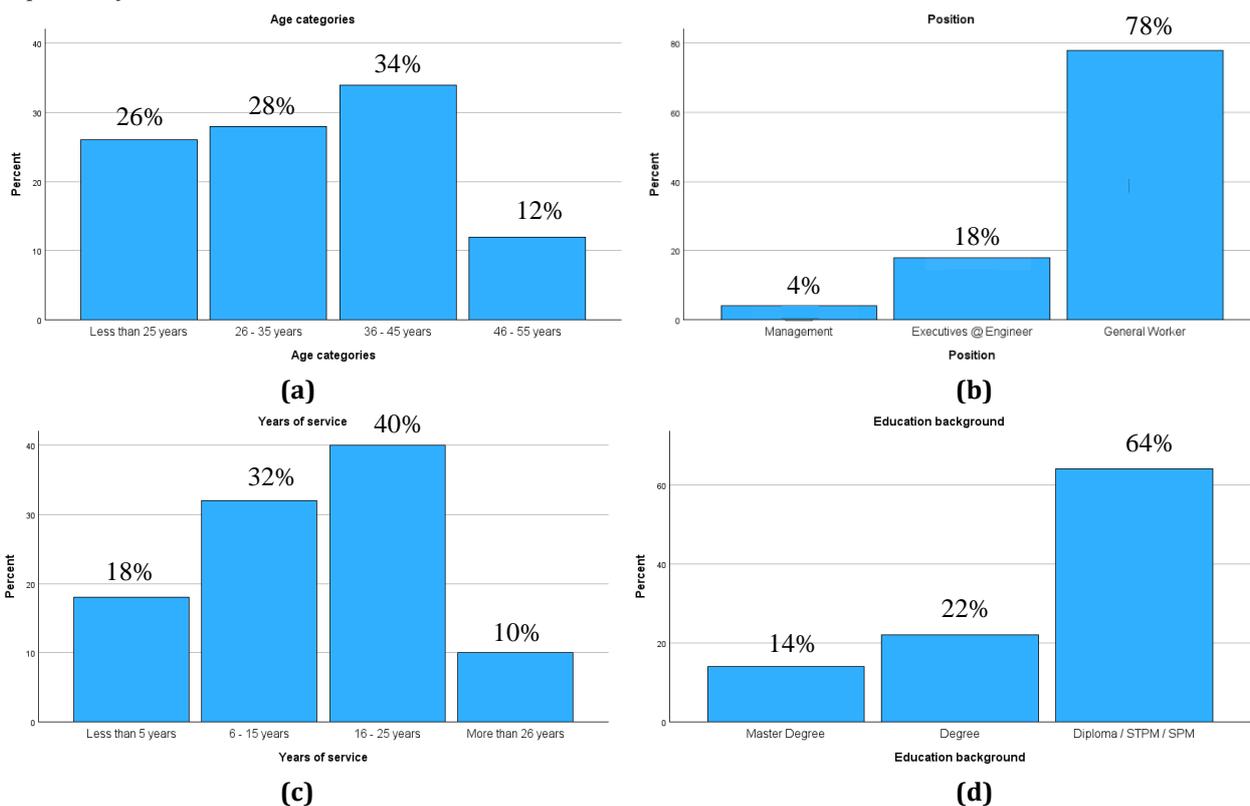


Fig. 3 Respondent's population divided by (a) age categories; (b) position; (c) year of service; (d) education background

3.2 One-way ANOVA Test Result

The data presented in Table 2 indicates that the F-value for age categories is 0.857, with a corresponding p-value of 0.470. Given that the significance level is greater than 0.05, the null hypothesis is accepted. There is no statistically significant difference in the impression of construction job challenges among respondents of different age categories.

Table 2 ANOVA test result for age categories to construction work problems

Age categories	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.533	3	0.178	0.857	0.470
Within Groups	9.543	46	0.207		
Total	10.076	49			

The data presented in Table 3 indicates that the F-value for position categories is 0.169, with a significant value of 0.845. Given that the p-value is greater than 0.05, we accept the null hypothesis. There is no significant difference observed between the impressions of construction job problems among respondents of different rank categories.

