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Root Causes and Safety Challenges of Fatal Construction Accidents in Vietnam

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Abstract

Construction safety is increasingly recognized as a critical pillar of the construction process. The rising costs of insurance and workers' compensation underscore the urgency of minimizing worksite accidents. This study investigates fatal construction accidents in Vietnam from 2014 to 2022, analyzing 440 incidents reported by the Ministry of Labor, Invalids, and Social Affairs. The findings reveal three primary types of fatal accidents: falls from height (60.4%), electric shocks (38.5%), and entrapment by or between objects (1.1%). Contributing factors include unsafe methods or procedures (34.1%), insufficient support structures or safety guards (26.4%), and inadequate site maintenance (11.0%). Unsafe behaviors such as neglecting personal protective equipment (18.7%) and violating established safety protocols (16.5%) also played significant roles. The study utilizes the Accident Root Cause Tracing Model (ARCTM) to identify underlying causes, focusing on the interaction between hazardous conditions and decisions to continue work despite clear risks. Key issues include a lack of adequate worker training (53.8%) and deficiencies in safety management systems (35.2%). To address these challenges, the research emphasizes the need for comprehensive safety training programs, stricter regulatory enforcement, and improved site-specific safety management. The findings provide actionable insights into reducing fatal accidents in Vietnam's construction sector and highlight the pressing need for systemic safety reforms.

1. Introduction

The construction industry is considered among the most dangerous sectors [1, 2], with a high potentiality of facing substantial dangers for workers [3]. Fatal construction accidents represent a significant issue [2], underscoring the urgent necessity for robust safety and health management systems. These incidents result in substantial project delays, worker absenteeism, and considerable economic losses for both people and society [4].

Fatal construction incidents have gained significant attention as they exemplify the consequences of safety deficiencies [2]. Numerous studies have analyzed the underlying causes of fatal construction accidents, often categorizing them into human, organizational, and technical factors [5]. Research has highlighted various strategies and interventions to reduce the risk of fatal accidents in construction, including Behavioral-Based Safety which focuses on modifying workers' behaviors through observation, feedback, and training [6], integrating BIM with safety management systems [7, 8], ensuring compliance with OSHA regulations and international safety standards [9], etc.. The Accident Root Cause Tracing Model (ARCTM) proposed by Abdelhamid and Everett [10], which has been recommended popularly, can provides a robust framework for analyzing construction accidents.

Despite advancements in safety technologies and stricter regulations, fatal accidents continue to occur, underscoring gaps in safety implementation and monitoring [11]. Significant challenges remain in ensuring the safety

of workers, particularly in developing countries like Vietnam. In developing countries, the picture of fatal accidents is getting much worse due to weaker safety codes and standards, a lack of personal protective equipment, inadequate safety training, poorly designed facilities, and substandard material quality [1]. Managing safety and health in construction involves identifying, mitigating, and preventing risks associated with dangerous activities such as working at high levels, operating heavy equipment, and exposure to hazardous substances [12]. To reduce the human and material consequences, it is necessary to study effective measures to prevent fatal accidents in the construction industry.

Despite numerous global studies on construction safety, the root causes and systemic issues behind fatal accidents in Vietnam's construction industry are underexplored. This creates a critical research gap in understanding how local practices, worker behaviors, and safety management systems contribute to high accident rates. The construction industry is characterized by: (1) exposure to weather conditions [13]; (2) strenuous and dynamic labor [13]; (3) intricate construction processes [14]; (4) hazardous environments (dust, noise, vibration, etc.) [15]; (5) predominantly untrained labor force [16]. Therefore, the construction industry is one of the most dangerous industries due to its high rate of fatal accidents.

Research to predict the causes of fatal accidents is one of the best ways to reduce the number of construction worker deaths. In other words, identifying and analyzing root causes and major causes of fatal accidents is the most effective way to comprehend the problems of labor accidents. A thorough grasp of root causes as well as critical factors causing fatal accidents should be the first step to be undertaken in preventing fatal accidents in the construction industry.

This paper describes some of the results of a survey of fatal accidents conducted in Vietnam. The objectives of the study are to identify and classify the main types of fatal construction accidents in Vietnam, analyze the root causes using ARCTM, and highlight systemic issues. The paper also demonstrates that the need for improvement and prevention of occupational safety in the Vietnamese construction industry (VCI) is evident. Lessons learned and recommendations for future research are provided as a result of this study.

