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Research paper

Factors influencing labour safety within construction sites in the Mekong delta

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Abstract: Construction workers consistently prioritise safety when carrying out their tasks on construction sites. The matter of ensuring labour safety on construction sites requires attention, investment, and strict adherence to regulations from the outset. This is crucial due to the numerous potential risks inherent in the construction industry. In the current market economy, many entities have shown a lack of focus on safety in favour of profit. This article examines the factors influencing labour safety during the construction process on sites in the Mekong Delta region. It employs a survey to gather insights from experts and managers in the area, followed by the application of SPSS software to quantitatively assess the impact of these factors on labour safety in the region's construction sites. The analysis results provide a foundation for relevant units to suggest solutions aimed at minimising occupational accidents and enhancing awareness among participants at construction sites across the country, with a specific focus on the Mekong Delta region. This initiative ultimately aims to ensure that workers at construction sites enjoy a comfortable and safe working environment, while also mitigating financial losses to the national budget and fostering a secure workplace for all workers.

Keywords: construction site, accident, labour safety, project, risk

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1. Introduction

Research [1] indicates that this industry has consistently been recognised as one of the most hazardous and perilous sectors, characterised by elevated accident and fatality rates. Farooqui et al. [2] highlight that the mortality rate in the construction sector is notably higher than in other sectors. In Hong Kong, the construction industry has a death rate of 64.2‰, whereas other industries have a significantly lower rate of 8.6‰. In Canada, the overall death rate across all industries is 6.1‰, whereas in construction, it rises significantly to 20.9‰.

Numerous studies exist in this area, including research [3–6], which focusses on construction safety management as a means of regulating safety policies, procedures, and practices on construction sites. The process is dynamic and can be tailored to the activities at the construction site, ensuring that the desired goals are met while preventing occupational accidents during regular operations on the site [7].

Ning et al. [8] examined the elements influencing safety management in construction projects within China. The research highlighted six elements that influence construction safety management: safety training, promotion of safety policies, elimination of safety hazards, safety supervision, management's commitment to safety, and the safety budget. Jokkaw and Tongthong [9] examined the factors influencing safety management status and assessed the safety management status in construction projects in Cambodia. The study identified nine factors that are deemed to have a significant impact on safety management in construction sites, including: budget allocated for safety management, safety policy, project manager awareness, safety training, safety organisation, safety regulations, use of personal protective equipment (PPE), investigation of accidents on construction sites, and establishment of safety committees. Yadi et al. [10] examined the key factors contributing to the effectiveness of occupational safety (OSH) management in high-rise construction projects in China. Six groups of key success factors were identified: management measures, management organisation, management plan, OSH behaviour, safety environment, and workers' safety knowledge and awareness.

Many other researchers, including Priyadarshani et al. [11, 12], have also reported similar studies. The findings of the research review indicate that the topic of occupational safety in construction has garnered significant interest from numerous researchers. In Vietnam, there has not been a dedicated study examining the factors influencing and the metrics for assessing occupational safety management in construction sites. This study has identified 21 factors that influence occupational safety management on construction sites, based on a review of previous studies. These factors serve as the foundation for constructing and developing the survey in this research.

Research [13] indicates that the factors associated with project complexity are consistently referenced in all studies pertaining to construction management, as they can influence a majority of project management activities. This includes elements such as the intricacy of the structure and architecture. Additionally, studies [14, 15] have explored factors related to pressure on progress. The two studies indicate that a significant factor contributing to occupational safety loss is the pressure to prioritise project progress for timely use, which often results in extended work shifts or the concentration of numerous construction resources.

Research has identified a range of factors associated with errors in construction drawing design [14, 16]. These studies highlight issues related to the construction process or sequence depicted in the design, which can result in mistakes during workers' operations and may lead to occupational safety risks. Studies [17, 18] indicated that training and education on occupational safety for each working group influence occupational safety. Research on factors related to leadership capacity highlighted the importance of communication from management positions during project implementation regarding operational activities to subordinates [15, 18]. The study examined the influence of occupational accidents on the performance of workers on construction sites and the overall team dynamics [19]. The study found that the Board of Directors of construction companies in the industry ought to place a higher importance on the health and safety of workers rather than on economic concerns associated with training expenses. The research primarily focused on occupational health and safety concerns within construction sites in the Czech Republic [20].

A study in Vietnam [21] examines the impact of various factors associated with the contractor's construction organisation process on construction safety in construction projects within the country. The research findings have consolidated the primary categories of factors and highlighted that the groups associated with safety training and coaching, the contractor's safety assurance capabilities, and the competencies of project leadership roles exhibit a statistically significant impact ($p \ll 0.05$) on construction safety. However, the study has not put forth any solutions to mitigate occupational accidents on construction sites. The study [22] aimed to evaluate how worker characteristics and management methods influence worker safety performance. The study utilised multiple regression analysis and statistical tests to identify 9 worker characteristics and 8 management factors that impact workers' safety performance. Furthermore, the rate of accidents was assessed by evaluating the time lost during incidents, with an average of 0.193% recorded.

Study [23] Construction sites present challenging working conditions with numerous potential hazards for accidents. To ensure labour safety, it is essential for workers and engineers to wear protective equipment, particularly safety helmets, upon entering the construction site. Nonetheless, unfortunate incidents continue to happen. A primary reason is that the safety helmets utilised by workers do not effectively assist in preventing labour accidents. Study [24] This research establishes a framework for evaluating occupational safety management (OSM) at construction sites in Ho Chi Minh City. The research has pinpointed 16 elements that influence OSM management in construction environments.

Tung [25] examined the key factors influencing the execution of the occupational safety program in construction projects in Vietnam. The research findings indicated that the periodic assessment of the safety program's effectiveness was the most significant factor. Through factor analysis, eight factors were consolidated into four primary factors: Oversight and assessment of safety measures at the construction site; Execution and regular review of the safety program; Adequate resources paired with education and training; Effective collaboration among all participants at the construction site. Phuong [26] carried out a study that integrated the EFQM model with system dynamics to enhance safety culture. The author outlined six primary categories of factors that influence the safety culture within the organisation: (1) Leadership, (2) Policy and strategy, (3) People, (4) Partnerships and resources, (5) Process, (6) Goals.

Duc [27] examined the elements influencing labour safety costs and introduced a quantitative forecasting model for these costs in construction projects in Ho Chi Minh City. The results identified various factors influencing labour safety costs, including those associated with accident barriers and security at the construction site, construction measures, transportation of materials to elevated areas, the structure of the construction site, inspection of safety measures during equipment operation, the frame of the net covering around the site, pile foundation equipment, worker health, protective gear for individuals entering the site.