Table 3 ANOVA test result for position categories to construction work problems

Position categories	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.072	2	0.036	0.169	0.845
Within Groups	10.004	47	0.213		
Total	10.076	49			

Table 4 displays the F-value of 1.567 for the year of services, with a significant value of 0.210. Given that the significance level is greater than 0.05, the null hypothesis is accepted. There is no significant correlation between the respondents' years of service and their impression of construction job issues.

Table 4 ANOVA test result for year of services to construction work problems

Year of Services	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.934	3	0.311	1.567	0.210
Within Groups	9.141	46	0.199		
Total	10.076	49			

Table 5 displays an F-value of 1.126 and a significant value of 0.333 for the education background. Given that the p-value is greater than 0.05, the null hypothesis is accepted. There is no significant correlation between the education background of respondents and their view of construction job challenges.

Table 5 ANOVA test result for education background to construction work problems

Education Background	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.720	2	0.036	0.169	0.845
Within Groups	10.004	47	0.213		
Total	10.076	49			

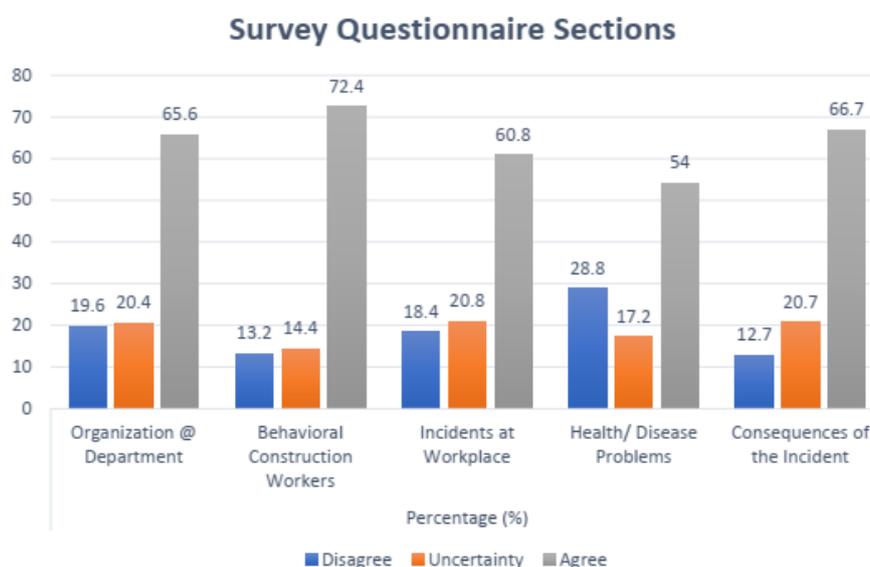
3.3 Correlation and Interferential Analysis

Pearson's correlation is essential for determining the correlation between two or more continuous variables. The range of Pearson's connection coefficient is from 0.00 (indicating no connection) to 1.00 (indicating perfect correlation), as shown in Table 6. Correlations exceeding 0.80 are generally considered to be significantly strong.

Table 6 Correlation strength [7].

Correlation	Negative	Positive
None	-0.09 to 0.0	0.0 to 0.09
Small	-0.3 to -0.1	0.1 to 0.3
Medium	-0.5 to -0.3	0.3 to 0.5
Strong	-1.0 to -0.5	0.5 to 1.0

The study is being performed using the survey questionnaires and replies obtained from 50 construction workers at the job site, as depicted in Figure 4. The survey questionnaires are categorized into five distinct sections: Topics covered: organization/department, behavioral construction workers, workplace incidents, health and disease issues, and incident consequences.

**Fig. 4** Overall Score from Survey Questionnaire for Each Section Distributed to Construction Workers at Construction Site

3.3.1 Analysis on Each Subsection

The data shown in Table 7 indicates that the Pearson correlation coefficient, $r = 0.654^{**}$, suggests that there is no significant association between organization/department roles and responsibilities and construction work difficulties. Given that the p-value (p) is less than the significance level (α) of 0.05, we reject the null hypothesis. Consequently, there exists a statistical association between the roles and responsibilities of organizations/departments and the occurrence of construction work difficulties among construction workers at construction sites.

