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Exploring the Relationship Between Stress, Burnout, and Occupational Accidents in Civil Construction

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Abstract

This study investigates the factors influencing work-related stress, burnout, and occupational accidents in the civil construction sector. Using a mixed-methods approach, the research integrates both qualitative and quantitative methodologies. Measurement scales for stress, fatigue, and occupational accidents were reviewed, translated, and adapted from prior studies to suit the context of construction workers. A total of 275 questionnaires were distributed, with 269 valid responses analyzed using SmartPLS (ver 3.2.8). Data analysis encompassed evaluating the validity and reliability of scales and exploring the relationships among key concepts in the research model. The findings highlight the significant influence of job attributes, co-worker relationships, and work environment on work-related stress. These factors trigger psychological changes that exacerbate worker fatigue and contribute to increased occupational accident rates. Novel insights emphasize the interdependence of these elements in shaping worker behavior and safety outcomes. The study provides a foundation for developing targeted strategies to mitigate stress and fatigue, reduce occupational hazards, and promote well-being among construction workers. By offering an integrated analysis, this research contributes to advancing the understanding of safety management practices in the construction industry.

Keywords:

Stress;
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1- Introduction

Stress has significant effects on both the health and work efficiency of individuals, particularly as a cause of occupational accidents [1]. In terms of health, stress can lead to various complications, and if the condition persists, it disrupts the body's adaptive responses, resulting in numerous pathological disorders and burnout [2].This exhaustion leads to increased feelings of tiredness and negative thoughts, consequently compromising safety in the workplace [3].

According to statistics from the Ministry of Labor, War Invalids and Social Affairs of Vietnam, in 2022, there were 7,718 occupational accidents nationwide, an increase of 1,214 cases compared to 2021, resulting in 7,923 victims (a rise of 1,265 victims from 2021) [4]. In the labor-related sectors alone, material damages due to occupational accidents in 2022 amounted to over 14.117 billion Vietnamese Dong (569,923.29 USD) (an increase of about 10.163 billion Vietnamese Dong (410,294.71 USD) compared to 2021). This total includes medical expenses, funeral costs, and compensation for the families of the deceased and injured. Additionally, occupational accidents resulted in property damages amounting to approximately 268 billion Vietnamese Dong (equivalent to 10,819,539.76 USD), reflecting a significant increase of around 250 billion Vietnamese Dong (10,092,854.25 USD) compared to 2021. These accidents also led to over 143,000 lost workdays, a rise of about 27,000 days from the previous year. In Ho Chi Minh City alone, 803 occupational accidents were reported, involving 832 victims. The city recorded the highest number of fatal

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workplace incidents nationwide, with 83 cases and 86 fatalities [5]. The construction industry experienced the most fatalities due to occupational accidents, accounting for 14.73% of the total cases and 15.26% of the total fatalities [6]. Out of 347 occupational accidents resulting in 352 fatalities (from 2019 to 2023) in Ho Chi Minh City, 213 occurred at construction sites, particularly in civil construction projects (over 61%) [7].

Extensive research has examined the impact of stress and burnout on occupational accidents across various industries, focusing on factors such as job environment, workload, and psychological well-being. These studies have shed valuable light on the relationship between workplace conditions and worker safety. Huang & Zou (2024) investigated the relationship between role stress, occupational burnout, and depression among emergency nurses [8]. Conducted with 295 nurses from eight tertiary hospitals in western China, the study used standardized scales to assess these factors. Results showed that 54.6% of participants experienced depressive symptoms, and 48.1% faced severe occupational burnout. Positive correlations were found between role stress, burnout, and depression, with burnout explaining 37.1% of the variation in depression. Meanwhile, Azimi et al. examined the connection between job burnout and unsafe behavior, emphasizing the mediating role of resilience among 200 workers in Iran's spinning and weaving sectors [9]. The findings revealed that resilience plays a crucial role in reducing the adverse effects of burnout on safety compliance and participation, with the strongest impact observed on safety compliance. Various dimensions of burnout, including emotional exhaustion, depersonalization, and personal accomplishment, affect safety outcomes both directly and indirectly, indicating that tailored strategies to strengthen resilience could effectively minimize unsafe behaviors and enhance workplace safety. However, the civil construction industry in Ho Chi Minh City, despite its high incidence of occupational accidents, has received limited scholarly attention. This study addresses this gap by adopting a mixed-methods approach to provide a comprehensive analysis of the intricate relationships between stress, burnout, and workplace accidents within this under-researched context. Based on the research results, the authors propose management implications to mitigate stress, burnout, and accidents among laborers at civil construction sites within the city.

This article is organized as follows: The next section reviews the relevant literature, providing the theoretical foundation for the study. The materials and methods used are detailed in Section 3. Section 4 presents the results, followed by a discussion and conclusion in Section 5. Finally, Section 6 addresses the study's limitations and suggests directions for future research.

2- Literature Review

Stress is a non-specific biological response of the body to environmental stimuli. It represents the body's reactions to restore internal equilibrium and overcome unfavorable situations to ensure its reasonable maintenance and adaptation in the face of constantly changing living conditions. It arises from physical and emotional responses that occur when work demands are incongruent with the workers' abilities, resources, and needs. Lazarus posited that work-related stress involves the interaction between individuals and their work environment [10]. Stress has cyclical and repetitive characteristics and can influence future outcomes by enhancing or impairing an individual's ability to cope with stress. In cases of continuous or severe occurrence, stress can lead to prolonged psychological effects. Lazarus & Folkman defined a state of stress as a threatening or harmful condition for individuals that they believe they cannot control or manage [11, 12].

According to the International Labour Organization (ILO), work-related stress is recognized globally as a significant challenge to the health of workers and the well-being of organizations. Workers are highlighted as particularly susceptible to the detrimental impacts of stress, leading to reduced productivity, burnout, and an increased susceptibility to occupational accidents. Stress can manifest through symptoms such as unstable emotions, discomfort, a preference for solitude, difficulty sleeping, excessive smoking, anxiety, elevated blood pressure, and impaired digestion [13-15].