In this paper, based on the review of both international and domestic research, it is essential to examine the effects of construction on labour safety at construction sites in the Mekong Delta region. This will enable the proposal of suitable solutions aimed at enhancing labour safety and reducing labour accidents for construction workers.

2. Materials and methods

2.1. Research Procedure

Secondary data collection methods: Secondary data refers to the information that the author has gathered and synthesised from various research projects, both domestically and internationally. This method assists the author in gathering essential information during the report writing process.

Primary data collection methods: The expert method involves gathering insights from specialists to assess and evaluate a product, event, or practical issue. The expert method gathers diverse viewpoints from specialists, allowing them to evaluate one another for a more impartial understanding of a given issue. The investigation and survey method is recognised as a sociological approach and is frequently utilised across various disciplines. The questionnaire investigation method involves three key areas that require careful consideration: sample selection, questionnaire design (interview form), and result processing [28]. Develop and create interview questionnaires using clear, straightforward language, minimising abbreviations and ambiguous terms; avoid referencing private or sensitive personal matters. In the study assessing factors influencing labour safety at construction sites in the Mekong Delta region, the author employed a 5-level Likert scale to gather feedback from participants (shown in Figure 1).

2.2. Data collection method

The survey consists of three sections:

- Part 1: in project implementation, and types of projects they have participated in, along with information about the individuals involved in the interview.
- Part 2: A comprehensive evaluation of the effects of construction on labour safety at construction sites in the Mekong Delta.
- Part 3: Evaluation of the effects of construction on worker safety in the Mekong Delta.

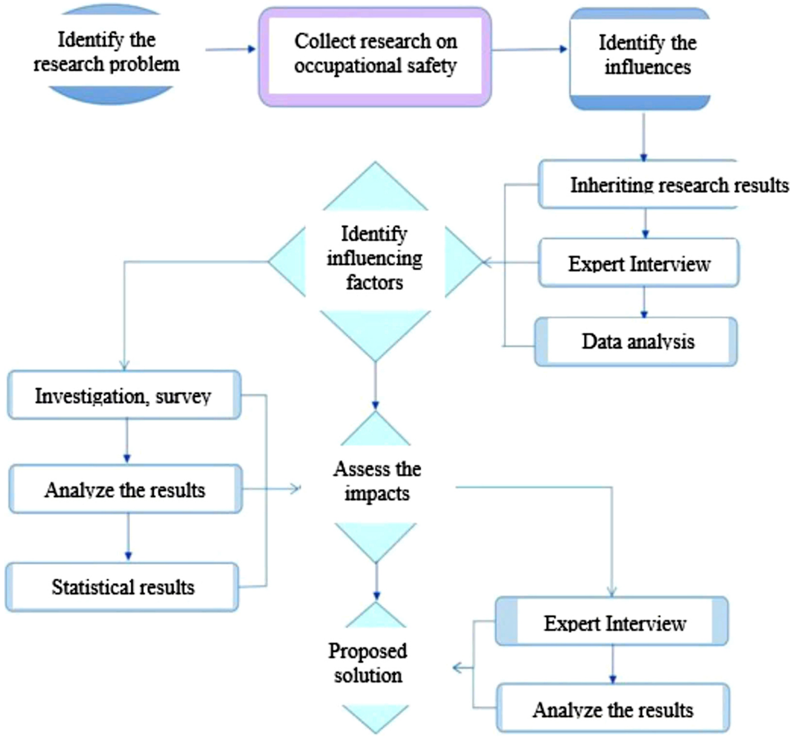

Fig. 1. Research diagram [Authors]

2.3. Data analysis and processing methods

For qualitative data in-depth interviews: Following comprehensive interviews with experts aligned with the research objectives regarding the influence of construction on labour safety at construction sites in the Mekong Delta, the author compiled the responses of the research subjects documented in the diary. Subsequently, the author chose significant, persuasive, and credible content that aligns with the research objectives of the topic to incorporate into the report. The study ultimately examined the data by creating an interview analysis table, choosing keywords and associated information to enhance the credibility of the report.

For quantitative data:

- The research team utilised specialised software SPSS 20 to clean and process the data, aiming to identify the trends and statistical patterns within the collected data set.
- The author employs exploratory factor analysis (EFA) to identify the factors influencing labour safety in construction sites within the Mekong Delta region. The study employed a 5-level influence scale to assess the information [29].
- The distance value is calculated as (maximum–minimum)/n, which equals (5 – 1)/5, resulting in 0.8. Where: Max represents the highest value, Min denotes the lowest value, and n indicates the scale utilised (Table 1).

Table 1. Analysis of the average values [29]

Scale	1	2	3	4	5
	No effect	Little Affect	Affect	Significant effect	Extremely effect
Value	1.00–1.80	1.81–2.60	2.61–3.40	3.41–4.20	4.21–5.00

Exploratory factor analysis The process of EFA involves the subsequent steps:

- Step 1: Conduct the Cronbach's Alpha test [29–32].
- Step 2: Exploratory Factor Analysis (EFA) [29–32].
- Step Three: Analysis of the factor score matrix: Employ the factor score matrix analysis technique to identify the variables that exert significant or minimal influence on each factor within the model.

Utilise the analysis results from objective 1 and objective 2 to assess, from which proposed solutions can be derived to reduce occupational accidents in the research area.

2.4. Determine sample size

Prior to carrying out a survey, it is essential to determine the required number of samples to serve as a foundation for data collection. The calculation of the number of samples is based on the mathematical Formula (2.1) outlined in [33].

$$n = \frac{z^2 \cdot s^2}{(\mu - \overline{x})^2} \tag{2.1}$$

where: s is the standard deviation of the sample; z is the value representing the required confidence level, with a confidence level of 95% or 99% the corresponding value of z is 1.96 or 2.58; $(\mu - \overline{x})$ is half the width of the required confidence level.

Furthermore, Gorsuch highlighted that factor analysis necessitates a minimum of 200 observations. Or Hachter demonstrated that the sample size must be a minimum of five times the observed variable. Bollen determined that the minimum sample ratio required for estimating a parameter is 5 samples.

In the context of the research topic, the author has determined an appropriate sample size of 250 samples, drawing on the ability and implementation time of the topic, as well as building upon the research findings of Gorsuch.

2.5. Guidelines for choosing participants for the questionnaire

Personnel and supervisors engaged in initiatives within the Mekong Delta regions.

Work experience is categorised into: < 3 years, 3 to 5 years, 5 to 7 years, and more than 7 years.

Qualifications in construction from a university or higher institution.

Data selection:

– Exclude questionnaires where respondents provided irrelevant answers regarding the significance of occupational safety in the context of construction projects in the Mekong Delta.
– Exclude questionnaires from respondents who were not part of the study conducted by the author.