2. Literature Review

The belief that accidents are unavoidable events that "simply happen" reflects a fatalistic view of workplace incidents. This perspective tends to dismiss accidents as inevitable, rather than recognizing them as preventable occurrences stemming from factors like inadequate safety measures or poor supervision. Such a mindset often leads to a lack of accountability in implementing proactive safety measures [17]. In reality, most accidents result from human error and are preventable. The primary causes of accidents are tied to the unique challenges of the construction industry, including human behavior, hazardous worksite conditions, and ineffective safety management, which often lead to unsafe work practices, equipment, and procedures [18]. While numerous studies have examined the causes of construction-related injuries [19-22], research into the root causes of fatal accidents remains limited due to the sensitive nature of such data, particularly concerning deceased workers.

Global research has identified various causes of fatal accidents. For example, Trinh, Feng, and Mohamed (2019) found that in the U.S. construction industry, falls were the leading cause of fatal accidents, accounting for nearly half of all fatalities [23]. Similarly, a study in India (1974–1979) revealed that 54% of fatal accidents were caused by falls [24], while research in the UK (1981–1985) reported a comparable figure of 52% [25]. Sawacha, Naoum, and Fong (1999) highlighted that worker behavior, influenced by organizational safety culture, plays a critical role in accident causation [21]. Research worldwide has consistently shown that falls, electric shocks, and struck-by-object incidents are the leading causes of construction-related fatalities. Malhotra (1988) examined safety legislation in developing countries and found that weak regulatory frameworks often lead to higher accident rates [24]. Jaselskis and Recarte Suazo (1994), who studied construction safety practices in Honduras and identified systemic issues such as lack of personal protective equipment (PPE) and poor site management [19].

In developing nations, including Vietnam, weak enforcement of safety codes and the reliance on untrained labor exacerbate the risks of fatal accidents. Abdelhamid and Everett (2000) demonstrated that root causes such as insufficient hazard identification and decisions to continue work despite unsafe conditions are particularly prevalent in such contexts [10]. Vietnam's construction ignores these challenges, where a lack of mandatory reporting and inadequate training significantly hinder accident prevention. In Vietnam's construction sector (2013–2018), 45% of fatal accidents were due to falls, followed by electric shocks (28.3%) and entrapment incidents (16%) [23]. These findings illustrate that falls are a common cause of fatalities across both developed and developing countries.

Analyzing OSHA-reported fatal accidents in the U.S. construction industry (1985–1989), Hinze et al. (1998) discovered that over 99% of fall-related fatalities involved falls from elevations. Additionally, many "struck by" accidents were caused by falling equipment or materials, especially heavy machinery. For electrical shocks, most incidents occurred due to contact with overhead power lines. Entrapment-related fatalities were often linked to heavy equipment or cave-ins [22]. In Vietnam, however, collecting accurate fatal accident data is challenging due to the lack of mandatory reporting requirements for contractors [26].

Abdelhamid and Everett (2000) introduced the Accident Root Cause Tracing Model (ARCTM), which aims to: (1) identify the underlying causes of construction accidents, (2) understand why unsafe conditions persist, and (3) assess

the roles of both management and workers in accident causation [10]. Identifying root causes is essential for effective accident prevention, as it shifts the focus from addressing symptoms to understanding the factors that lead to accidents. The Accident Root Cause Tracing Model (ARCTM) provides a robust framework for analyzing construction accidents. Unlike traditional approaches that focus on immediate causes, ARCTM investigates the interplay between hazardous conditions and unsafe behaviors. This model has been applied successfully in various contexts to identify systemic weaknesses and improve safety practices. However, its application in Vietnam is relatively novel, making this study a unique contribution to the literature.

In Vietnam, the Labor Code and Administrative Rules mandate that fatal accidents across all industries be reported to the Ministry of Labor, Invalids, and Social Affairs (MOLISA) [27]. This agency collects and manages data on labor accidents nationwide. The data collection focuses primarily on accident occurrences rather than root causes. While regulations mandate reporting, the lack of detailed incident analysis hampers effective prevention strategies. This research leverages ARCTM to fill this gap, offering insights into underlying issues and actionable recommendations for improving safety management in Vietnam's construction industry.