Leung et al. categorize stress factors into four groups: (1) Job-related stress often involves excessive workload, job role conflicts, and ambiguity in daily tasks; (2) Organizational stress originates from the organization itself, encompassing its structure and career development environment. Poor organizational structure includes the presence of bureaucratic machinery, hierarchy, rigid rules, and unfair treatment within the organization; (3) Individual stress comprises stress within each person and between individuals. Individual stress pertains to irritability, impatience, suspicion, competitiveness, multitasking, and unfriendliness [16]; and (4) Physical stress is related to stress factors arising from the work environment. In construction sites, workers often operate in unfavorable environmental conditions, including extreme temperatures, inadequate lighting, and noise, all contributing to stress [17].

Burnout Syndrome: Exhaustion due to work is closely related to work-related stress. Most researchers believe that work-related stress originates from factors within a person's job [18, 19]. Burnout is a research concept built upon the resource conservation theory and can be understood as enduring stress over a long period leading to this phenomenon [20, 21]. According to Maslach et al. burnout is a core component that involves feeling excessively effortful and depleted in both mental and physical resources [22]. Kammeyer-Mueller et al. state that when someone experiences burnout, they will feel burnout and demotivated throughout the workday. The short-term exhaustion might intensify and persistently

affect task performance [23]. Consequently, they feel unhappy and disappointed with their accomplishments at work. In terms of symptoms, some studies have approached burnout using medical methods [24-26]. The results indicate that commonly observed symptoms include extreme burnout, mental exhaustion, back pain, headaches, insomnia, digestive disorders, irritability, and other related symptoms.

2-1- Occupational Accident

According to Article 142 of the Vietnam Labor Code, a workplace accident is an incident that causes harm to any part or function of the body or results in the death of a laborer [27]. It occurs during work and is directly related to the performance of job tasks or labor duties. An accident is an unforeseen and unintended situation that leads to injury or damage to individuals, property, and the environment. Accidents are typically characterized by their unpredictable nature, with the exact timing being uncertain. The causes can arise from random occurrences or deliberate actions and do not occur continuously or extend over a prolonged period.

According to Selye, the body's physiological response when faced with a dangerous threat consists of three stages: the Alarm stage - warning; the Adaptation (resistance) stage, and the Exhaustion stage [18]. If stress persists to a certain level, the body will become exhausted. Stress reaction becomes pathological when an unexpected and overwhelming stressful situation exceeds the body's adaptability. Changes in psychological and neural states and behavior alterations appear overwhelmingly, leading to unsafe behaviors. According to Janssen et al.; Li & Poon, workers experiencing job-related burnout are considered intermediaries between stressors and safety outcomes, resulting in reduced safety performance as they fail to meet safety conditions while performing tasks [28, 29]. Nahrgang et al. and Poonet and et al. assess the relationship between stress due to job nature and prolonged working hours, resulting in burnout that leads to occupational accidents, which affect organizations by causing labor shortages, increasing project costs, and negatively influencing safety performance at construction sites [30, 31].

According to Leung et al. research, worker injury incidents are directly influenced by the organization's failure to establish goals and safety behaviors that impact the degree of worker injuries [32]. Moreover, workplace injuries are also affected by inadequate provisions of safety equipment, emotional stress, and physical burnout, which directly affect workers' safety behaviors.

According to the study by Cooper & Williams, six stress factors influencing safety behavior were identified: job nature, co-worker relationships, organizational structure, career development, work-family conflict, and job objectives [33]. Goldenhar et al. demonstrated a relationship between job-related stress factors, occupational accidents, and worker fatalities [34]. Among the 12 groups of stress factors related to work, direct connections to occupational accidents range from minor to severe, including job demands, safe work environment, on-site safety supervision, sense of responsibility, organizational construction competence, safety training, labor safety policies, worker expertise and experience, compliance with labor safety regulations, and job stability. Other factors, such as discrimination and low qualifications, indirectly affect occupational accidents through psychological or physical stress.

Leung et al. conducted research to identify and evaluate the impact of workplace stress factors on construction workers' safety behavior and occupational accidents [35]. Correlation and regression analysis results indicated three groups of factors: (1) Physical stress, including job nature, peer support, and safety equipment, directly influences safety behavior and occupational accidents; (2) Mental stress directly affects safety behavior; (3) Workers' safety behavior controls and reduces the risk of accidents.

2-2- Hypotheses

According to Beehr et al., communication and feedback are essential aspects of management within an organization [36]. Parker & Decotis, Leka et al. and Rollison suggest that the organization plays a significant role in influencing job-related stress among employees [37-39]. Workers are constrained by factors such as inadequate policies, insufficient training, inadequate wages, job instability, lack of proper safety training, low wages, unsafe working environments, unsafe labor equipment, staff shortages, being pressured, poor communication, delayed responses, unfair treatment, late salary payments, experience disappointment, self-doubt, psychological burnout, and job-related stress. Therefore, the research hypothesis H1 is proposed as follows:

H1: The Organizational Stressors would positively influence job-related stress.

Smith defines job nature as the overall goal of the job, activities within the job, and social relationships linked to the job [40]. Parker & Decotis suggest that job nature varies depending on the specificity of each profession, resulting in stress for workers [37]. Workers feel more stressed when job tasks are overwhelming; working hours are extended; there is little break time, strict job demands, insufficient support and trust from superiors and peers, limited autonomy, limited promotion and advancement opportunities, high precision, and strict job requirements. Hence, the research proposes hypothesis H2 as follows:

H2: Job nature would positively influence job-related stress.

Parker & Decotis state that relationships are one of the factors causing stress for employees within an organization [37]. Organizational relationships encompass relationships with colleagues, superiors, and subordinates. Workers feel pressured, uncomfortable, and uneasy when peer relationships lack support and trust from superiors, exhibit conflicts between superiors and colleagues, or involve competition among individuals. This can be explained by the importance of attitudes and perceptions when encountering difficult situations. Positive attitudes and actions lead to lower job-related stress than those with opposing, pessimistic viewpoints. Strong co-worker relationships in the workplace are critical for individual job performance. When these relationships are poor, individuals become dissatisfied with their jobs and prone to psychological stress. Therefore, hypothesis H3 is proposed as follows:

H3: Poor co-worker relationships would positively influence job-related stress.

According to Robbins, the work environment is where employees work, and it's a place where employees desire a safe and comfortable environment similar to being at home, equipped with necessary tools and a clean workspace [41]. Prolonged work in a physically challenging environment with hazards, dust, high temperatures, excessive noise, lack of lighting, physically demanding tasks, complicated work, fire and explosion risks, poor ventilation, etc., increases job-related stress. Hence, hypothesis H4 is proposed as follows:

H4: Hazardous work environments would positively influence job-related stress.