2.6. Survey investigation plan

The Mekong Delta comprises 13 administrative units, which include one city directly governed by the Central Government, Can Tho City, along with 12 provinces: Long An, Dong Thap, An Giang, Tien Giang, Ben Tre, Vinh Long, Tra Vinh, Hau Giang, Kien Giang, Soc Trang, Bac Lieu, and Ca Mau. The author engaged with 250 survey forms, establishing connections or receiving introductions from esteemed experts across various departments, branches, and construction companies to distribute the surveys (shown in Figure 2).

Fig. 2. Map of the Mekong Delta region [internet]

2.7. Factors affecting construction on labor safety

Examine the findings of research pertaining to the subject. These studies highlight various factors that influence labour safety overall, with a specific focus on the effects of construction activities on labour safety within the Mekong Delta region. Analyse the elements that influence labour safety in construction environments. The factors serve as the foundation for expert discussions, guiding the selection of influencing elements to incorporate into the survey form.

3. Results and discussion

3.1. Evaluate the results from the survey

Drawing from prior relevant studies, insights from experts in the construction sector, and an analysis of the current conditions in the Mekong Delta region (see Table 2), the author identified 19 factors that influence labour safety at construction sites. The following factors are categorised as such:

- Group 1: Technical measures in construction
- Group 2: Machinery and equipment for construction
- Group 3: Management of Contractors
- Group 4: Workers
- Group 5: Additional considerations

Table 2. Elements influencing labour safety in construction projects within the Mekong Delta [Authors]

No	Effect factors
1	Approved construction technical measures, yet not appropriate for real construction conditions.
2	The technical measures for construction have yet to receive approval.
3	Insufficient organisation to assess and review safety conditions of construction technical measures prior to implementation
4	Uninspected construction equipment has been put into operation.
5	Construction machinery and equipment undergo inspection, though they are not tested prior to being utilised.
6	Utilising the machine for its designated function
7	Operating the machine beyond its limits
8	The construction unit's management capacity is limited, and there is a deficiency in experience with the application of new technology in construction.
9	The contractor employs unsuitable construction equipment.
10	There are no safety measures implemented for construction projects.
11	The contractor failed to supply protective equipment for the workers.
12	Utilising low-quality scaffolding formwork
13	Construction may not adhere to technical instructions, or the technical instructions may not be properly established.
14	Seasonal workers lack training in occupational safety.
15	Insufficient observation and focus in the workplace
16	Noncompliance with established safety regulations as outlined
17	Inadequate use of protective equipment pertinent to the tasks being carried out
18	Weather
19	Working environment around

The author developed a survey questionnaire incorporating various factors that influence labour safety at construction sites.

The survey was conducted over a period of 5 months across 13 provinces in the Mekong Delta. The authors compiled a list of individuals to be surveyed, along with their contact details, through their friends and work associates. The author subsequently carried out a direct survey, distributing the questionnaires through email to officials who were unable to meet face-to-face. Following the direct survey, the data gathered included:

– Total number of questionnaires distributed: 250 questionnaires.
– Total number of questionnaires collected: 250.
– The total count of valid questionnaires is 246.

The author processed the data from 246 valid questionnaires to prepare for the subsequent steps of analysis.

Participant details (Table 3, Figure 3).

Table 3. Job title [Authors]

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Management staff	71	28.9	29.1	29.1
	Technical staff	166	67.5	68.0	97.1
	Support staff, advisors	6	2.4	2.5	99.6
	others	1	0.4	0.4	100.0
	Total	244	99.2	100.0	
Missing	System	2	0.8		
Total		246	100.0		

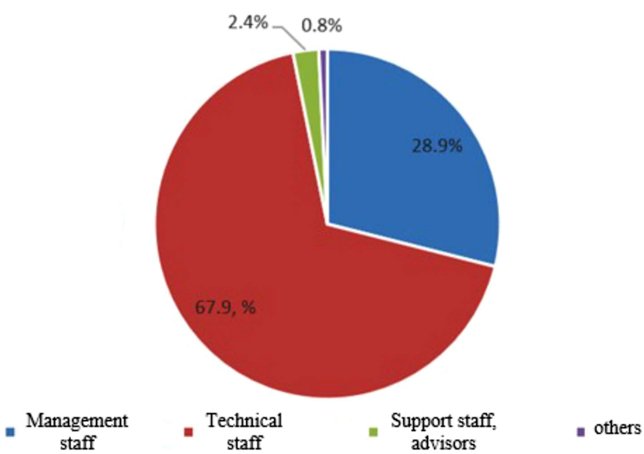

Fig. 3. Classification of respondents by job position [Authors]

Classification based on years of experience (Figure 4). This study reveals that the majority of respondents possess over 7 years of working experience, representing the largest segment at 56%. Meanwhile, individuals with 5–7 years of experience make up 34%, and those with 3–5 years account for 10%. Notably, there are no respondents with less than 3 years of experience. Most respondents possess work experience that is at least equivalent to a level 2 certificate or higher. The information gathered from the survey is objective and possesses significant practical value.

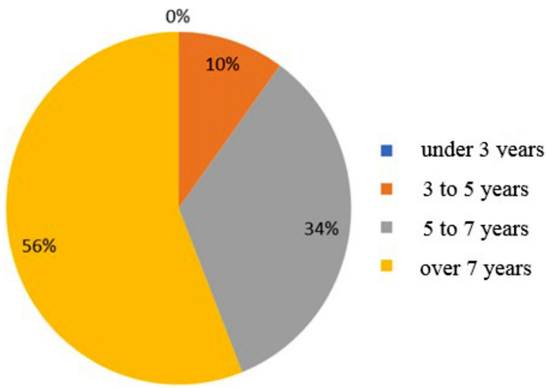

Fig. 4. Classification of respondents by years of experience [Authors]

Classification based on project implementation position (Table 4, Figure 5).

Table 4. Project implementation location [Authors]

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Investor	51	20.7	20.9	20.9
	Consulting unit	136	55.3	55.7	76.6
	Contractor	57	23.2	23.4	100.0
	Total	244	99.2	100.0	
Missing	System	2	0.8		
	Total	246	100.0		

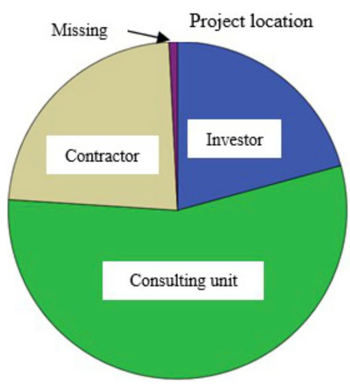

Fig. 5. Classification of respondents by project implementation location [Authors]

3.2. Assessment of factors affecting construction on labor safety at construction sites

The author provides content in the section regarding the assessment of factors influencing labour safety at construction sites in the Mekong Delta region, derived from a data set comprising 246 observation samples collected by the author. The author initially proposed a total of 19 observed variables, organised into 5 factor groups.