Table 7 Pearson correlation between Organization/Department Roles and Responsibilities and Construction Work Problems

		Organization/Department Roles and Responsibility	Construction Work Problems
Organization/Department Roles and Responsibility	Pearson Correlation	1	0.654**
	Significance (2-tailed)		< 0.001
	N	50	50
Construction Work Problems	Pearson Correlation	0.654**	1
	Significance (2-tailed)	< 0.001	
	N	50	50

*Correlation is significant at the 0.05 level (2-tailed)

The data presented in Table 8 indicates that the Pearson correlation coefficient, $r = 0.748^{**}$, suggests that there is no significant correlation between behavioral construction workers and construction job difficulties. Given that the p-value (p) is less than the significance level (α), which is 0.05, we reject the null hypothesis. Therefore, there is a statistical link between behavioral construction workers and construction work difficulties among construction workers at construction sites.

Table 8 Pearson correlation between Behavioral Construction Workers and Construction Work Problems

		Behavioral Construction Workers	Construction Work Problems
Behavioral Construction Workers	Pearson Correlation	1	0.748**
	Significance (2-tailed)		< 0.001
	N	50	50
Construction Work Problems	Pearson Correlation	0.748**	1
	Significance (2-tailed)	< 0.001	
	N	50	50

*Correlation is significant at the 0.05 level (2-tailed)

The data presented in Table 9 indicates that the Pearson correlation coefficient, $r = 0.704^{**}$, suggests that there is no significant association between incidents at work and construction work difficulties. Given that the p-value (p) is less than the significance level (α), namely $p < 0.001$ and $\alpha = 0.05$, we can conclude that the null hypothesis is rejected. Hence, there exists a statistical correlation between workplace incidents and construction-related issues among construction workers at a construction site.

Table 9 Pearson correlation between Incident at Workplace and Organization/Department Roles

		Incident at Workplace	Construction Work Problems
Incident at Workplace	Pearson Correlation	1	0.704**
	Significance (2-tailed)		< 0.001
	N	50	50
Construction Work Problems	Pearson Correlation	0.704**	1
	Significance (2-tailed)	< 0.001	
	N	50	50

*Correlation is significant at the 0.05 level (2-tailed)

The data presented in Table 10 indicates that the Pearson correlation coefficient, $r = 0.728^{**}$, suggests that there is no significant correlation between health/disease problems and construction work problems. Given that

the p-value (p) is less than the significance level (α), which is 0.05, we can conclude that the null hypothesis is rejected. Consequently, there is a statistical association between health/disease issues and construction-related difficulties among construction workers at construction sites.

Table 10 Pearson correlation between Health/Disease Problems and Construction Work Problems

		Health/Disease Problems	Construction Work Problems
Health/Disease Problems	Pearson Correlation	1	0.728**
	Significance (2-tailed)		< 0.001
	N	50	50
Construction Work Problems	Pearson Correlation	0.728**	1
	Significance (2-tailed)	< 0.001	
	N	50	50

*Correlation is significant at the 0.05 level (2-tailed)

Table 11 indicates that the Pearson correlation value, $r = 0.665^{**}$, suggests that there is no correlation between the consequences of the incident and construction work issues. Given that the p-value (p) is less than the significance level (α), which is 0.05, we reject the null hypothesis. Therefore, there is a statistical association between the consequences of the incident and the occurrence of construction job problems among construction workers at the construction site.

Table 11 Pearson correlation between Consequences of the Incident and Construction Work Problems

		Consequences of the Incident	Construction Work Problems
Consequences of the Incident	Pearson Correlation	1	0.665**
	Significance (2-tailed)		< 0.001
	N	50	50
Construction Work Problems	Pearson Correlation	0.665**	1
	Significance (2-tailed)	< 0.001	
	N	50	50

*Correlation is significant at the 0.05 level (2-tailed)