According to Wahab, emotional stress or mental strain often presents as negative thinking, chronic anxiety, low energy, low self-confidence, inability to make decisions, and difficulty concentrating [42]. Continuous work-related emotional stress can lead to employee burnout, causing them to lose dedication, focus, and attention on the job [43]. Psychological stress reduces attention and care during work, leading to feelings of disappointment, exhaustion, personality changes, and neglect of safety behaviors [44, 45]. Based on this, hypothesis H5 is proposed as follows:

H5: Mental stress would positively influence employee burnout.

Mellner et al. state that working regularly under stress leads the human brain to release hormones to adapt to changes [46]. Long-term adjustments to these changes affect individuals, resulting in physical issues such as headaches, back pain, joint pain, insomnia, dizziness, memory problems, and other similar symptoms. Extended stress-related hormonal adjustments affect the body's physiological functions, leading to employee burnout. Thus, hypothesis H6 is proposed as follows:

H6: Physical stress would positively influence employee burnout.

According to Wahab, behavioral stress is manifested through symptoms such as anxiety, anger, aggression, alcohol and tobacco use, and substance abuse [42]. If employees regularly use stimulants or addictive substances, it will further deteriorate their physical condition, leading to physical depletion and unstable behavior. Some individuals initially turn to alcohol or drugs to alleviate stress and anxiety, but these substances can ultimately increase anxiety, leading them to increase their usage. This repetitive behavior escalates, contributing to employee burnout. Hypothesis H7 is proposed as follows:

H7: Depersonalization would positively influence employee burnout.

Wahab states that continuous stress negatively affects the health of employees and leads to chronic illnesses such as high blood pressure, stomach ulcers, heart problems, and other ailments [42]. This exhaustion causes burnout and physical depletion and exacerbates employee burnout. Therefore, the research proposes hypothesis H8 as follows:

H8: Emotional exhaustion would positively influence employee burnout.

According to Bidgoli et al., job-related stress refers to an individual's reaction to the threatening aspects of the work environment, relationships with colleagues, excessive pressure, work overload, and unclear responsibilities [47]. Poon and colleagues assert that prolonged stress over an extended period leads to employee burnout, directly or indirectly impacting employee safety behaviors [31]. Therefore, hypothesis H9 is proposed as follows:

H9: Job-related stress would positively influence employee burnout.

Alexander & Klein, Elfering et al. and Leung et al. state that when employees experience job-related stress, it impairs their ability to concentrate during work and leads to negligence, causing them to overlook safety measures [44, 45, 48]. Consequently, this increases the rate of workplace accidents. Hypothesis H10 is proposed as follows:

H10: Job-related stress would positively influence occupational accidents.

According to Pines & Aronson, burnout is a state of emotional, mental, and physical exhaustion characterized by a lack of energy, purposelessness, reduced efficiency, and negative attitudes toward everything [49]. Burnout makes individuals have a negative outlook on everything around them. Poonet et al. and Nahrgang et al. argue that when employees experience burnout, they become subjective and careless, disregarding safety regulations, making mistakes, and causing accidents for themselves and others [30, 31]. Therefore, hypothesis H11 is proposed as follows:

H11: Employee burnout would positively influence occupational accidents.

3- Research Methodology

The flowchart can visually depict the following steps:

Step 1: Survey Design - Questionnaire developed based on existing literature and expert input.

Step 2: Participant Recruitment - construction professionals surveyed.

Step 3: Data Collection - Responses gathered via the survey.

Step 4: Measurement of Constructs - job-related stress, burnout, and occupational accidents are measured.

Step 5: Analysis - Structural Equation Modeling (SEM) to test relationships.

3-1- Participants

The sample was collected from construction sites in Ho Chi Minh City, including middle-level officers, managers, and workers currently working at construction sites in the city. The convenience sampling method was used in this study. A total of 280 survey questionnaires were distributed, and 275 were collected. After eliminating six invalid questionnaires, the author had 269 valid questionnaires for data entry, achieving a data entry rate of 97.8%. After cleaning the data, the author had a complete survey dataset with 269 samples.

Regarding age, the highest number of workers was in the age range of 18 to 25, accounting for 34.6%, and the age range of 26 to 30 accounted for 22.7%. This group represents an abundant young labor force with energy and enthusiasm, fresh graduates with limited experience, and prone to agitation. Workers aged 31 to 40 and 41 to 50 accounted for 27.5% and 12.3% respectively. They are experienced in both work and mentality, exhibiting maturity and stability in their thinking. The age group over 51 accounted for 3%, representing workers with weaker health who frequently fall ill and cannot perform strenuous tasks.

Regarding educational qualifications, those with university degrees accounted for 22.7%, and master's degrees accounted for 3%. This group often includes managers, designers, supervisors, and machine operators. Although they make up a small proportion, they are usually key personnel in the enterprise. Workers with vocational school degrees accounted for 8.9%, and those with college degrees accounted for 5.2%. These groups include skilled workers and those with secondary education, making up 60.2% of workers who still need to receive specialized training. This group directly participates in construction activities.

In terms of work experience, the majority of workers had over five years of experience, accounting for 36.8%. Those with 3 to 5 years of experience accounted for 11.2%, those with 1 to 3 years accounted for 23.8%, and those with less than one year accounted for 28.3%. Overall, the data indicates that a significant proportion of workers had extensive work experience in construction. However, the percentage of respondents with less than five years of experience is still relatively high (Table 1).

Table 1. Demographic of participants

	n	%
Gender		
Male	232	86.2
Female	37	13.8
Age		
From 18 to 25	93	34.6
From 26 to 30	61	22.7
From 31 to 40	74	27.5
From 41 to 50	33	12.3
Above 50	8	3
Working time		
Less than 1 year	76	28.3
From 1 to 3 years	64	23.8
From 3 to 5 years	30	11.2
More than 5 years	99	36.8
Professional qualification		
High school	162	60.2
Vocational	24	8.9
College	14	5.2
Bachelor (University)	61	22.7
Masters	8	3

Notes: N = 269; **Abbreviations:** n, number of participants; %, percentage.