The initial factor is the factor: Construction technical measures, which include a total of three observed variables ranging from YT1 to YT3.

The second factor pertains to construction machinery and equipment, organised from YT4 to YT7, encompassing a total of four observed variables.

The third factor is Contractor management, which includes the contribution of six observed variables, ranging from YT8 to YT13.

The fourth factor is as follows: Workers are organised from YT14 to YT17, encompassing a total of 4 observed variables.

The fifth factor is identified as follows: Other factors are organised from YT18 to YT19, encompassing a total of 2 observed variables.

Identifying the factors that influence labour safety at construction sites in the Mekong Delta region serves as a crucial foundation for research aimed at proposing effective solutions. This research seeks to enhance efforts in reducing labour accidents, ultimately minimising the adverse effects of such incidents on the local economy and society. The factors will be incorporated into the Cronbach's Alpha reliability test.

Cronbach's Alpha Analysis: The study incorporated 19 observed variables categorised into 5 groups of factors to assess the influences on labour safety at construction sites in the Mekong Delta region. Presented below in Table 7 are the results of Cronbach's Alpha (Table 5).

Table 5. Cronbach's Alpha results [Authors]

Factors affecting	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
Group1: Technical measures for construction and Cronbach's Alpha = 0.621		
YT1. Technical measures for construction have been approved, yet they are not appropriate for the actual conditions on site.	0.424	0.535
YT2. The technical measures for construction have yet to receive approval.	0.422	0.532
YT3. Insufficient organisation to assess and review safety conditions of construction technical measures prior to implementation	0.447	0.500
Group 2: Cronbach's Alpha for Construction Equipment = 0.756		
YT4. Uninspected construction equipment has been put into use.	0.557	0.697

Continued on next page

Table 5 – *Continued from previous page*

Factors affecting	**Corrected Item-Total Correlation**	**Cronbach's Alpha if Item Deleted**
YT5. Construction machinery and equipment undergo inspection, though they are not tested prior to being utilised.	0.533	0.711
YT6. Utilising the machine for its designated function	0.536	0.709
YT7. Operating the machine beyond its limits	0.588	0.680
Group 3: Contractor Management Cronbach's Alpha = 0.801		
YT8. The construction unit's management capacity is limited, and there is a deficiency in experience regarding the application of new technology in construction.	0.483	0.789
YT9. The contractor employs unsuitable construction equipment.	0.570	0.767
YT10. There are no safety measures in place for construction projects.	0.669	0.742
YT11. The contractor failed to supply protective equipment for the workers.	0.520	0.779
YT12. Utilising substandard scaffolding formwork	0.557	0.770
YT13. Construction not adhering to technical instructions or lack of established technical instructions	0.551	0.772
Group 4: Worker Cronbach's Alpha = 0.850		
YT14. Seasonal workers lack training in occupational safety.	0.630	0.835
YT15. Insufficient observation and focus in the workplace	0.719	0.797
YT16. Noncompliance with established safety regulations	0.712	0.801
YT17. Inadequate use of appropriate protective equipment related to the tasks being carried out	0.700	0.805
Group 5: Other factors Cronbach's Alpha = 0.895		
YT18. Weather	0.810	
YT19. The atmosphere in the workplace	0.810	

The Cronbach's Alpha test (shown in Table 7) was conducted for 19 observed variables across 5 factor groups: (1) Construction technical measures, (2) Construction machinery and equipment, (3) Contractor management, (4) Workers, and (5) Other factors. The results indicate that all factors exhibit high Cronbach's Alpha coefficients, specifically 0.621, 0.756, 0.801, 0.850, and 0.895 for the 5 factor groups. The total correlation coefficient for all observed variables varies between 0.422 and 0.810, indicating that all 19 observed variables are incorporated in the exploratory factor analysis (EFA). In particular, when evaluating Cronbach's Alpha for the factor group "Construction technical measures" using three observed variables from YT1 to YT3, the Cronbach's Alpha coefficient for the factor achieved a value of 0.621, which is greater than 0.6. This indicates that the scale is entirely appropriate for factor analysis. The total correlation coefficient of the observed variables exceeds 0.3. Next, testing Cronbach's Alpha for the factor "Construction machinery and equipment" (YT4 to YT7) yielded a Cronbach's Alpha coefficient of 0.756, which is significantly higher than the acceptable threshold of 0.6, indicating that the scale meets the standard. The proposed model's observed variables exhibit a total correlation coefficient exceeding 0.3. Consequently, no observed variables associated with the factor "Construction machinery and equipment" (YT4 to YT7) were removed from the research model at this stage.

The Cronbach's Alpha test for the factor group "Contractor Cronbach's management," which includes 06 observed variables from YT8 to YT13, yielded a Cronbach's Alpha coefficient of 0.801, exceeding the threshold of 0.6. This indicates that the scale is entirely appropriate for factor analysis. The total correlation coefficient of the observed variables exceeds 0.3.

The Cronbach's Alpha test for the factor group "Worker," which includes four observed variables from YT14 to YT17, yielded a Cronbach's Alpha coefficient of 0.850, exceeding the threshold of 0.6. This indicates that the scale is highly appropriate for factor analysis. The total correlation coefficient of the observed variables exceeds 0.3.

The test result for the factor "other factors" with observed variables from YT18 to YT19 showed that the Cronbach's Alpha coefficient reached a value of 0.895, which is greater than 0.6, indicating that the scale meets the standard. The total correlation coefficient of the observed variables is 0.81, indicating that no observed variables are eliminated.

Consequently, following the assessment of Cronbach's Alpha for the observed variables, all variables remain included in the model. A total of 19 observed variables were incorporated into the exploratory factor analysis model.

3.3. Exploratory factor analysis EFA

Following the assessment of Cronbach's Alpha, the research performed exploratory factor analysis to consolidate and categorise observed variables into significant factors, thereby improving the explanatory power of the utilised factors. Exploratory factor analysis (EFA) is a quantitative analysis technique employed to condense a large array of interrelated measurement variables into a more manageable set of factors. This process aims to enhance the interpretability of the data while preserving the majority of the information contained in the original variable set [34]. Factor analysis finds application in various scenarios: Identifying aspects or factors that correlate within a set of variables, determining a relatively small number of new variables that are uncorrelated with one another for subsequent multivariate analysis, or selecting a few prominent variables from a larger set for use in later multivariate analyses [29].

