FORMULATION OF MACRO-MICRO SAFETY PREDICTORS IN HIGH-RISE CONSTRUCTION SITES BASED ON DEMATEL ALGORITHM

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ABSTRAK

Industri pembinaan memainkan peranan penting dalam memacu pertumbuhan ekonomi negara dan pembangunan modal insan. Namun, kadar kematian di tempat kerja yang tinggi telah menimbulkan kebimbangan serius mengenai keselamatan, dengan kemalangan di tapak pembinaan sering dikaitkan dengan keadaan kerja yang tidak selamat dan tingkah laku pekerja. Menangani pematuhan keselamatan dan penyertaan keselamatan adalah penting untuk meningkatkan prestasi keselamatan. Walaupun penyelidikan terdahulu menumpukan pada penyelesaian teknologi, terdapat sedikit penekanan pada intervensi tingkah laku. Teori Tingkah Laku Terancang (TPB) menyediakan rangka kerja untuk memahami pematuhan keselamatan dan penyertaan, kerana ia berpendapat bahawa tingkah laku dipengaruhi oleh niat, yang pada gilirannya dibentuk oleh sikap, norma subjektif, dan kawalan tingkah laku yang dirasai. Walaupun terdapat rangka kerja ini, belum ada kajian yang meneliti hubungan antara ramalan keselamatan, niat pematuhan keselamatan, dan penyertaan keselamatan, terutamanya dalam konteks tapak pembinaan. Kajian ini bertujuan untuk memodelkan pengaruh ramalan keselamatan makro dan mikro terhadap niat pematuhan keselamatan dan penyertaan keselamatan dalam projek pembinaan dengan menggunakan teknik Makmal Ujian dan Penilaian Pembuatan Keputusan (DEMATEL). Sebanyak 25 pakar telah dijemput untuk memberikan penarafan berpasangan bagi ramalan keselamatan. Bagi memastikan kebolehpercayaan dan konsistensi data, 7 responden dikecualikan daripada analisis akhir, menjadikan maklum balas daripada 18 responden sahaja yang digunakan. Kajian ini menilai ramalan keselamatan mikro (contohnya, Sikap, Norma Subjektif, Kawalan Tingkah Laku yang Dirasai, Gaya Kepimpinan, Pengetahuan Keselamatan, Iklim Keselamatan, Motivasi Keselamatan, Persepsi Risiko, dan Komunikasi) dan ramalan keselamatan makro berdasarkan Teori Institusi (contohnya, Tekanan Paksaan, Tekanan Meniru, dan Tekanan Normatif). Hasil kajian menunjukkan hubungan yang signifikan antara semua ramalan keselamatan, dengan "Sikap" dikenal pasti sebagai ramalan keselamatan mikro yang paling berpengaruh dan "Tekanan Paksaan" muncul sebagai ramalan keselamatan makro yang paling penting. Kajian ini menyediakan pandangan yang bernilai mengenai hubungan antara ramalan keselamatan makro dan mikro, niat pematuhan keselamatan, dan penyertaan keselamatan, menekankan keperluan bagi organisasi untuk memberi tumpuan kepada "Sikap" dan "Tekanan Paksaan" bagi meningkatkan prestasi keselamatan di tapak pembinaan. Memahami interaksi ini adalah penting untuk membangunkan intervensi yang berkesan bagi memperbaiki hasil keselamatan dalam industri pembinaan.