3.4 New Intervention Plans

3.4.1 Implementation of Toolbox Meeting (TBM) and Toolbox Talk (TBT)

Toolbox meetings (TBM) are standard practices designed to enhance safety awareness and promote the sharing of work-related information [7]. During the TBM, workers gather around a team leader to collectively verify and discuss job details and safety protocols before starting work [7]. The use of TBM facilitates inter-employee communication, enhancing and refreshing their knowledge and insights regarding safety. Toolbox talks (TBTs) are increasingly gaining popularity in the construction sector. TBT, or Toolbox Talks, is an informal training program conducted at worksites with the goal of fostering safe work practices and minimizing work-related incidents [8]. Toolbox talks, often referred to as stand-up talks and tailgate training, provide contractors with a concise opportunity to effectively convey essential safety information to a group of personnel who may experience frequent turnover [9]. Although TBTs have the capacity to enhance worker empowerment, enhance safety, reduce injuries, and improve communication, they often fail to effectively impart essential safety lessons in the construction sector [9]. The acronyms TBM (Tunnel Boring Machine) and TBT (Time-Based Target) are both highly relevant in the construction sector.

3.4.2 Toolbox-Training Program

The purpose of the Toolbox Training Program is to strengthen the planning and safety communication abilities of construction workers with their coworkers, supervisors, other professionals, and clients. The training program aims to minimize physical wear and tear on workers' health and enhance injury and accident prevention, as well as foster a culture of health and safety. The program is expected to promote consistent safety communication among workers and the many parties on site, foster teamwork among site participants, and improve their

individual involvement in OSH discussions. Participation is recommended to enhance the influence of workers and site members on safety procedures and planning, hence enhancing the promotion of occupational safety and health (OSH) and safety culture on construction sites, ultimately resulting in improved business outcomes [10]. The primary objective of Toolbox Training is to facilitate open communication among employees, enabling them to identify the hazards they encounter regularly and effectively address them with a focus on safety and dependability. Start the discussion by introducing inquiries that require a longer answer than a single word. Convene employees to share their own encounters with similar situations and provide suggestions for mitigating local risks. Toolbox training can efficiently address specific building hazards, provided that staff members actively engage in the discussions [11].

3.4.3 Monitor Physiological Condition of Construction Workers

Monitoring the physiological conditions of employees has the potential to enhance the safety, well-being, and productivity of the construction team. The Physiological Status Monitor (PSM) is a dependable instrument for assessing physiological parameters during common sports science and medical testing procedures, including cycle ergometer and treadmill protocols. An essential prerequisite for every ergonomics study is the evaluation of the physiological condition of workers. Excessive physical demand in the workplace can negatively affect the well-being, focus, drive, and ability of workers to do physically demanding tasks. This can have a harmful effect on safety and productivity [12]. According to the research conducted by E. N. Corlett [13], every study on ergonomics should start with assessing the physiological conditions of the workers. Excessive physical requirements in the workplace can negatively affect the physical and mental well-being, focus, drive, and capacity of workers to do physical tasks, ultimately compromising safety and productivity. The Physiological Status Monitor significantly enhanced the productivity of construction workers by monitoring their physiological state [12].

4. Conclusion

Conclusively, this study effectively accomplished its primary research goal of identifying the various forms and consequences of falling item occurrences on workers, firm assets, and reputation. The initial research objective can be accomplished by defining the problem, creating objectives, and developing the study approach. In addition, the literature review procedure also involves analyzing the underlying reasons and the resulting effects of the instances involving falling objects. This study identified various underlying factors, such as insufficient training, faulty tools and equipment, human fallibility, and natural calamities. This study also emphasized the diverse repercussions arising from this tragedy. The implications include physical harm or death, damage or loss of property, and the potential harm to a company's reputation. The methodology used to analyze the statistical data was SPSS software via Reliability Tests, One-way ANOVA Tests, and Correlation and Interferential Analysis. The results revealed a strong statistical correlation ($r > 0.5$, $n = 50$, $p < 0.05$) between organizational/departmental roles and responsibilities, the behavioral behavior of construction workers, incidents at work, health/disease problems, and the consequences of the incident. Furthermore, this study is capable of suggesting a novel intervention strategy to decrease the occurrence of workplace incidents by implementing Toolbox Meeting (TBM) and Toolbox Talk (TBT), the Toolbox Training Program, and the Monitoring of Physiological Condition for Construction Workers. The proposed intervention plans aim to minimize the impact of occupational health issues on construction workers at building sites.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

All authors have contributed to this work.

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