This study employs Principal Components Analysis (PCA) with Varimax rotation. The Kaiser–Meyer–Olkin value falls within the range of $0.5 \leq \text{KMO} \leq 1$ (Table 6), and the significance level is indicated by a coefficient of Sig. = 0.000, confirming statistical significance. Furthermore, a Multivariate Data Analysis score of 0.5 indicates a good quality observed variable, with a minimum threshold of 0.3 [33]. The research model in this study will yield the following three tables from the first exploratory factor analysis (EFA).

Table 6. KMO and Bartlett's Test [33]

Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.806
Bartlett's Test of	Approx. Chi-Square	2030.997
Sphericity	Df	171
	Sig.	0.000

The initial results of the EFA analysis indicate that all factor loading coefficients exceed 0.5. Consequently, the factors guarantee convergent and discriminant values when conducting an analysis of EFA. Furthermore, EFA investigates the connections between variables across various groups (factors) to identify observed variables that are associated with multiple factors. Furthermore, EFA analysis assists the study in reorganising the observed variables in a manner that is more suitable than the originally suggested model. The analysis results indicate that the observed variables YT4 and YT5 are appropriately categorised within factor group 1: Construction technical measures. Specifically, YT4 refers to construction machinery and equipment that have not been inspected and put into use, while YT5 pertains to construction machinery and equipment that have been inspected but not checked prior to use. These two factors align closely with factor group 1, as any work accidents arising from them are likely to occur during the construction phase. Consequently, by modifying the variables in the factors, these independent factors remain unchanged, neither increased nor decreased.

Therefore, the initial group of factors consists of a total of 05 observed variables, which are: YT1, YT2, YT3, YT4, and YT5. This initial set of factors aims to clarify the issues concerning construction technical measures that impact labour safety at construction sites in the Mekong Delta region. This initial set of factors pertains to unapproved construction technical measures or approved measures that are inappropriate for the actual construction conditions, as well as uninspected construction machinery and equipment that are in use, or inspected machinery and equipment that have not undergone checks prior to being utilised. Furthermore, the absence of a structured approach to inspect and assess the safety conditions of construction technical measures prior to their application and construction is a significant factor that warrants attention within this group of considerations. The initial factor is referred to as "Construction technical measures" and is labelled X1.

The second group of factors consists of two observed variables: YT6 and YT7. This second group of factors elucidates the influence of construction machinery and equipment on labour safety at construction sites in the Mekong Delta region. The use of machinery that does not align with its intended function or exceeds its capacity. Consequently, the author designates the group of factors as "Construction machinery and equipment", referred to as X2. The third category of factors is referred to as "Contractor management" and is labelled as X3. The contractor management factor group consists of six observed variables: YT8, YT9, YT10, YT11, YT12, and RR13. The variables identified in the third group of factors pertain to issues like the use of inadequate formwork and scaffolding, the absence of a design for labour safety measures in construction projects, and the failure to adhere to technical instructions or the lack of established technical guidelines. Furthermore, it pertains to the contractor's failure to supply labour protection equipment for workers and the use of unsuitable construction equipment by the contractor. Simultaneously, the management capabilities of the construction unit and the lack of experience in implementing new technologies in construction will impact labour safety at construction sites in the Mekong Delta region. This is also one of the factors highlighted by the author in his research.

The fourth group of factors consists of four observed variables: YT14, YT15, YT16, and YT17. This group encompasses the factors related to the worker aspect. Workers do not completely adhere to the prescribed safety regulations and do not fully utilise the protective equipment associated with their tasks. Workers often exhibit a lack of observation and attention to their tasks, which impacts labour safety at the construction site. Furthermore, the employment of seasonal workers lacking training in labour safety also contributes to the research issue. Consequently, the fourth factor group referred to as "Workers" is designated as X4. The fifth factor group consists of a factor group created with two observed variables, namely: YT18 and YT19. This is a factor group that pertains to other factors. The weather and the surrounding working environment significantly influence labour safety at construction sites in the Mekong Delta region. The fifth factor group, referred to as "Other factors", is designated as X5.

3.4. Factor score matrix analysis

Following the exploratory factor analysis (EFA), 19 observed variables were identified, categorised into 05 groups of factors that influence labour safety at construction sites in the Mekong Delta region. The study then performed a factor score matrix analysis to assess the extent to which observed variables contributed to each group of factors within the model (Table 7).

The coefficient of the first factor group X1 is articulated for the factor "Construction technical measures" using the following expression: $X1 = 0.305 \cdot YT1 + 0.332 \cdot YT2 + 0.273 \cdot YT3 + 0.24 \cdot YT4 + 0.274 \cdot YT5$. The analysis reveals that the observed variable "YT2. Construction technical measures not yet approved "exerts the most significant influence on this factor group. The coefficient of the second factor group X2, which includes 2 observed variables, is expressed in the following manner: X2 equals $0.515 \cdot YT6 + 0.46 \cdot YT7$. This coefficient represents the factor "Construction machinery and equipment" in the research model discussed in the topic. The findings from expression X2 indicate that the observed variable "YT6. Using the machine for the wrong purpose" contributes the most significant coefficient (0.515) to the model. This also clarifies that utilising the machine for inappropriate purposes will lead to occupational safety hazards.

The coefficient for the factor "Contractor management" or X3 is expressed as follows: $X3 = 0.178 \cdot YT + 0.305 \cdot YT9 + 0.263 \cdot YT10 + 0.333 \cdot YT11 + 0.345 \cdot YT12 + 0.233 \cdot YT13$. It is evident that the variable "YT11. Contractor does not provide workers with protective equipment" exerts the most significant influence on the third factor in the model.