3. Research Methodology

This research employs the Accident Root Cause Tracing Model (ARCTM), proposed by Abdelhamid and Everett (2000) [10], as the primary framework for analyzing fatal construction accidents. ARCTM integrates accident causation theories with human error theories, focusing on worker behaviors and their interplay with unsafe conditions. By shifting the focus from surface-level symptoms to deeper systemic issues, ARCTM enables a comprehensive understanding of accident root causes and provides actionable insights for prevention.

The research was conducted in Hanoi, the second-largest city in Vietnam, a location representative of the country's construction sector dynamics [26]. Data were gathered from the Ministry of Labor, Invalids, and Social Affairs (MOLISA), encompassing 273 cases of fatal construction accidents. The reports included detailed descriptions of accident developments. However, key information necessary for in-depth analysis, such as specific unsafe actions or conditions, was not always fully documented. To address this, researchers supplemented the data through expert interpretation and interviews.

The dataset includes comprehensive information about each accident, such as: Accident details (Time, location, type, and sequence of events); Worker characteristics (Name, age, gender, injury type, salary, trade, and work experience); Employer details (Company employing the deceased workers).

Quantitative analysis was employed to identify patterns and correlations, while interviews with foremen, site engineers, and other stakeholders provided qualitative insights. These interviews clarified contextual factors that were not explicitly stated in official reports, further enriching the analysis.

The methodology aligns with ARCTM's principles by examining three critical areas:

- Improper acts: Unsafe worker behaviors that contribute to accidents.
- Unsafe conditions: Hazardous environmental factors present during the accidents.
- Root causes: Systemic issues, such as inadequate training or management failures, that create or perpetuate unsafe practices.

This dual approach of integrating qualitative and quantitative methods ensures a robust understanding of accident dynamics, fulfilling the study's objectives and providing a solid foundation for subsequent discussions and recommendations.

4. Results and Discussion

The results of data analyses are shown in this section with a description of the dead worker characteristics. Discussions about significant research findings are presented.

4.1 Dead Workers' Characteristics

The majority of deceased workers were male (98.9%) with an average age of around 28 years (Table 1). Most of them were unskilled laborers, accounting for 60.4%, while electricians comprised 12.1%, followed by masons (7.7%), welders and mechanics (5.5%), carpenters (3.3%), concrete workers (3.3%), piling workers (1.1%), and workers in other occupations (6.6%). In terms of experience, 68.1% had been working for less than six months, 19.8% for 6–12 months, 7.7% for 1–5 years, and only 4.4% had over five years of experience.

The high proportion of fatalities among unskilled and short-tenure workers suggests that many were employed seasonally and had limited awareness of accident prevention measures, highlighting a critical gap in training and safety management.

Table 1 *Characteristics of dead workers*

Variable	Description	Frequency	Percent (%)
Gender	Male	270	98.9
	Female	3	1.1
Work experience	<= 3 months	159	58
	3 - 6 months	27	10
	6 - 12 months	54	20
	1 - 5 years	21	8
	Over 5 years	12	4
Construction worker type	Unskilled workers	168	61.5
	Electricians	33	12.1
	Masons	21	7.7
	Welders	15	5.5
	Carpenters	9	3.3
	Concrete workers	9	3.3
	Other trades	18	6.6

In Vietnam, construction workers rarely receive formal training in their profession [23]. Up to now, with no specific skills and low education, laborers are easily to get a job in the booming construction industry. Due to less work experience, fresh workers do not perceive unsafe conditions to avoid labor accidents [26]. Therefore, it is necessary that contractors must provide sufficient safety training to fresh workers before they are assigned to specific tasks.

As can be depicted in Figure 1, most of the dead workers are young people, often less than 40 years old. This feature is reflected in the frequency distribution of dead workers' age. The low rate of dead cases in relation to age can be explained that workers were assigned to perform less dangerous tasks due to professional qualification and experience.