The characteristics of the sample indicated that the survey results are pretty good. The respondents paid close attention to their answers and provided logically reasonable responses, which helps avoid random errors and makes the quantitative analysis more effective. Therefore, the survey sample is relatively representative of the population. The random characteristics regarding gender, age, and work experience among different groups are reasonable and suitable for conducting the study.

3-2- Questions Design

The article's objective was to investigate the relationship between stress, burnout, and workplace accidents in the construction industry. The approach taken in the article combined qualitative and quantitative research, with a primary focus on quantitative methods. The qualitative method was used to refine the measurement scales. Based on theoretical reviews and previous studies, the author proposed measurement scales for the research concepts in the proposed research model. Next, the author conducted interviews with several managers working in the construction field to gather opinions and contributions to adjust the measurement scales to fit the natural environment and Vietnamese context better. This helped refine the questionnaire, which was then used for the survey. The Likert scale was designed with 5 points.

Different authors proposed various sample sizes. Hair et al. suggest a minimum requirement of 100-150 observations [50]. Tabachnick & Fidell mention that > 300 observations were good, > 500 observations were excellent, and > 1,000 were excellent [51]. According to Hair et al., the sample size should be at least five times the number of variables observed or, ideally, ten times [52].

Based on these recommendations, the study followed the proposal of Hair et al., which suggests a sample size of at least five times the number of variables observed [52]. There are 38 variables in this study, so a minimum of 38x5=190 observations were required. According to Hoelter, a minimum sample size of 200 observations was needed. Larger sample sizes lead to higher accuracy [53]. The sample size depends on the analysis method. However, to ensure objectivity and enhance the value of the study, the initial estimated sample size was set at 275, which closely aligned with Hoelter's calculation [53].

The research subjects in this study were construction workers at construction sites in Ho Chi Minh City, regardless of gender. After collecting and cleaning the data, it was analyzed using the SmartPLS 3.2.8 software to evaluate the validity and reliability of the measurement scales and explore the relationships between the concepts in the research model.

3-3- Measurement

This research employed a mixed method approach and using systematic review to identify factors and scales that measure important constructs in the model. The qualitative research method was used to select stress factors contributing to burnout and consequently influencing workplace accidents among construction workers at construction sites in Ho Chi Minh City. This was done to propose hypotheses and construct a model based on the selected factors, as advised by experts. The author interviewed ten experts with over five years of experience in the construction field who were currently working at a civil construction company in Ho Chi Minh City [54-64].

Subsequently, a preliminary measurement scale was developed. The author conducted a second round of interviews with the experts and held group discussions with ten specialists from the Ho Chi Minh City construction company. This was aimed at exploring and adjusting the factors in the research model, refining and supplementing observed variables used to measure concepts, and developing measurement scales. Additionally, the author reviewed and evaluated the use of language in each observed variable to ensure that the questions were accurate and precise, making it easy for respondents to answer.

The measurement scale for job-related stress was a latent variable in the model, measured by four level-1 latent variables: organizational stress (represented as "TC"), job nature stress (described as "CV"), co-worker relationship stress (defined as "DN"), and work environment stress (represented as "MT"). 16 observed variables measured these four level-1 variables (Table 2).

Table 2. Job-related Stress Factors

	Code	Reference(s)
Organizational Stressors	***TC***	
My job is unstable.	TC1	Enshassi et al. [62]; Görgens-Ekermans & Brand [63]; Leung et al. [17, 32, 35, 45]
The company doesn't provide adequate safety training.	TC2	
My income at the company is low.	TC3	
The company doesn't regularly inspect or supervise workers for occupational safety.	TC4	
The rewards I receive at the company do not correspond to the value of my work.	TC5	
The company lacks a safety-oriented culture.	TC6	
Managers lack knowledge of occupational safety.	TC7	

Job Nature	***CV***	
I have to work overtime frequently.	CV1	Enshassi et al. [62]; Leung et al. [17, 32, 35, 45]
The job is overloaded.	CV2	
The job requires high precision.	CV3	
The working hours are strict.	CV4	
Co-Worker Relationship	***DN***	
Lack of support from superiors and colleagues	DN1	Enshassi et al. [62]; Leung et al. [17, 32, 35, 45]
Work environment	***MT***	
Dangerous work site	MT1	Enshassi et al. [62].
Excessive heat	MT2	
Loud noise	MT3	
Poorly lit workplace	MT4	

The Maslach Burnout Inventory (MBI) scale, developed by Maslach et al., was utilized in the study [20]. The measurement investigated the burnout aspect, utilizing three components of the MBI scale and building upon previous research. Burnout was a latent variable in the model. It was measured by four level-1 latent variables: psychological stress (represented as "TK"), psychophysiological stress (defined as "TL"), negative behavior changes (described as "HV"), and physical exhaustion and depletion (represented as "CT"). 18 observed variables measured these four level-1 variables (Table 3).

Table 3. Burnout Factors

	Code	**Reference(s)**
Physical stress	***TK***	
I experience stomach pain when thinking about work.	TK1	Maslach & Jackson [65].
Working with colleagues makes me feel sick or stressed.	TK2	
Mental Stress	***TL***	
I'm bored with my current job.	TL1	Maslach & Jackson [65].
I feel unsafe at work.	TL2	
I give derogatory nicknames to colleagues I don't like.	TL3	
I'm afraid to go to work.	TL4	
My current job doesn't stimulate me to work.	TL5	
Depersonalization	***HV***	
I feel disheartened about my job position.	HV1	Maslach & Jackson [65].
At work, I feel like people avoid me.	HV2	
I'm disappointed in my job.	HV3	
I distance myself and limit communication with others.	HV4	
I avoid meeting my colleagues.	HV5	
I want to isolate myself at work.	HV6	
I often have conflicts with my colleagues.	HV7	
Emotional Exhaustion	***CT***	
I'm indifferent to my job.	CT1	Maslach & Jackson [65].
I feel stressed at work.	CT2	
I can't concentrate on my work.	CT3	

According to Bakker & Costa, they studied that employees with high levels of burnout exhibit self-destructive behaviors, evident in their increased errors at work and frequent conflicts in the workplace or accidents during their commute home [56]. Therefore, the work/occupational accidents scale (represented as "TN") was measured through 5 observed variables (Table 4).