The coefficient of the fourth factor, represented by X4, is as follows: "Workers". X4 equals 0.330 times YT14 plus 0.305 times YT15 plus 0.314 times YT16 plus 0.320 times YT17. This indicates that the observed variable "YT14. Seasonal workers have not been trained in

Table 7. Results of factor score matrix analysis [Authors]

Observation variable	**Factor**				
	1	**2**	**3**	**4**	**5**
Construction technical measures					
YT1. Technical measures for construction have been approved, yet they are not appropriate for the actual conditions on site.	0.305				
YT2. The technical measures for construction have yet to receive approval.	0.332				
YT3. Insufficient organisation to assess safety conditions of construction technical measures prior to implementation	0.273				
YT4. Uninspected construction equipment has been put into use.	0.24				
YT5. Construction machinery and equipment undergo inspection, though they are not tested prior to being utilised.	0.274				
Machinery and equipment used in construction					
YT6. Utilising the machine for its designated function		0.515			
YT7. Operating the machine beyond its limits		0.46			
Contractor Management					
YT8. The construction unit's management capacity is limited, and there is a deficiency in experience regarding the application of new technology in construction.			0.178		
YT9. The contractor employs unsuitable construction equipment.			0.305		
YT10. There are no safety measures in place for construction projects.			0.263		
YT11. The contractor failed to supply protective equipment for the workers.			0.333		
YT12. Utilising substandard scaffolding formwork			0.345		
YT13. Construction may not adhere to technical instructions, or there may be a lack of established technical instructions.			0.233		
Worker					
YT14. Seasonal workers lack training in occupational safety.				0.330	
YT15. Insufficient observation and focus in the workplace				0.305	
YT16. Noncompliance with established safety regulations				0.314	
YT17. Inadequate use of appropriate protective equipment related to the tasks being carried out				0.320	
Other factors					
YT18. Weather					0.498
YT19. The atmosphere in the workplace					0.468

occupational safety" exerts the most significant influence among the four observed variables of the fourth factor – Workers. This accurately evaluates the reality of occupational accidents at construction sites in the Mekong Delta region, reflecting the regional characteristics of workers who primarily engage in labour according to the agricultural season. During the rice season, they will refrain from construction work and concentrate on the crop season instead. Once the crop season concludes and work is scarce, they will transition to construction jobs.

The coefficient of the final factor X5 is expressed as: $X5 = 0.498 \cdot YT18 + 0.468 \cdot YT19$. This demonstrates that the observed variable "YT18. Weather" exerts the greatest influence among the two observed variables of the fifth factor – Other factors.

The survey results and the expressions X1, X2, X3, X4, and X5 indicate that all observed variables positively influence each factor in the model. Consequently, any changes to the observed variables in the model will influence labour safety at construction sites in the Mekong Delta region. Thus, we can depend on the extent of this impact to manage and suggest measures for enhancing labour safety at these sites.

3.5. Suggesting measures to minimise workplace accidents in construction in the Mekong delta

Foundation for suggested resolution: The study aims to propose effective solutions for reducing occupational accidents at construction sites in the Mekong Delta region through the collection and analysis of relevant data. To achieve thorough and evidence-based solutions, the topic elucidates the foundation for developing these solutions. The findings from the research on the present circumstances have highlighted elements influencing occupational safety in construction environments. The influence of each observed variable (factor) on the group of factors is also examined concurrently. The study identified five groups of factors influencing occupational safety at construction sites in the Mekong Delta region: Construction technical measures (X1), Construction machinery and equipment (X2), Contractor management (X3), Workers (X4), and Other factors (X5).

Collection of solutions regarding construction technical measures: The construction method refers to the sequence and approach taken to complete a specific project, starting from the initial phase and concluding with the handover. This method must outline aspects such as time efficiency and preventive measures (including accident and fire prevention) to ensure the project is finished promptly, effectively, and safely. Every project will utilise a distinct construction method tailored to meet the specific requirements of that project. Within the realm of construction technical measures, five factors influence labour safety at construction sites in the Mekong Delta region: YT1. Approved construction technical measures that do not align with actual construction conditions; YT2. Construction technical measures that lack approval; YT3. Insufficient organisation for inspecting and evaluating the safety conditions of construction technical measures prior to application; YT4. Construction machinery and equipment that have not undergone inspection before use; YT5. Construction machinery and equipment that are inspected but not verified before being utilised. Based on the findings presented in section 3.2, the authors suggest measures aimed at mitigating occupational accidents associated with this set of factors:

1. Before commencing construction, all projects are required to have an approved construction organisation design and construction design for the works involved. The aim of creating a construction design (TKTC) is to identify the most efficient construction method that minimises labour, shortens construction duration, reduces costs, decreases material usage, enhances the quality of construction work, and ensures the safety of workers.
2. For approved construction technical methods that do not align with actual construction conditions, it is essential to form a contractor expert team comprising skilled engineers to reassess the current status of the project and provide well-considered proposals and modifications prior to commencing construction.
3. It is essential that all construction technical methods undergo inspection and assessment for safety conditions prior to implementation, and that they are closely monitored throughout the implementation process.
4. The machinery and equipment utilised must undergo inspection, possess a comprehensive machine history, and be licensed for use in accordance with the regulations set forth by the Ministry of Labour.
5. Machinery and equipment used in construction must undergo inspection, installation, and testing to ensure quality, with alternative plans in place prior to construction.
6. It is essential that all machinery and equipment on the construction site maintain a tracking record to guarantee compliance with safety and quality standards at all times. On extensive construction sites, a colour-coded stamp system that changes every quarter can be employed to enhance the management of machinery and equipment. For instance: quarter I – blue stamp, quarter II – red stamp, quarter III – purple stamp. At the conclusion of each quarter, the records and documents will be reviewed, and the machinery and equipment on-site will be inspected prior to applying a new stamp. Machinery and equipment failing to meet safety requirements will remain unstamped until they are either repaired or removed from the construction site, and their use is prohibited. This Stamp system allows for the straightforward identification of machines and equipment that fail to comply with safety standards.

3.6. Group of solutions on machinery and equipment for construction

The collection of machinery and equipment utilised in construction encompasses the following elements: YT6. Utilising the machine for an incorrect purpose; YT7. Employing the machine beyond its intended capacity. The suggested solution in this group is as follows:

Contractors must thoroughly examine the procedures, criteria for machinery inspection, and the functions and capacity of the equipment before bringing it to the construction site. It is essential to refrain from using the machine for inappropriate purposes. When seeking to utilise machinery and equipment for tasks that do not align with their intended use, such actions must receive approval from the safety officer and require careful supervision.

Avoid operating the machine beyond its designated capacity. Ensure that there is a machine instruction manual available and that supervision is always present.

3.7. Contractor management solutions group

The management team of the contractor encompasses the following elements: YT8. The construction unit's management capacity is limited, and there is a deficiency in experience with the application of new technology in construction; YT9. The contractor employs unsuitable construction equipment; YT10. Absence of labour safety measures in project construction; YT11. The contractor fails to supply labour protection equipment for workers; YT12. Utilisation of substandard formwork and scaffolding; YT13. Construction practices do not adhere to technical instructions, or such instructions are not established.