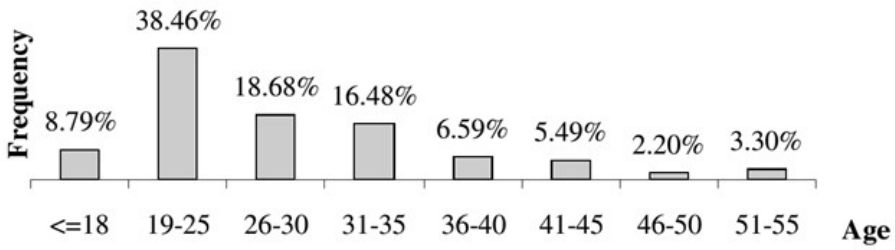

Fig. 1 *Frequency distribution of dead workers' age*

4.2 Unsafe Conditions

OSHA defines unsafe conditions are hazards that have the potential to cause injury or death to an employee [28]. Some of these hazards include erroneous safety procedures, malfunctioning equipment or tools, or failure to utilize necessary safety equipment such as goggles and masks. Data were analyzed to define the existence of the most common unsafe conditions on sites when fatal accidents occurred. It was found that hazardous methods/procedures (34.1%), inadequate support and guards (26.4%), poor housekeeping (11.0%) are the most common unsafe conditions (Table 2). "Management don't care about unsafe conditions" and "management fail to identify unsafe conditions" are also identified as causes for non-removing those unsafe conditions as expressed by respondents.

Table 2 *Description of fatal accidents by main unsafe conditions*

Main unsafe conditions	Frequency	Percent (%)
Hazardous methods/procedures	93	34.1
Insufficient supports/guards	72	26.4
Poor housekeeping	33	11.0
Hazardous environment around workplace	24	8.8
Improper assignment of personnel	21	7.7
Inadequate warning systems	21	7.7

Main unsafe conditions	Frequency	Percent (%)
Inadequate illumination	6	2.2
Unsafe storage-congestion, overloading	3	1.1
Others	3	1.1

4.3. Other Factors Affecting Fatal Accident Occurrence

It is interesting to point out that state-owned companies have more (54.9%) dead workers than other sectors (Table 3). It is possible that state-owned companies get more construction contracts than other company types. In addition, almost all the state-owned companies often hire crews by the piece for construction contracts, so crews also small business units. As a result, many unskilled workers were employed in small business units to reduce costs. High concentration of unskilled workers is also a reason for potentially fatal accidents.

Table 3 *Description of fatal accidents by type of the labor contract, type of the dead workers' company*

Variable	Description	Frequency	Percent (%)
Type of dead workers' company	State-owned companies	150	54.9
	Private companies	81	29.7
	Mobile construction groups	39	14.3
	Joint venture companies	3	1.1
Type of the labor contract	No labor contracts	213	78.0
	Labor contract with non-limited time	33	12.1
	Labor contract with the time over a year	24	8.8
	Semiannual labor contract	3	1.1

4.3.1 Fatal Accidents Against Main Unsafe Conditions

Data were analyzed to find the possible relationship between the types of fatal accident and the types of main unsafe conditions. The results indicate that many fatal accidents involving hazardous construction procedures were fall from elevations (37.1%), struck by objects (50%), caught in/between objects (64.3%) and electric shock (24.1%). Inadequate support or guards were also one of the main unsafe conditions that caused electric shock accidents (24.1%). The outcomes also suggest that poor safety management procedures/methods are a serious problem that led to many fatal accidents in Vietnam construction industry.

4.3.2 Fatal Accidents Against Main Unsafe Actions

There is a significant discrepancy found between the types of the main unsafe actions, and those of the fatal accidents. A rate of 88.2% of failed to wear/use PPE, 58.3% of psychological factors and 50% of took unsafe position/postures caused falling from heights. Meanwhile, 54.5% of using defective equipment, 50% unsafe actions of other workers, 66.7% of disregard prescribed/known construction procedures/methods caused electric shocks. Using unsafe procedures in loading, mixing, placing, and combining often caused "caught in between object".

4.3.3 Fatal Accidents Against Trades

The data were analyzed to explore the relationship between the types of fatal accidents and the trades of the victims. A significant majority of masons (85.7%) and welders (80%) lost their lives due to falls from heights. Similarly, electricians faced dual hazards, with fatalities evenly split between falls from heights (45.5%) and electric shocks (45.5%). These findings highlight the high-risk nature of electrical work, masonry, and welding conducted at elevated positions.

Key contributing factors to falls from heights likely include unstable platforms and scaffolding, unsafe working postures, hazardous work methods, insufficient use of personal protective equipment (PPE), and the absence of critical safety measures such as safety nets and harnesses.

4.3.4 Type of the Labor Contract Against Age of Dead Workers

The survey results reveal that 46.5% of deceased workers were aged between 21 and 30 years old and lacked formal labor contracts. The absence of a labor contract may have contributed to lower focus and engagement in their work, increasing their susceptibility to fatal accidents. Additionally, 74.6% of the deceased workers were unskilled laborers without labor contracts. This high proportion of unskilled workers employed by construction companies is likely due to employers seeking to avoid social security contributions and reduce other costs.