ABSTRACT

The construction industry plays a pivotal role in driving national economic growth and human capital development. However, high workplace mortality rates have raised significant safety concerns, with construction accidents often linked to unsafe working conditions and worker behavior. Addressing safety compliance and safety participation is essential for improving safety performance. While previous research has focused on technological solutions, there has been little emphasis on behavioral interventions. The Theory of Planned Behaviour (TPB) provides a framework for understanding safety compliance and participation, as it posits that behavior is influenced by intention, which in turn is shaped by attitude, subjective norms, and perceived behavioral control. Despite this framework, no study has yet examined the interrelationships between safety predictors, safety compliance intention, and safety participation, particularly in the context of construction sites. This study aims to model the influence of macro and micro safety predictors on safety compliance intention and safety participation in construction projects using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique. A total of 25 experts were invited to provide pairwise rankings of safety predictors. To ensure data reliability and consistency, 7 respondents were excluded from the final analysis, leaving feedback from 18 respondents. The study evaluated micro safety predictors (e.g., Attitude, Subjective Norm, Perceived Behavioral Control, Leadership Styles, Safety Knowledge, Safety Climate, Safety Motivation, Risk Perception, and Communication) and macro safety predictors based on Institutional Theory (e.g., Coercive, Mimetic, and Normative Pressures). The findings indicate significant relationships between all safety predictors, with "Attitude" identified as the most impactful micro safety predictor and "Coercive Pressures" emerging as the most significant macro safety predictor. The study provides valuable insights into the interrelationships between macro and micro safety predictors, safety compliance intention, and safety participation, emphasizing the need for organizations to focus on "Attitude" and "Coercive Pressures" to enhance safety performance on construction sites. Understanding these interactions is critical for developing effective interventions to improve safety outcomes in the construction industry.

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LIST OF ABBREVIATIONS

DEMATEL	Decision Making Trial & Evaluation Laboratory
TPB	Theory of Planned Behaviour
OSHA	Occupational Safety and Health Administration
PWD	Public Works Department
CIDB	Construction Industry Development Board
DOSH	Department of Occupational Safety and Health Malaysia
SOSCO	Social Security Organization
FAR	Fatal Accident Rate
IRM	Influential Relation Map

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter presents the Definition of Key Terms, Background of Study, Problem Statement, Research Questions, Research Objectives, Scope of Study and Significance of Study. This research concentrating on the construction sector in Selangor, Malaysia and focus on high-rise building construction project. The study aims to explore critical micro-macro safety predictors influencing safety compliance intention and participation. There are a total of four Research Questions and Research Objectives in this study, designed to provide a comprehensive understanding of safety performance in high-rise construction.

1.2 Background of Study

The construction sector is making enormous advancement and profitability. It is one of the most significant industries contributing to the economy of a nation. This sector boosts economic growth in developing nations like China, India, Indonesia and Malaysia by creating employment possibilities. However, construction is an adventurous activity in which different stakeholders participate in countless challenges under the same environment (Ayob et al., 2018). With the huge economic contribution of the construction sector, the construction industry safety has become the main disquiet of many nations (Bavafa et al., 2018).

In Malaysia, construction projects are divided into two categories: public sector and private sector. The Public Works Department (PWD) is in charge of public sector projects, while the Construction Industry Development Board (CIDB) is in charge of both public and private construction projects (Manzoor et al., 2021). Due to the pandemic, Malaysia construction work was estimated to amount to roughly RM111.98 billion in 2021, a significant decline from previous years (Intelligence, 2022). In 2021, the public sector's residential building construction in Malaysia was valued at approximately RM1.02 billion (DOSM, 2022). However, until 2019, Malaysia's public residential building construction market was valued at RM1.9 billion, rise from RM1.46 billion. The private residential building construction value in

Malaysia was approximated to be around RM25.22 billion in the same year, down from RM27.26 billion in 2020 (Intelligence, 2022).

According to the National Fire Incident Reporting System (NFIRS), high-rise buildings are classified into four categories based on their height: 7–12 stories, 13–24 stories, 25–49 stories, and 50 stories and above. This classification helps standardize the reporting and analysis of incidents related to fire safety and other emergencies in buildings of varying heights (Hall, 2013). There have been numerous accidents and fatalities in the construction of high-rise buildings, making it one of the most hazardous sectors in the construction industry (Manzoor et al., 2022).