A successful and sustainable construction project involves various elements, ranging from the initial concept and design to the actual implementation of the construction. The construction contractor plays a crucial role in the process of ensuring a project's success. To guarantee that the team of workers and employees operates efficiently, the contractor must clearly and firmly assign responsibilities to each individual and each role. The contractor is also required to ensure the transfer of all essential technical procedures to the relevant locations, enabling them to provide mutual support throughout the construction process:

– Prior to dispatching workers to the construction site, the contractor will arrange for retraining, testing, and classification of workers tailored to each individual and specific group of individuals. Supply information and safety gear for labour protection. The contractor will place greater emphasis on management and construction instructions, particularly for general workers involved in short-term recruitment.
– The contractor is required to conduct regular inspections to ensure the safety of machinery and equipment. Additionally, construction machinery and equipment should be utilised for their intended functions to maintain productivity.
– It is essential to establish safety measures during construction to guarantee the safety of labourers. Approved measures by superiors should be communicated effectively and training provided for the workers directly involved in construction.
– Workers must be equipped with essential labour protection during construction, including fabric shoes, safety belts, protective clothing, safety helmets, and more.
– It is essential to evaluate the load-bearing capacity of formwork and scaffolding prior to their utilisation. When installing any structure, it is essential to calculate and verify the load-bearing capacity based on two conditions.
– Establishing technical instructions for each work is essential. At every stage of construction, it is essential to meet technical requirements, utilise appropriate materials, and engage skilled personnel. Those who suggest construction methods should possess knowledge, experience, keen observation, and an understanding of various construction types. For each type of project, it is essential to propose the most suitable and efficient construction method. Outdated methods that no longer fit the current context should be avoided. Promote the understanding and integration of global large-scale projects to enhance the domestic construction sector.
– Form an inspection team to evaluate labour safety at the construction site.

3.8. Worker solutions group

Workers at construction sites play a crucial role in the construction and installation of various projects, including civil houses, high-rise buildings, infrastructure, bridges, roads, and numerous other construction endeavours. They play a crucial role in the development of infrastructure and other significant projects, ensuring that these initiatives are finished on time and adhere to safety and quality standards. Construction sites present numerous risks and hazards for workers, inherent to the nature of the industry. To reduce risks and guarantee the safety of workers, the authors suggest several solutions including:

- The best approach is to ensure that workers grasp the significance of occupational safety. Therefore, prior to dispatching workers to the construction site, contractors should arm themselves with knowledge regarding occupational safety and provide clear instructions on the use of safety equipment. Particularly regarding seasonal workers, it is essential to focus more on management and construction guidelines.
- Workers are required to adhere to labour safety regulations throughout the entire working process at construction sites. Safety measures and labour safety regulations should be prominently displayed at the construction site for all to see and adhere to; hazardous areas on the construction site must be marked with instructors and warnings to avert accidents. Sanctions are in place to ensure that workers adhere strictly to labour safety regulations. It is strictly prohibited for anyone to consume alcohol, beer, smoke, or use any stimulants that may induce nervous tension during working hours at the construction site.

3.9. Group of solutions on other factors

Construction is a unique industry where workers frequently operate outdoors, particularly in elevated positions, in hot and humid environments, and in areas with severe weather conditions. The Mekong Delta is situated in the heart of Asia's tropical monsoon region. From May to the end of September, it experiences the influence of the southwest monsoon, bringing humidity and rainfall, marking the rainy season. In contrast, from November to mid-March of the following year, the northeast monsoon from the mainland results in drier and less rainy conditions, defining the dry season from October to November. Additionally, from September to March of the following year, morning and evening tides occur.

Providing sufficient drinking water for workers is essential, as high temperatures and sunny conditions can raise body temperature, resulting in excessive sweating. It is essential for workers to promptly rehydrate by consuming adequate amounts of water; therefore, a supply of drinking water must always be available on the construction site. The scheduler needs to be aware of climatic conditions to organise work in a way that avoids adverse weather for the tasks at hand. If the work continues due to project requirements, the contractor must implement specific measures to mitigate the effects of weather conditions. This includes ensuring comfortable working conditions by supplying appropriate clothing and protective equipment to safeguard workers from the impacts of high temperatures. Utilise the cooler temperatures for outdoor tasks, reserve the hotter days for indoor activities, or strategically position your work area based on the sun's direction.

4. Conclusions

Based on the results of the study lead to the following conclusions:

Ensuring safety in construction is consistently a primary focus. It is the duty of investors, contractors, and workers involved in construction. To ensure safety and reduce incidents that impact the health of construction participants, assets, and equipment, related units must implement preventive measures from the outset. Both workers and employers should equip themselves with fundamental knowledge to safeguard their health and assets. The study identified five groups of factors, comprising 19 elements, that influence labour safety during the construction process at sites in the Mekong Delta region. It also proposed targeted solutions aimed at reducing labour accidents in these construction environments. The study additionally put forward several recommendations for units, including: It is essential for investors to oversee and monitor the execution of construction safety measures carried out by contractors. Clear disciplinary regulations exist, including fines or prosecution, for relevant units involved in construction sites. The design consulting unit emphasises that safety measures should be closely aligned with the actual construction conditions during the design process. Contractor: Suggest and implement labour safety measures for individuals, machinery, assets, and the overall project. Mandatory regulations must be established to ensure that workers who lack training in labour safety and are not fully equipped with protective equipment are prohibited from entering the construction site. Consistently dispatch employees to training programs focused on contemporary construction technology, followed by preparing workers prior to the commencement of construction activities on-site. It is essential to conduct labour safety training for all groups of workers involved in production on the construction site on a periodic and regular basis. Workers are required to adhere to the labour safety regulations set forth by the construction unit, remain vigilant about their personal safety while on the job, and ensure they are fully equipped with the appropriate labour protection gear for each specific task. Construction inspectors are required to conduct regular inspections and impose fines for unsafe labour practices at construction sites.

References

[1] A. Albert, B. Pandit, et al., "Does the potential safety risk affect whether particular construction hazards are recognized or not?", *Journal of Safety Research*, vol. 75, pp. 241–250, 2020, doi: 10.1016/j.jsr.2020.10.004.

[2] R.U. Farooqui, F. Arif, and S.F.A. Rafeeqi, "Safety Performance in Construction Industry of Pakistan", in *First International Conference on Construction in Developing Countrie*s. Karachi, 2008, vol. 2, pp. 74–87.

[3] J.M.J. Wilson and E. Koehn, "Safety management: problems encountered and recommended solutions", *Journal of Construction Engineering and Management*, vol. 126, no. 1, pp. 77–79, 2020, doi: 10.1061/(ASCE)0733-9364(2000)126:1(77).

[4] W. Drozd, "Cluster analysis in research of accident rate in construction sector", *Archives of Civil Engineering*, vol. 64, no. 3, pp. 159–172, 2018, doi: 10.2478/ace-2018-0036.

[5] P. Sivaprakash and S. Kanchana, "A study on statutory provisions for construction safety in India", *Archives of Civil Engineering*, vol. 64, no. 1, pp. 171–179, 2018, doi: 10.2478/ace-2018-0011.