Furthermore, the data show that 80% of workers who had labor contracts had less than six months of work experience, suggesting that more experienced workers are less prone to fatal accidents. These findings highlight that inadequate safety management practices and methods are a significant issue contributing to the high number of fatal accidents in Vietnam's construction industry.

4.4. Unsafe Actions

According to OSHA, unsafe actions refer to behaviors or activities that pose risks to the health or safety of workers [28]. Analysis of the data identified several common unsafe actions performed by workers during fatal accidents. These included failure to use or wear personal protective equipment (PPE) (18.7%), employing unsafe methods or procedures (18.7%), neglecting established safety rules and protocols (16.5%), psychological factors such as distractions, interpersonal conflicts, or substance abuse (13.2%), and using defective equipment (12.1%). Actions by coworkers or others, such as unsafe practices (11%), also contributed significantly.

Table 4 *Description of fatal accidents by main unsafe actions*

Main unsafe actions	Frequency	Percent (%)
- Failure to use/wear personal protective equipment (PPE)	51	18.7
- Using unsafe construction procedures/methods	51	18.7
- Disregards prescribed/known construction procedures	45	16.5
- Psychological factors: distraction, quarrelling, teasing, etc.	36	13.2
-Using defective equipment	33	12.1
- Unsafe actions of co-workers	30	11.0
- Took unsafe positions/postures	12	4.4
- Operated equipment without the authority	9	3.3
- Remove safety devices	3	1.1
- Disorderly throwing materials/objects	3	1.1

The reluctance to use PPE, except for hard hats, is often attributed to workers' lack of familiarity with or unwillingness to wear such equipment. Many contractors view PPE as an unnecessary expense, leading to insufficient provision on-site. Coupled with inadequate safety management, this fosters unsafe work practices. Furthermore, widespread neglect of established safety protocols reflects a systemic disregard for safety, both by workers and management. These findings highlight the urgent need to strengthen safety enforcement and foster better safety practices on construction sites.

4.5. Root Causes and Problem Behind Fatal Accidents

As outlined by the Accident Root Cause Tracing Model (ARCTM), labor accidents often stem from three primary causes: (1) Failure to detect hazardous conditions before or during task execution, (2) Proceeding with tasks despite recognizing unsafe conditions, and (3) Engaging in unsafe behaviors regardless of initial workplace safety [10].

Data analysis (Table 5) revealed that the most prevalent root cause of fatal accidents is the combination of the first and second causes (60.4%), followed by the first cause alone (38.5%), and the second cause (1.1%). These findings suggest that many workers lack the training or education required to recognize hazardous conditions, making them vulnerable to accidents.

Table 5 *Description of fatal accidents by root causes and problems behind accidents*

Variable	Description	Frequency	Percent (%)
Root Causes			
- Combination of 1st and 2nd causes	Unsafe conditions undetected and work continued despite risks	165	60.4
- 1st cause only	Failure to detect unsafe conditions	105	38.5
- 2nd cause only	Continuing work after identifying unsafe conditions	3	1.1
- 3rd cause	Unsafe actions regardless of initial conditions	0	0
Problems Behind Accidents			
- Lack of worker training	Insufficient knowledge or preparedness	147	53.8

- Inadequate management	Poor oversight or safety enforcement	96	35.2
- Negative worker attitudes	Disregard for safety or complacency	30	11

Additionally, underlying issues contributing to fatal accidents were identified: insufficient worker training (53.8%), inadequate management procedures (35.2%), and workers' negative attitudes towards safety (11%). These insights underscore the need for effective training programs tailored to enhance workers' hazard awareness. Establishing rigorous on-site safety checks and maintaining proper management procedures are crucial steps to reducing accident rates. Implementing these measures will significantly improve safety conditions and decrease annual fatal accident rates.

4.6. The Occurrence Time of Fatal Accidents

As can be shown in Table 6, most of fatal accidents occurred between 9:30 and 11:30 during morning hours (37.4%). Hinze and Russell (1995) explained this phenomenon by contending that at those times, when worker is most intent on accomplishing their tasks, accident is more likely to occur [29]. None of significant levels were found between fatal accident occurrence and day of the week. Several other researchers found that more accidents tend to occur on Monday than on other days, but this survey revealed that the highest fatal accident rate occurred on Tuesday and Thursday.