The construction industry in Malaysia is critical to the nation's economic growth. On the contrary, the alarmingly high number of deaths and accidents in construction project sites is cause for concern. Although the construction sector is a very proactive and booming business that is contributing to the country's development, high accident and mortality rates not only stifle the industry's growth and development but also have a negative impact on it (Manzoor et al., 2021). Furthermore, construction of high-rise building projects is a risky activity due to the distinctiveness and condition of the activities, along with the variability of the working environment; however, safety issues maintain critical in the construction sector. (Bavafa et al., 2018).

Despite significant advances in construction technology and management practices, work - related injuries statistics show that construction workers remain at a greater risk than workers in other occupations (Choi & Lee, 2022). It has been demonstrated that the number of accident cases is steadily increasing year after year; consequently, in order to prevent accidents, a proper approach to safety regulation should be followed (Hamid et al., 2019).

During the high-rise construction process, the project faces tremendous challenges, for instance environmental, management and technical complexity. Due to the installation of critical equipment necessitates the collaboration of multiple teams to achieve diverse objectives (including such project schedule, quality and cost) enhancement, it is usually based on a teamwork operational process. According to statistics, 70% of construction site safety accidents are directly linked to the construction workers team (Haslam et al., 2005). Therefore, the control and management of unsafe behaviour in the construction team are critical to creating safety management and safe production. Consequently, it has sparked widespread interest in industry and academia.

Construction projects are vigorous, changing frequently and consist of intrinsic risks (Newaz et al., 2016). Workplace safety has long been a major issue for both researchers and practitioners (Álvarez-Santos et al. 2018). With poor workplace safety behaviour, the consequences can be catastrophic. Due to poor safety compliance and participation on construction sites, variety of stakeholders have to struggle significant losses from the presence of mishaps. Workplace deaths and injuries result in significant losses for both individuals and communities (Xu et al., 2021). Thus, workers safety is a pressing issue that must be addressed to avoid negatively impacting organizational costs and subsequent loss of productivity (Singh & Misra, 2020).

In order to avoid errors and accidents, traditional workplace safety interventions have concentrated on managing the physical environment of work and job procedures. (Fogarty & Shaw, 2010). A modern approach to workplace accidents places equal focus on human factors, taking into consideration psychological influences, cultural variations, and other factors that influence safety behaviour (Fogarty, 2004). This paper investigates the human variables that influence construction employees' safety behaviour (this includes both safety compliance and safety participation). In this study, we look at the predictors of intention-driven behaviour as proposed in Theory of Planned Behaviour by Ajzen (1991) and other possible predictors of workers' safety behaviours.

High-rise construction accidents typically occur when unsafe working conditions combine with unsafe worker behaviour (Lee et al., 2021). According to Goh et al. (2018), managing safety behaviour is a significant aspect of construction safety management because most accidents are caused by behavioural issues. Managers must design interventions to create safe behaviour a norm in the workplace to reduce the likelihood of accidents.

In accordance with work performance theory there are 2 key elements of safety behaviour which are safety participation and safety compliance. Safety compliance be in line with work performance and refers to "main tasks that personal should perform to be able to produce a safety environment" (Griffin & Neal, 2000). These actions involve events like wearing PPE and observing safety regulations. Safety participation be in line with environmental manifestation and refers to "behaviour that indirectly contribute to individual secure but does assist in the establishment of a safety workplace" (Griffin & Neal, 2000). For instance, taking part in voluntary programs to enhance safety of workplace, demonstrating initiative, and helping colleagues to solve safety problems.

The only way to prevent a fatal event is to implement a highly effective safety behavioural intervention. Singh and Misra (2020) agreed that enhanced safety behaviour is necessary in order to address safety issues. Improvements to safety management can be done through proper safety adherence (Renecle et al., 2021). Company could use it for continuous monitoring and review of their safety performance. The only answer to have an effective safety management system, as far as concerning to the safety practitioners, is by measuring safety performance. The only way to truly convince people that safety management exists is to evaluate and measure it. Through behavioural interventions, innovative approaches to managing safety would effectively and proactively avoid accidents on high-rise construction sites (Xia et al., 2018).