Table 4. Occupational Accident Factors

	Code	Reference(s)
Occupational Accidents	***TN***	
I often cause accidents when working under stress and fatigue.	TN1	Leung et al. [17, 32, 35, 45] and Enshassi et al. [62].
When tired, I often forget to follow safety measures at work.	TN2	
I often feel tired and dizzy when working under stress.	TN3	
I have many scars and injuries from workplace accidents.	TN4	
I often stumble and injure myself when working under stress.	TN5	

4- Results

Internal consistency reliability is necessary when assessing the reliability of different observed variables measuring the same construct [57]. Traditionally, internal consistency reliability can be evaluated through Cronbach's Alpha. However, Cronbach's Alpha is relatively sensitive to the number of observed variables, so it doesn't accurately reflect the internal consistency reliability [52]. Therefore, considering this limitation, the study will also focus on a more appropriate alternative measurement, the Composite Reliability (CR) and rho_a, as Dijkstra & Henseler asserted as an essential measurement coefficient in PLS-SEM [58].

In this study, the Cronbach's Alpha for all variables is 0.938, which is above the commonly accepted threshold of 0.7, indicating good reliability. However, to account for the limitation of Cronbach's Alpha, Composite Reliability (CR) and rho_a are considered more robust measures in this context. The CR values are 0.952, which is well above the threshold of 0.8, confirming excellent internal consistency across all variables. rho_a coefficients are also provided, with all variables meeting the minimum acceptable threshold of 0.7, except for DN (Co-worker Relationship), which is perfectly reliable with a rho_a of 1 because it only has one observed variable. This suggests that all constructs, except the single-item variable, demonstrate good reliability (Table 5).

Table 5. Construct correlations, reliability, and validity

	Cronbach's Alpha	rho_a	Composite Reliability	AVE
CT	0.900	0.901	0.938	0.834
CV	0.853	0.858	0.901	0.695
DN	1.000	1.000	1.000	1.000
HV	0.935	0.935	0.948	0.754
MT	0.872	0.873	0.912	0.722
TC	0.902	0.903	0.925	0.673
TK	0.820	0.820	0.917	0.847
TL	0.932	0.933	0.949	0.787
TN	0.938	0.938	0.952	0.800

Abbreviations: CT, Emotional Exhaustion; CV, Job Nature; DN, Co-Worker Relationship; HV, Depersonalization; MT, Work Environment; TC, Organizational stressors; TK, Physical Stress; TL, metal Stress; TN, Occupational Accidents.

Average Variance Extracted (AVE) is a measure of the convergence validity of the scales. An AVE value above 0.5 indicates that the construct explains more than half of the variance in its items. The AVE of the scale of physical exhaustion and depletion has the highest value (AVE = 0.834), indicating the convergence value is ensured [59]. It is above the 0.5 threshold, indicating excellent convergent validity for this scale. This confirms that the observed variables accurately measure the underlying construct of burnout, particularly in terms of emotional exhaustion.

Discriminant validity measures whether constructs that are supposed to be unrelated are truly distinct from each other. Here, the results indicate that the discriminant validity among latent variables is below 0.85, meaning that the correlations between constructs are not too high, which ensures that each construct is measuring something unique. This supports the idea that the scales are properly distinguishing between different dimensions of stress, burnout, and occupational accidents (Table 6).

Table 6. Heterotrain-monotrait (HTMT) ratios

	CT	CV	DN	HV	MT	TC	TK	TL	TN
CT									
CV	0.492								
DN	0.514	0.481							
HV	0.705	0.609	0.588						
MT	0.568	0.525	0.653	0.582					
TC	0.552	0.588	0.509	0.551	0.551				
TK	0.696	0.597	0.629	0.707	0.661	0.526			
TL	0.702	0.557	0.636	0.762	0.652	0.57	0.781		
TN	0.703	0.673	0.645	0.738	0.670	0.601	0.763	0.772	

Abbreviations: CT, Emotional Exhaustion; CV, Job Nature; DN, Co-Worker Relationship; HV, Depersonalization; MT, Work Environment; TC, Organizational stressors; TK, Physical Stress; TL, metal Stress; TN, Occupational Accidents.

The above results show that all the interaction effects have P-values < 0.001; these interaction effects are statistically significant. Two variables influence occupational accidents: job stress, with a standardized coefficient of 0.352, and burnout, with a standardized coefficient of 0.522. Thus, these coefficients suggest that burnout has a stronger influence on occupational accidents than job stress, highlighting the critical role of employee well-being in preventing accidents in the workplace (see Table 7 and Figure 1).

Table 7. Path coefficients

	β	SD	T	p	f^2	Q^2
CTCV → KS	0.777	0.032	24.601	< 0.001	1.520	
CTCV → TN	0.352	0.051	6.859	< 0.001	0.155	
KS → TN	0.522	0.047	11.039	< 0.001	0.341	

Note: SD, Standard Deviation; T, T value; p, p value. **Abbreviations:** CTCV, Job-related stress; KS, Burnout; TN, Occupational Accidents.

According to Cohen, f^2 values are 0.02 (indicating a small effect), 0.15 (indicating a medium effect), and 0.35 (indicating a large effect) [57]. The analysis results show that the predictive capability of job stress on occupational accidents is at a medium level. Still, the predictive capabilities of both job stress and burnout on occupational accidents are substantial, with burnout having the stronger effect. This aligns with the significant impact that burnout has on safety outcomes, reinforcing the need for employers to implement effective burnout management programs. These could include mental health resources, workload adjustments, and recovery time to reduce burnout levels, which in turn could lower the risk of accidents in the workplace.