[6] M. Kowalik and W. Drozd, "Evaluation of the influence of selected factors on hazardous events in construction", *Archives of Civil Engineering*, vol. 68, no. 2, pp. 377–390, 2022, doi: 10.24425/ace.2022.140648.

[7] E.W.L. Cheng, H. Li, D.P. Fang, and F. Xie, "Construction safety management: an exploratory study from China", *Construction Innovation*, vol. 4, no. 4, pp. 229–241, 2004, doi: 10.1108/14714170410815114.

[8] D.C. Ning, J.P. Wang, and G.D. Ni, "Analysis of Factors Affecting Safety Management in Construction Projects", in *International Conference on Management and Service Science*. Wuhan, China, 2010, pp. 1–5, doi: 10.1109/ICMSS.2010.5576911.

[9] N. Jokkaw and T. Tongthong, "Factors influencing on safety management status and evaluation of safety management status in construction projects in Cambodia", *ASEAN Engineering Journal*, vol. 5, no. 1, pp. 34–48, 2016, doi: 10.11113/aej.v5.15470.

[10] L. Yadi, N. Yan, and T.C. Wei, "Critical Success Factors for Safety Management Building Construction Projects in China", *Advances in Civil Engineering*, vol. 2018, no. 1, pp. 1–15, 2018, doi: 10.1155/2018/1516354.

[11] G.H.K. Priyadarshani and G. Karunasena, "Factors Affecting Construction Safety Management in Sri Lanka", in *International Research Conference on Sustainability in Built Environment*. Colombo, Sri Lanka, 2010, pp. 192–197.

[12] Q.Z. Yu, L.Y. Ding, C. Zhou, and H.B. Luo, "Analysis of factors influencing safety management for metro construction in China", *Accident Analysis & Prevention*, vol. 68, pp. 131–138, 2014, doi: 10.1016/j.aap.2013.07.016.

[13] A. Mohammadi, M. Tavakolan, and Y. Khosravi, "Factors influencing safety performance on con-struction projects: A review", *Safety Science*, vol. 109, pp. 382–397, 2018, doi: 10.1016/j.ssci.2018.06.017.

[14] A.O. Akinsola, K.F. Potts, I. Ndekugri, and F.C. Harris, "Identification and evaluation of factors influencing variations on building projects", *International Journal of Project Management*, vol. 15, no. 4, pp. 263–267, 1997, doi: 10.1016/S0263-7863(96)00081-6.

[15] S. Han, F. Saba, S. Lee, et al., "Toward an understanding of the impact of production pressure on safety performance in construction operations", *Accident Analysis & Prevention*, vol. 68, pp. 106–116, 2014, doi: 10.1016/j.aap.2013.10.007.

[16] B.H. Guo, T.W. Yiu, and V.A. González, "Identifying behaviour patterns of construction safety using system archetypes", *Accident Analysis & Prevention*, vol. 80, pp. 125–141, 2015, doi: 10.1016/j.aap.2015.04.008.

[17] Y. Feng, S. Zhang, and P. Wu, "Factors influencing workplace accident costs of building projects", *Safety Science*, vol. 72, pp. 97–104, 2015, doi: 10.1016/j.ssci.2014.08.008.

[18] D. Fang, C. Wu, and H. Wu, "Impact of the supervisor on worker safety behavior in construction projects", *Journal of Management in Engineering*, vol. 31, no. 6, 2015, doi: 10.1061/(ASCE)ME.1943-5479.0000355.

[19] M. Segbenya and E. Yeboah, "Effect of Occupational Health and Safety on Employee Performance in the Ghanaian Construction Sector", *Environmental Health Insights*, vol. 16, 2022, doi: 10.1177/11786302221137222.

[20] M. Novy and J. Novakova, "Protecting Occupational Health and Safety in Construction Companies in the Czech Republic", *Procedia Computer Science*, vol. 219, pp. 1793–1800, 2023, doi: 10.1016/j.procs.2023.01.475.

[21] N.L. Hai, "An investigation the impact of the construction executing into construction safety in Vietnam", *Journal of Science and Technology in Civil Engineering*, vol. 13(1V), pp. 66–74, 2019.

[22] T.H. Tuan, "Analysis of factors acffecting safety performance of labour construction", *CTU Journal of Science*, vol. 12, pp. 162–170, 2009.

[23] D.T. Sy, N.H. Dai, L.G. Huy, and N.H. Thanh, "Applying IoT technology integrating with helmets for safety management at construction sites", *Journal of Building Materials and Construction*, vol. 13, no. 1, pp. 112–117, 2023, doi: 10.54772/jomc.01.2023.445.

[24] N.T. Viet and H.Ng. Viet, "Building a framework for assessing the safety management on construction sites in HCM city", *Journal of Science and Technology - Industrial University of HCMC*, vol. 53, no. 5, pp. 16–28, 2021, doi: 10.46242/jstiuh.v53i05.4133.

[25] B.T. Tung, "Research on important factors affecting the implementation of occupational safety programs in construction projects in Vietnam", M.A. thesis, Ho Chi Minh City University of Technology, Vietnam, 2013.

[26] B.H. Phuong, "Combining EFQM model and SYSTEM DYNAMICS to improve safety culture", M.A. thesis, Ho Chi Minh City University of Technology, Vietnam, 2014.

[27] D.T. Duc, "Research on factors affecting labor safety costs and propose a quantitative forecasting model for labor safety costs in construction works in Ho Chi Minh City", M.A. thesis, Ho Chi Minh City University of Technology, Vietnam, 2017.

[28] V.C. Dam, *Research methodology*. Hanoi: Science and Technology Publishing House, 2005.

[29] H. Trong and C.N.M. Ngoc, *Analyzing research data with SPSS*. Statistical Publishing House, 2008.

[30] N.D. Tho, *Research Methods in Business*. Social Labor Publishing House, 2011.

[31] E. Cristobal, C. Flavián, and M. Guinaliu, "Perceived E-Service Quality (PeSQ) Measurement Validation and Effects on Consumer Satisfaction and Web Site Loyalty", *Managing Service Quality: An International Journal*, vol. 17, no. 3, pp. 317–340, 2007, doi: 10.1108/09604520710744326.

[32] P. Loc, *SPSS 26 User Guide - Applying quantitative analysis to writing theses and economic research topics*.

[33] J.F. Hair Jr., R.E. Anderson, R.L. Tatham, and W.C. Black, *Multivariate Data Analysis*, 7th ed. Macmillan Publishing Company, 2010.

[34] R. Fellows and A. Liu, *Research Methods for Construction*, 4th ed. Oxford: John Wiley and Sons Ltd, 2008.

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