1.3 Problem Statement

Construction field is still one of the riskiest industries (Khahro et al., 2020; Lee et al., 2019) which accounts for 30% to 40% of all work-related injuries and deaths even though it only employs about 7% of the entire labour force. Annually, approximately 1% of construction workers suffer a fatal injury, marking the highest rate of fatalities in any industry (BLS, 2023).

Construction had three times the amount of fatalities as other industries around the world (DOSM, 2022). One of the riskiest lines of work is construction; 20% of the 5,000 private industrial worker fatalities came from this sector, making construction responsible for one out of every five worker fatalities. The four major causes of death in the construction industry are falling, being electrocuted to death, being struck by an object, and being stuck between something or two objects. These accidents account for 59.9% of construction worker deaths in the private sector. While for the non-fatal injuries, one in every 10 construction workers is injured annually (OSHA, 2022).

The construction sector is well-known for being dangerous due to its strategic nature and complexity. In 2023, the construction sector in Malaysia witnessed 159 accidents, an increase from the previous year's figures (Statista, 2024b). Workplace safety is vital and is regulated by the 1994 Malaysian Occupational Safety and Health Act. Construction site workers face heightened risks due to working at high elevations, handling heavy tools, and exposure to loud noises. The Malaysian Department of Occupational Safety and Health (DOSH) noted that employers might often overlook common workplace hazards, leading to injuries or fatalities. In 2023, 45 of these construction accidents resulted in deaths. However, numerous industrial safety and accident investigation researchers consider that a single factor will never result in an accident. On the contrary, significant industrial incidents happened due to behavioural, technological and operational factors (Bensonch et al., 2022).

The increase in the amounts of construction-related fatalities and injuries are causing complications in Malaysia. There were 32,674 occupational accidents, with 312 cases of workplace fatalities in 2020 (Mahidin, 2021). Services are the leading contributors to workplace accidents, next is manufacturing and followed by construction. Despite ranking third in total injuries, the construction industry ranks first in work-related casualties. Rather than exhibiting a long-term consistent track record, construction has the largest proportion of work-related casualties, which is 3.3 times greater than the average nationwide for 2020 and thus remains the most dangerous sector in Malaysia.

Other countries have also reported greater work-related casualties rate in the construction industry when contrasted to other industries. The United States Bureau of Labour Statistics recorded 1,008 workplace fatalities in the nation construction industry, with a rate of 10.2 deaths per 100,000 workers, contrasted to a rate of 3.4 fatalities across all industries (BLS, 2023). While in the United Kingdom, the Health and Safety Executive recorded the construction work-related casualties rate of 1.74 contrasted to 0.34 for all industries (HSE, 2021). For the Asia region, Singapore reported a fatal accident rate of 2.2 per 100,000 workers in the construction industry (all industries: 0.9 per 100,000 workers), while Japan had a fatal accident rate of 5.24 (all industries: 1.49 per 100,000 workers) (Zaini et al., 2022).

In 2018, more than 19% of all occupational fatalities in the United States occurred in the construction industry, which reported 1,038 death occupational injuries. While the overall national average rate of 5.2 death occupational injuries per 100,000 workers, the construction industry had 16.2 death occupational injuries per 100,000 workers. In the same year, an another 77,500 workers struggled from non-fatal workplace injuries and illnesses in construction project sites (Choi & Lee, 2022). In a different instance, the construction industry in Korean recorded 517 occupational fatalities in 2019, which is more than a fifth of all deaths attributable to employment during the same year. It had a 1.9-fold higher injury rate compared to the overall industry rate of 1.08 deaths for every 100,000 workers, (Jung et al., 2022).