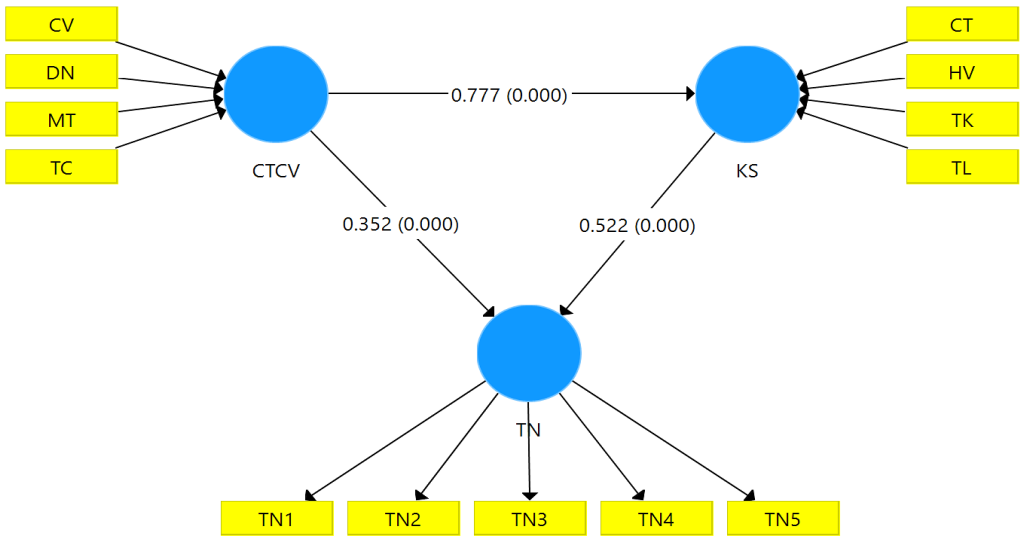

Figure 1. Partial least squares structural equation modeling results. (Abbreviations: CT, Emotional Exhaustion; CV, Job Nature; DN, Co-Worker Relationship; HV, Depersonalization; MT, Work Environment; TC, Organizational stressors; TK, Physical Stress; TL, metal Stress; TN, Occupational Accidents).

In summary, the results demonstrate strong internal consistency and validity for the measures used in the study, with ***burnout*** having a particularly strong predictive effect on ***occupational accidents***. The findings suggest that, while ***job stress*** is an important factor, addressing ***burnout*** should be a top priority for organizations aiming to improve workplace safety. The combination of robust statistical measures, including ***reliability coefficients*** (rho_a and CR), ***AVE***, and ***f^2 effect sizes***, confirms the relevance and importance of these constructs in understanding occupational safety outcomes.

5- Discussion and Conclusion

The research, utilizing Structural Equation Modeling (SEM), reveals key findings regarding the relationships between job-related stress, burnout, and occupational accidents. The measurement scales used in the study, which were derived from previous research, demonstrated strong reliability, convergent validity, and discriminant validity, with no signs of multicollinearity. Furthermore, the study found significant correlations between stressors and burnout, suggesting that factors such as job characteristics, co-worker stress, environmental stress, and organizational stress impact work-related stress, which in turn leads to burnout and occupational accidents.

The study also tested hypothesis using the Partial Least Squares Structural Equation Modeling (PLS-SEM) for the theoretical model. The results of the structural model testing indicated that job characteristic stress (H2: 0.342), co-worker stress (H3: 0.392), and environmental stress (H4: 0.307) have significant correlations with work-related stress leading to burnout and occupational accidents. The organizational stress factor (H1: 0.219) exhibited the lowest correlation among the stressors. Physiological stress factors (H6: 0.373) and behavioral changes (H7: 0.308) were significantly correlated with burnout leading to occupational accidents. The psychological stress factor (H5: 0.297) and physical exhaustion and burnout (H8: 0.176) followed these. It was discovered that there are interdependent relationships between job-related stress and burnout (H9: 0.777) and their correlation with occupational accidents (H10: 0.532). Burnout was also significantly correlated with occupational accidents (H11: 0.522).

The factors causing job-related stress include four elements: organizational factors, job nature, work environment, and co-worker relationships among individuals, which impact the burnout status of the workers. Regarding the level of contribution to job-related stress, co-worker relationships among individuals, job characteristics, and work environment stress have a significant impact on causing work-related stress that affects the workers' psychological, behavioral, and nervous aspects, leading to burnout and occupational accidents. The organizational factor has the most negligible impact on the burnout status of the workers. These results align with Herzberg's Two-Factor Theory, where job dissatisfaction is a cause of job stress, which in turn leads to burnout and occupational accidents. The empirical research draws a parallel conclusion in line with Wu et al. [66].

Regarding stress due to a lack of support from superiors and colleagues, we can observe that skilled workers who possess extensive job knowledge but do not share or support their fellow workers and engage in unhealthy competition are the most significant factors leading to stress and burnout. This harms the workers' health, resulting in occupational accidents ($\beta = 0.392$, $p < 0.001$). This directly affects the lives of the workers. Vietnamese culture, in particular, and Asian culture, in general, highly value emotional connections and relationships among colleagues. Therefore, support from superiors and colleagues in the workplace significantly influences the workers' mental well-being and life, reducing stress and burnout, thus limiting occupational accidents. Furthermore, this can foster stronger bonds between workers and between workers and management, creating a friendly work environment. This hypothesis is supported and aligns with the research conducted by Leung et al. [17].

In the construction industry, which is highly technical and characterized by immense pressure in terms of technical aspects, workload, and deadlines, work-related stress weighs heavily on the shoulders of construction workers. This indicates that construction workers face high levels of job pressure, and prolonged job-related stress can result in weakened health and reduced work capacity. Labor costs account for approximately 20% of construction costs but play a pivotal role in determining the ability and quality of construction execution for construction businesses. Consequently, these businesses select and value experienced workers who can handle high-pressure situations and adapt to various circumstances to minimize burnout-related issues leading to occupational accidents, increasing management costs for the business. Therefore, job-related stress due to the nature of the work is ranked second among the factors contributing to work-related stress. Frequent overtime and excessive workloads are the most stress-inducing factors that affect burnout and occupational accidents, with the external load factor ranging from 0.798 to 0.900. Hence, the hypothesis that the nature of the work correlates positively with work-related stress leading to occupational accidents ($\beta = 0.342$, $p < 0.001$) is supported. This aligns with previous research by Cooper & Williams [33]. Managers need proper planning, task allocation, and time management to reduce overtime, improving work-related stress and reducing burnout and occupational accidents.

Furthermore, the hazardous working environment is ranked third among the factors causing work-related stress. When construction workers operate in a dangerous environment, facing physical demands and frequent exposure to chemicals, they must endure pressure and often struggle to concentrate. Working in adverse and harsh conditions for an extended period increases burnout and occupational accidents. This issue is currently a significant concern for businesses operating

in the construction industry. When the working hours exceed the time for rest, it increases psychological stress. Workers will experience conflicts with colleagues and family members, leading to an imbalance in their psychological well-being. This, in turn, elevates the likelihood of accidents, with the external load factor for corresponding observed variables ranging from 0.833 to 0.888. The structural equation modeling (SEM) results demonstrate that an unsafe working environment increases work-related stress, leading to burnout and occupational accidents ($\beta = 0.307$, $p < 0.001$) [55]. This finding is consistent with Leung et al.; Wu et al. research [45, 61].