Table 6 *Description of fatal accidents by root causes and problems behind accidents*

Variable	Description	Frequency	Percent (%)
Hour of the day	7:00 - 9:30	63	23.1
	9:31 - 11:30	102	37.4
	13:00 - 15:00	33	12.1
	15:31 - 16:30	45	16.5
	After 16:30	30	23.1

In addition, it is interesting to point out that fatal accidents also occurred more often with the highest frequency in April (19.8%) and during the period between March and April (28.6%) than on other months (Table 7). It is possible that the construction work schedule was accelerated in those months to cope with the rainy season to come (Figure 2). Accident occurrence was lowest during February because in the middle of February is the New Year of Vietnam during which people tended to be not careful with their works (Figure 2).

In Vietnam, an Eastern country, the Lunar New Year holiday usually falls in February, and in February and March of the solar calendar. Around this time, Vietnam often has a lot of traditional festivals, activities lasting until mid-March. After that, people return to work. Due to inertia and reduced physical strength, the spirit and attitude of construction workers are neglected, combined with the accelerated progress, very stressful, so the period at the end of March and April is very prone to accidents.

Table 7 *Description of fatal accidents by months and seasons of the year*

Variable	Description	Frequency	Percent (%)
Month of the Year	January	12	4.4
	February	3	1.1
	March	24	8.8
	April	54	19.8
	May	24	8.8
	June	27	9.9
	July	21	7.7
	August	30	11.0
	September	33	12.1
	October	12	4.3
	November	15	5.5
	December	18	6.6
Season of the Year	January - February	15	5.5
	March - April	78	28.6
	May - June	51	18.7

Variable	Description	Frequency	Percent (%)
	July - August	51	18.7
	September - October	45	16.4
	November - December	33	12.1

4.6.1 Type of the Fatal Accident

As described in Table 8, the highest number of fatal accidents (60.4%) was "falling of person". This result was not much different from previous research around the world. "Falling of persons" accidents involved with roof work, other works on floors and scaffolds. The main causes are inadequate Personal Protective Equipment (PPE) such as safety belts, safety nets; the worker's carelessness and slipping; ladder collapsing, fall of people from scaffolds, especially several fatal accidents resulting from a height of 1.7m. It is worth mentioned that brain injury is a cause leading to a death for workers while falling from small heights. In such fatal accidents, the serious level of fatal accidents may be reduced if workers wore hard hats.

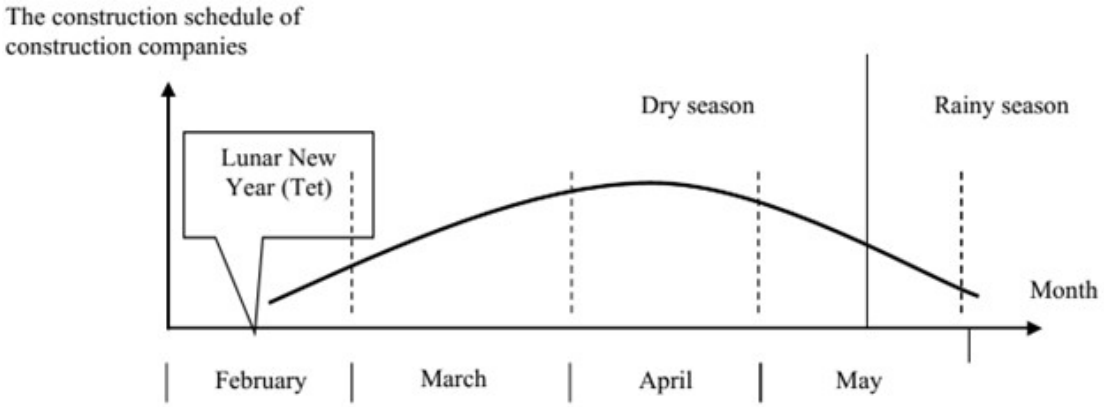

Fig. 2 *Construction schedule of construction companies*

Table 8 *The type of the fatal accident, the labor contract, and the company of dead workers*

Variable	Description	Frequency	Percent (%)
Type of the fatal accident	Falling of persons	165	60.4
	Electric shock	105	38.5
	Caught in/between objects, excavations, structures, etc.	3	1.1
	Fire and explosion	0	0
	Struck by objects	0	0
	Others	0	0