The most significant features of the construction sector are the complexity of the construction building, the short-term organizational structure, changes in the workplace, the working environment's complexity and the workers' peculiar behaviour under various working conditions (Gholamnia et al., 2019). Rapid changes and complex working environments are the construction projects representative characteristics and have continuously become the cause of disappointing safety records in the construction field (Luo et al., 2017).

The top four accidents (Falls, Caught-In/Between, Struck-By and Electrocutions) which listed in the frequency statistics of fatal construction safety accidents reported by the United States Occupational Safety and Health Administration (OSHA) are directly related to the construction workers' unsafe behaviour. Workers in construction engage in a wide range of activities, each with its own set of risks. The worker who performs a task is straightforwardly subjected to the dangers associated with it, as well as passively revealed to risks created by nearby co-workers (Suárez Sánchez et al., 2017). The repercussions of inadequate workplace safety behaviour compliance and safety participation can be disastrous. Various stakeholders are forced to endure significant losses as a result of poor safety compliance and participation on construction sites. Individuals and societies alike suffer greatly from workplace fatalities and injuries (Xu et al., 2021).

To control workers' unsafe behaviours, traditional safety management strategies depend greatly on individual-oriented regulatory tools, like penalties. (Choi & Lee, 2018). However, rather than blaming workers, the factors influencing safety behaviours have lately been concentrating on in order to find new ways to enhance safety behaviours among workers. Many previous studies, for example, have found links between construction workers' safety behaviours and personal characteristics for example safety knowledge (Fung & Tam, 2013; Hasanzadeh et al., 2017), personality (Hasanzadeh et al., 2019; Sun et al., 2020), age and gender (Fung & Tam, 2013; Shuang et al., 2019), type of work (Choudhry & Fang, 2008) and work experience (Chmutina & Rose, 2018; Cooper & Phillips, 2004).

Furthermore, other researches have provided empirical support for the influence of management factors including such leadership (Grill et al., 2017; Sheehan et al., 2016), group norms (Choi et al., 2017a; Fugas et al., 2011), supervisors (Fang et al., 2015), training (Namian et al., 2016; Xu et al., 2019), safety climate (Andersen et al., 2018; He et al., 2020) and communication (He et al., 2019; Zohar & Polachek, 2014) on safety behaviours.

Improving site safety requires a thorough understanding of construction site compliance behaviours. The cornerstone of successful safety performance is understanding safety compliance behaviour (Hu et al., 2020). The critical factors that influence safety behaviour and compliance would be studied by using Theory of Planned Behaviour (TPB). TPB posits that actual behaviour can be predicted by intention, while the establishment of intention is mainly determined by attitude, subjective norms and perceived behavioural control. Besides, the macro safety predictors that influence safety behaviour and compliance would be studied by using Institutional Theory to describe how three different kinds of institutional pressures (i.e., coercive, mimetic, and normative pressures) will affect safety behaviour on construction sites. Despite the posited framework considering TPB, there is scarce literature on the study of macro predictors and the cognitive domains (subjective norms, attitude, and perceived behavioural control), and there is no evidence to prove the correlation between intention to comply with safety and macro-micro safety predictors in construction project sites (Lee et al., 2018a).

On the other hand, safety participation has come to prominence as a significant aspect of construction workers' safety behaviours. (Choi & Lee, 2022). Despite previous attempted to find out variables influencing safety participation among workers, it is unclear how any of these factors affect the mechanism of personal behaviour (Asilian-Mahabadi et al., 2020). In addition, these studies do not paid attention to the interdependencies among the macro-micro safety predictors, safety compliance intention and safety participation in construction project sites.