The survey results indicate that factors related to organizational stress have a minimal impact on workers' burnout and occupational accidents. These factors include unstable jobs, inadequate safety training, low income, compliance with safety regulations, and inappropriate safety equipment. Among these factors, job instability and insufficient safety training have the most significant influence within the job-related stress factor group, with external load factor correlations ranging from low to high, specifically between 0.774 and 0.847. This finding aligns with the research conducted by Leung et al. [32]. In the groups of factors causing work-related stress due to organizational issues, when testing the structural equation model (SEM), the author removed variable TC3 (due to having an external load factor lower than 0.7). The survey found that removing this variable was appropriate because salaries are typically negotiated between workers and employers, and organizations usually have mechanisms to ensure fair and reasonable compensation. Nowadays, the construction industry is of great interest to the government and various authorities for research, development, and the improvement of institutional frameworks. They aim to enhance the enforcement of laws and regulations, promote investment management in construction, and modernize the industry, making it fast, sustainable, and aligned with economic and social development strategies and plans. Additionally, businesses are increasingly focusing on labor safety training, corporate culture, and fair compensation to ensure workers feel justly treated and secure in their workplaces.

With the hypothesis that factors such as physiological stress, behavioral disturbances, nervous stress, physical exhaustion, and burnout lead to burnout and work-related stress and have a direct positive impact, the results align with the theory of resource conservation when work-related stress negatively affects the physiological, nervous, behavioral, and physical aspects of workers.

The research results demonstrate that work-related stress significantly increases the disturbance in physiological well-being and emotions of workers, leading to burnout and occupational accidents. Feelings of exhaustion, anxiety, insecurity at work, frequent absenteeism, and lack of concentration are the most common expressions of worker burnout when they experience work-related stress. This is evident in the range of impact, with external load factor correlations ranging from 0.879 to 0.902. According to the SEM results, work-related stress has a positive and linear relationship with specific worker burnout, as evidenced by the disturbance in workers' physiological well-being ($\beta = 0.373$, $p < 0.001$). The hypothesis that workers experiencing prolonged stress will experience increased burnout is supported and aligned with the views of authors such as Goliszek [43] and Enshassi et al. [62]. Therefore, limiting physiological stress in workers will lead to improved focus, adherence to occupational safety requirements, and a reduction in burnout, ultimately reducing occupational accidents. Hence, investments in infrastructure and equipment for cultural and sports activities for workers, staff, and employees, as well as the organization of sports, artistic, and exchange activities within the unit to promote the health and well-being of workers, are recommended beyond regular working hours.

Furthermore, work-related stress not only reduces the concentration of workers but also increases changes in their behavior. It ranks second in the group of manifestations of worker burnout. Workers often exhibit conflicts, isolate themselves, and limit their workplace interactions. These are the most evident signs of burnout when workers experience work-related stress, with relatively close correlations ranging from low to high, between 0.858 to 0.880 (excluding variable HV2 due to its external load factor being less than 0.7). The results of the structural equation model (SEM) analysis show that work-related stress leads to behavioral disturbances in workers in the same direction as burnout ($\beta = 0.308$, $p < 0.001$). This hypothesis aligns with the author Leung et al. views [32].

On the other hand, work-related stress also leads to psychological stress often characterized by symptoms such as insomnia, headaches, and stomachaches, with the degree of impact ranging from low to high, as indicated by the external load coefficients of 0.920 and 0.921, respectively. If these health issues persist over an extended period due to worker burnout, it can potentially lead to occupational accidents. Based on the linear SEM analysis results, it is evident that the greater the work-related stress, the more severe the psychological stress, and they are positively correlated with burnout ($\beta = 0.297$, $p < 0.001$). This perspective aligns with the views of the author Enshassi et al. when concluding that worker burnout due to psychological stress can lead to occupational accidents [62].

Moreover, according to the results of the structural equation model (SEM) analysis, work-related stress leads to physical burnout. The external load coefficients, which are 0.921, 0.912, and 0.906, respectively, indicate a strong relationship and the degree of influence between the observed variables and the latent variable of physical stress. When the body becomes burned out and exhausted, it results in worker burnout. Physical burnout and exhaustion lead to decreased concentration and lack of motivation and can contribute to occupational accidents ($\beta=0.176$, $p < 0.01$). This perspective aligns with the author Leung et al. views [32].

The results of the structural equation model (SEM) analysis show that work-related stress, burnout, and occupational accidents all have statistical significance. The impact coefficient of work-related stress on burnout is the highest ($\beta = 0.777$, $p < 0.001$). Next is the impact of burnout on occupational accidents ($\beta = 0.522$, $p < 0.001$), and the lowest impact is that of work-related stress on occupational accidents ($\beta = 0.352$, $p < 0.001$). These results align with previous research. Specifically, work-related stress and burnout positively impact construction worker occupational accidents. This hypothesis is consistent with Enshassi et al. [62], where work-related stress affects worker burnout, which subsequently negatively impacts occupational accidents, as suggested by Leung et al. [62]. Therefore, when identifying the causes of occupational accidents due to burnout, it is essential to consider the influence of work-related stress.

Workers who experience burnout are not only affected by factors like mental health issues, neurological problems, changes in behavior, physical exhaustion, and burnout but also directly impacted by work-related stress. Consequently, when addressing occupational accidents caused by burnout, attention should be paid to the influence of work-related stress. When decision-makers in construction project management organizations know the causes of accidents on their projects, they will be able to devise effective strategies to address the causes and, therefore, the number of accidents. Accidents can be reduced. The results obtained from the causes of accidents in a construction organization can also be shared with all stakeholders, including workers, customers, and consultants so that they can better understand the causes. Cause those accidents in your project. This will raise awareness among stakeholders and may lead to more mature action. For example, when workers know how they could cause an accident, their actions in the workplace will be safer. This will help workers learn how they can avoid those causes. Similarly, environmental conditions also contribute to a significant number of accidents. In most cases, work on-site continues even when environmental conditions are unsuitable. The main reason is that contractors often want to complete their work faster, and this is because contractors are sometimes under pressure from customers or consultants. When all stakeholders, such as contractors, customers, consultants, and workers, consider the environment as a possible cause of accidents, work will not be forced to be performed in poor environmental conditions. Likewise, clients and consultants will consider such reasons legitimate if any delay is caused to the work.