A significant proportion of fatal accidents are attributed to "electric shocks" (38.5%), a finding that contrasts with previous studies conducted in developed countries. Prior research [30] identified four common causes of electric shock incidents: (1) direct contact with uninsulated electrical wires; (2) crane operations coming into contact with overhead lines; (3) materials making contact with electrical wires; and (4) ladders entangling with overhead lines. Additionally, fatal accidents were also caused by high-voltage discharges from power cables and electrical leaks from faulty hand tools. Notably, these latter causes could be prevented by securing electrical safety zones and ensuring regular maintenance of hand tools.

The third most common cause of fatal accidents involves workers being "caught in/between objects, excavations, or structures" (1.1%). These incidents are primarily linked to unsafe construction practices and violations of safety standards, such as excavating without slope protection, lack of trench shoring systems, and improper removal of formwork. Interestingly, most of these accidents were observed in mobile construction teams. Insufficient safety training often leaves workers unaware of potential hazards, making them more likely to accept dangerous tasks.

Moreover, approximately half of fatal accidents (46.15%) were related to worker carelessness, including slipping on platforms, stepping directly onto fragile roofs, or disorderly disposal of materials. Other contributing factors include noncompliance with construction safety procedures (18.6%), inadequate use of personal protective equipment (PPE) (18.68%), and improper operational practices (16.48%).

These findings underscore the critical role of managerial safety awareness in enhancing organizational safety performance. To mitigate fatal accidents in Vietnam's construction industry, managers should implement proper construction procedures, regularly inspect and maintain tools, ensure workers are adequately equipped with PPE, and conduct comprehensive safety training programs.

As a general practice, Vietnamese workers do not want to use safety belts, although it will save their life. Workers do not feel convenient working with safety belts. Safety nets are too expensive for contractors to install to save their workers. Hence, almost 50% of the falling cases from elevation accidents involved "fail to wear PPE". Most unskilled workers were not aware of the danger when they work or have contact with electricity. Therefore, unskilled workers always neglect and disregard prescribed/known procedures while working with electric cables and electric tools. In cases of the maintenance of old houses in cities, construction workers had to work near the high-tension cables that were located very tangled. In cases of erecting of telephone poles, violation into the prohibited area of high-tension cables is popular, so accidents were occurred by the phenomenon of electric discharge. In addition, there was no supervision, no barriers and fences, no inspection during operation. As a result, high rate of "disregard prescribed procedures" causing electric shock is also obvious.

5. Recommendations

Based on the findings of this study and insights from prior research, several recommendations are proposed to enhance construction safety in Vietnam. While tailored to the local context, these recommendations offer a framework that can be adapted to other developing countries with similar safety challenges.

(1) **Enhancing Safety Training**
Young, unskilled workers with less than three months of experience account for the majority of fatalities in Vietnam's construction industry. Training programs specifically designed for these workers are essential. These programs should focus on basic safety practices, hazard identification, and proper use of personal protective equipment (PPE). Periodic refresher training for site managers and foremen is equally critical to maintain a strong safety culture.

(2) **Improving Safety Equipment and Procedures**
To prevent falls, construction workers must be provided with safety helmets, harnesses, and nets. Ensuring secure prohibited zones near high-tension cables or overhead lines is crucial to mitigating electrical hazards. Implementing and enforcing these safety measures can serve as a model for other developing nations.

(3) **Safety Inspections and Compliance**
Regular safety inspections by government agencies are critical. Targeted campaigns during high-risk months, such as April and September, could focus on enhancing compliance with safety regulations. Vietnam's approach could be adapted in other regions with similar seasonal risk patterns.

(4) **Time-Specific Monitoring**
Most accidents occur between 9:30 and 11:30 AM. Assigning supervisors to monitor safety practices during critical hours can be an effective intervention, applicable across various settings.

(5) **Managing Subcontractors and Mobile Crews**
Subcontractors and mobile crews often operate with minimal oversight. Assigning trained supervisors and conducting regular audits can mitigate risks. This recommendation is especially relevant in regions with prevalent subcontracting practices.

(6) **Broader Applicability**
While focused on Vietnam, these recommendations are relevant to other developing countries. For instance, the integration of ARCTM for identifying systemic issues and designing targeted interventions can be applied in contexts with similar socioeconomic conditions.