Malaysian major construction projects are vulnerable to hazardous circumstances, which can lead to accidents and undermine the project's safety results. However, studies on the safety predictors influencing the safety performance of the Malaysian construction industry are very limited (Albarkani & Shafii, 2021). Safety compliance and safety participation have a substantial effect on safety performance and must be addressed. Previous studies focused on technology methods for enhancing safety, but none of them considered behavioural treatments on the job (Jung et al., 2022). Almost no research has been done to investigate the role of planned behaviour in intervening in safety compliance on construction sites. Nonetheless, there is not yet a study mapped the interrelationships between the macro-micro safety predictors, safety compliance intention and safety participation in construction project sites using DEMATEL technique (Lee et al., 2018a).

Therefore, to address these needs, the purpose of this research is to create a model to formulate the macro-micro safety predictors in predicting safety compliance intention and safety participation among construction workers. Besides, a DEMATEL based model will be developed to examine the interrelationship between the macro-micro safety predictors, safety compliance intention and safety participation in construction project sites.

1.4 Research Questions

Following research questions are to be addressed by this study:

RQ1: What are the macro-micro safety predictors in predicting safety compliance intention and safety participation in construction sites?

RQ2: What are the interrelationships between the micro safety predictors and safety compliance intention in construction project sites?

RQ3: What are the interrelationships between the micro safety predictors and safety participation in construction project sites?

RQ4: What are the interrelationships between the macro-micro safety predictors in construction project sites?

1.5 Research Objectives

Reference to the research objective, this research is aimed:

RO1: To categorize the macro-micro safety predictors in predicting safety compliance intention and safety participation in construction sites.

RO2: To investigate the interrelationships between the micro safety predictors and safety compliance intention in construction project sites.

RO3: To examine the interrelationships between the micro safety predictors and safety participation in construction project sites.

RO4: To evaluate the interrelationships between the macro-micro safety predictors in construction project sites.

1.6 Scope of Study

The research concentrating on the construction sector in Selangor, Malaysia and focus on high-rise building construction project. The Malaysian construction industry is recovering after a two-year stagnation during the COVID-19 pandemic, with new skyscrapers and residential properties planned for 2024. The value of construction work increased by over ten billion Malaysian ringgit from 2022 to 2023 and is expected to rise again this year. With more than 1.3 million people employed in the construction industry, improving workplace safety is crucial for reducing accidents (Statista, 2024b). The research focus on Selangor area because it recorded the highest value of work done at RM6.8 billion in Second Quarter Construction Statistic Malaysia 2022, followed by Wilayah Persekutuan (RM5.2 billion) and Sarawak (RM3.5 billion) (DOSM, 2022).

High-rise building construction is the most general type of project which can be divided into residential and commercial buildings. Residential buildings include houses, apartments, and condominiums while commercial buildings include office tower and hotels. The designs are usually made by architects and construction works are executed by builders. In 2021, the public sector's residential building construction in Malaysia was valued at approximately RM1.02 billion. However, until 2019, Malaysia's public residential building construction market was valued at RM1.9 billion, rise from RM1.46 billion. The private residential building construction value in Malaysia was approximated to be around RM25.22 billion in the same year, down from RM27.26 billion in 2020 (Intelligence, 2022). In 2023, the value of residential building construction in Malaysia reached approximately 28.78 billion Malaysian ringgit, reflecting an increase from the previous year. The construction sector in Malaysia experienced slower growth in 2020 and 2021 due to the COVID-19 pandemic (Statista, 2024a).

The method applied in this study to collect the required responses is a quantitative method through structured interviews with construction companies' experts that meet the DEMATEL method criteria. The results were interpreted using the Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. It aids in determining the interrelationship between the macro-micro safety predictors, safety compliance intention and safety participation in construction project sites. The most critical safety predictors can also be found through the DEMATEL method to improve the safety behaviour among construction workers. The results will then be presented in a visual Influential Relation Map (IRM).