6- Limitations

During the research project, alongside the achievements, there were also some limitations: Firstly, the research was conducted over a short period, and the scope of the surveyed subjects consisted of construction workers at construction sites in Ho Chi Minh City. Therefore, the study could only provide a few conclusions and modest contributions to construction businesses operating in Ho Chi Minh City. Secondly, convenience sampling was used at Ho Chi Minh City construction sites for its practicality, time efficiency, and cost-effectiveness. However, this method may only partially represent the characteristics of some of the population. The model highlights the relationship between work-related stress, burnout, and occupational accidents. Work-related stress and burnout explain 68% of the variation in occupational accidents. Therefore, there are likely other factors influencing occupational accidents that this research did not address. These limitations are essential to consider when interpreting the study results and may suggest avenues for future research to explore the broader context and factors affecting occupational accidents in the construction industry.

7- Declarations

7-1- Author Contributions

Conceptualization, H.V.T. and A.V.T.; methodology, A.V.T. and H.V.T.; software, A.V.T. and T.T.L.; resources, A.V.T., T.T.L., and T.N.C.N.; writing—original draft preparation, A.V.T., T.T.L., T.N.C.N., and H.V.T.; writing—review and editing, H.V.T. and A.V.T.; supervision, H.V.T.; project administration, T.T.L. All authors have read and agreed to the published version of the manuscript.

7-2- Data Availability Statement

The data presented in this study are available on request from the corresponding author.

7-3- Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

7-4- Institutional Review Board Statement

The Ethical Committee of Hung Vuong University, Ho Chi Minh City, Vietnam has approved this study on 14 February 2023 (Ref. No. 24/2023/QĐ-HĐT).

7-5- Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

7-6- Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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Appendix I: Questionnaire

Part I: General information

1. The name of your corporation/company/organization

……..

2. How long have you been in your current job?

☐ Less than 1 year ☐ 1-3 years

☐ 3-5 years ☐ More than 5 years

3. Position.

☐ worker ☐ Supervisor

☐ Line manager ☐ Middle manager

☐ Top manager

4. How long have you been in your position? (month):……

Part II: Stress and Burnout at work

Mark your answer for each statement as the following Likert scale

Code	Item	Level of agreement				
		Disagree			Agree	
TC	***Organizational Stressors***					
TC1	My job is unstable.	1	2	3	4	5
TC2	The company doesn't provide adequate safety training.	1	2	3	4	5
TC3	My income at the company is low.	1	2	3	4	5
TC4	The company doesn't regularly inspect or supervise workers for occupational safety.	1	2	3	4	5
TC5	The rewards I receive at the company do not correspond to the value of my work.	1	2	3	4	5
TC6	The company lacks a safety-oriented culture.	1	2	3	4	5
TC7	Managers lack knowledge of occupational safety.	1	2	3	4	5
CV	**Job Nature**					
CV1	I have to work overtime frequently.	1	2	3	4	5
CV2	The job is overloaded.	1	2	3	4	5
CV3	The job requires high precision.	1	2	3	4	5
CV4	The working hours are strict.	1	2	3	4	5
DN	**Co-Worker Relationship**					
DN1	Lack of support from superiors and colleagues	1	2	3	4	5
MT	**Work environment**					
MT1	Dangerous work site	1	2	3	4	5
MT2	Excessive heat	1	2	3	4	5
MT3	Loud noise	1	2	3	4	5
MT4	Poorly lit workplace	1	2	3	4	5

Part III: Occupational Accident

Code	Items	Level of agreement				
		Disagree			Agree	
	Occupational Accidents					
TN1	I often cause accidents when working under stress and fatigue.	1	2	3	4	5
TN2	When tired, I often forget to follow safety measures at work.	1	2	3	4	5
TN3	I often feel tired and dizzy when working under stress.	1	2	3	4	5
TN4	I have many scars and injuries from workplace accidents.	1	2	3	4	5
TN5	I often stumble and injure myself when working under stress.	1	2	3	4	5

Part IV: Burnout

Code	Items	Level of agreement				
		Disagree			Agree	
TK	**Physical stress**					
TK1	I experience stomach pain when thinking about work.	1	2	3	4	5
TK2	Working with colleagues makes me feel sick or stressed.	1	2	3	4	5
TL	**Mental Stress**					
TL1	I'm bored with my current job.	1	2	3	4	5
TL2	I feel unsafe at work.	1	2	3	4	5
TL3	I give derogatory nicknames to colleagues I don't like.	1	2	3	4	5
TL4	I'm afraid to go to work.	1	2	3	4	5
TL5	My current job doesn't stimulate me to work.	1	2	3	4	5
HV	**Depersonalization**					
HV1	I feel disheartened about my job position.	1	2	3	4	5
HV2	At work, I feel like people avoid me.	1	2	3	4	5
HV3	I'm disappointed in my job.	1	2	3	4	5
HV4	I distance myself and limit communication with others.	1	2	3	4	5
HV5	I avoid meeting my colleagues.	1	2	3	4	5
HV6	I want to isolate myself at work.	1	2	3	4	5
HV7	I often have conflicts with my colleagues.	1	2	3	4	5
CT	**Emotional Exhaustion**					
CT1	I'm indifferent to my job.	1	2	3	4	5
CT2	I feel stressed at work.	1	2	3	4	5
CT3	I can't concentrate on my work.	1	2	3	4	5

Part VI: Respondent's information

1. Gender

☐ Male ☐ Female

2. Age

☐ 18-25 ☐ 26-30

☐ 31-39 ☐ 40-49

☐ 50-60

3. Education

☐ Highschool ☐ Vocational

☐ College ☐ Bachelor

☐ Master ☐ Doctorate

4. Salary (million VND)

☐ Below 10 ☐ 10-15

☐ 20-30 ☐ above 30

5. Residency

☐ HCM city ☐ Other province

6. You are living in

☐ Own house ☐ My family

☐ Rental house (alone) ☐ Rental house (group of friends)

7. Email:……..

8. Mobile No.:…….