By adopting these strategies, stakeholders can reduce accidents, improve safety performance, and foster a culture of proactive risk management. Future research should evaluate the effectiveness of these recommendations in diverse geographical settings, providing a basis for their broader application.

6. Limitations

The first limitation of this study lies in the sample size, as it includes 440 cases of fatal incidents. Expanding the scope to encompass a broader range of cases would likely provide more comprehensive and robust findings. The second limitation pertains to the insufficiency of data, which at times affected the relevance and precision of the results.

Although the fatal accident reports contained detailed and sufficient information, the identification of root causes and underlying issues relied on the perspectives of the Accident Root Cause Tracing Model (ARCTM) and the researchers' interpretations. Furthermore, since the data on fatal accidents was sourced solely from official reports provided by the Ministry of Labor-Invalids-Social Affairs, the findings could be enhanced in completeness and credibility if additional data were obtained directly from contractors.

7. Further research

This study provides an initial exploration of fatal accidents, aiming to reduce their frequency and enhance understanding of labor accidents in Vietnam. While several significant findings were uncovered, expanding the research with a larger sample size would yield more comprehensive insights.

Future studies should also investigate the role of psychological factors in the occurrence of fatal accidents. Additionally, detailed research is needed to examine and quantify the relationship between both the direct and indirect costs associated with fatal accidents. Case studies should be developed to design and implement effective accident prevention programs, building upon the issues identified in this study.

Lastly, further research should focus on revising and improving the Vietnamese Labor Code to enhance its effectiveness in promoting safety measures within the construction industry.

8. Conclusions

This study investigated the causes of fatal accidents within Vietnam's construction industry. The analysis of reported cases identified falls from heights, electric shocks, and incidents of workers being caught in or between objects as the most prevalent types of fatal accidents in the sector. The leading unsafe conditions contributing to these incidents were hazardous construction practices, inadequate supports and safeguards, and poor site housekeeping.

The study identified four prevalent unsafe actions contributing to accidents: neglecting or improperly using personal protective equipment (PPE), engaging in hazardous construction practices, ignoring established safety protocols, and psychological factors like distraction, interpersonal conflicts, teasing, or substance use. By applying the Accident Root Cause Tracing Model (ARCTM), tailored questionnaires were developed to suit Vietnam's unique context, providing critical insights into the root causes and systemic issues underlying fatal construction accidents.

Key findings point to two primary root causes: the failure to recognize unsafe conditions either before or during work activities, and the decision to proceed with tasks despite awareness of existing hazards. Additionally, the study identifies inadequate worker training and deficient safety management practices as critical contributors to fatal accidents. These findings underscore the need for targeted interventions to address these systemic issues.

The result of this research also demonstrates that lack of safety awareness and safety managerial skills, inappropriate safety management procedures, inadequate safety training, poor enforcement of safety regulations, have been existed for a long time in Vietnamese construction industries (VCI), hence, there are many opportunities to reduce fatal accidents in VCI. Providing safety-training programs to construction workers, sufficiently providing PPE, using adequate construction equipment, avoidance of fast construction procedures without safety are issues which must be properly dealt with by contractors to reduce potentially fatal accidents in the construction industry. As the study focuses on fatal accidents in the construction industry in Vietnam only, further studies should be carried on accidents which resulted in lost man-hours and near-misses. The study of such accidents can provide more meaningful image on current safe condition of the construction industry in Vietnam as well as recommend on preventive and corrective actions against these accidents.

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Conflict of Interest

The authors confirm that this study presented in this article has no conflict of interest.

Author Contributions

All authors contributed to the study's ***conception and design****. Pham Xuan Anh contributed to the* ***conceptualization of the study, led the data collection process, and provided critical insights into the analysis and interpretation of the results****; Nguyen Quoc Toan was responsible for the* ***statistical analysis of the data and contributed to the design of the methodology****. He also* ***reviewed and edited the manuscript for technical accuracy****; Nguyen Thi My Hanh participated in the* ***literature review and contributed to the discussion section by contextualizing the findings within the broader framework of construction safety research****; Le Van Tuan, the corresponding author, supervised the entire research process, ensured the alignment of the study with academic standards, and provided the final revisions to the manuscript. He also* ***coordinated communication with the journal and stakeholders involved****. All authors reviewed and approved the final manuscript and agree to be accountable for all aspects of the work.*

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