1.7 Significance of Study

a) Theoretical Contribution

A new conceptual model for predicting safety behaviour in construction projects can be developed through the formulation of macro-micro safety predictors. This research expands on the TPB framework by incorporating macro-level factors, such as organizational and societal pressures, and micro-level predictors, like individual attitudes, subjective norms and perceived behavioural control, to explain safety compliance and participation in the construction sector. By utilizing the DEMATEL technique, this study provides valuable data for students and researchers, enabling them to identify and analyse the interrelationships between these predictors and their influence on safety behaviour in construction project sites. This comprehensive approach not only deepens the theoretical understanding of safety predictors but also offers practical insights for improving safety performance in construction projects.

b) Practical Contribution

This study helps to improve the construction industry safety performance through formulation of macro-micro safety predictors. The most critical safety predictors can also be found through the DEMATEL method to improve the safety behaviour among construction workers.

This research creates an opportunity for the construction organization to learn and understand the macro-micro safety predictors which will affect the safety compliance intention and safety participation in construction project sites. They can use these findings to develop strategies to improve safety performance. As a result, accident and fatality rates in the construction industry can be controlled and losses due to the presence of deformities can be reduced.

1.8 Organization of Reports

There will be total of 5 chapters in this research study.

Chapter 1 is the introduction which will introduce the definition of key terms, background of study, problem statement, research objectives, research questions, scope of study and significance of study.

Chapter 2 is the literature review to previous research which in relation to safety compliance and safety participation in construction industry. A DEMATEL conceptual framework will be introduced to determine the interrelationships between the macro-micro safety predictors, safety compliance intention and safety participation in construction project sites.

Chapter 3 is the research methodology which will describes the methods and techniques implemented in the research. Operational Definitions of Variables, research framework, research design, measurement of variables, data collection method, population and sample and data analysis technique will be included in this chapter.

Chapter 4 is about the results and discussion, the results gained through interview with expert will be used for data analysis. The complete results can be produced through using DEMATEL. Discussion will be conducted by using the results produced.

Chapter 5 is the conclusion and recommendation. The key findings are summarized based on the research objectives. Recommendations for further research will be provided according to the deficiency.

1.9 Definition of Key Terms

a) High-rise Building

A high-rise building is defined as one that exceeds 75 feet (23 meters) in height, measured from the lowest level accessible by fire department vehicles to the floor of the highest occupiable story. This height of 75 feet typically corresponds to about seven stories. Prior to 1999, the National Fire Incident Reporting System (NFIRS) classified building heights into specific ranges, including those that could be considered high-rise. These ranges included 7-12 stories, 13-24 stories, 25-49 stories, and buildings with 50 stories or more (Hall, 2013).

b) Construction Industry

According to Business Dictionary construction industry is the national economic sector which engaged in land preparation, construction, alteration and maintenance of buildings, structures, and other real estate. While from the Standard Industrial Classification, the construction industry is a manufacturing and business branch that focuses on the construction, maintenance, and repair of structures. This includes solid mineral drilling and exploration.

b) Safety Predictors

Construction safety prediction is an emerging field that utilizes various forms of information and analytical techniques to forecast the likelihood or severity of future injuries. The Safety Predictors are the specific factors or variables that are used to make safety predictions. They could include data points such as machinery wear and tear, employee behaviours, environmental conditions, and past incident reports. Predictors are the inputs into a prediction model that help determine the likelihood of a safety incident.

c) Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is indeed a belief-based social cognition theory that evolved from the Theory of Reasoned Action (Fishbein & Ajzen, 1975). According to the TPB, people's behavioural, normative, and control beliefs are formed by their expectations and ideals about engaging in a behaviour. People's attitudes, subjective norms, and perceived behavioural influence toward their intention, eventually, their behaviour, are influenced by these beliefs (Ajzen, 1991). The main elements of TPB will be further discussed in Chapter 2.

d) DEMATEL

The Decision-Making Trial & Evaluation Laboratory (DEMATEL) method was pioneered in 1972 by the Science and Human Affairs Program at the Battelle Memorial Institute in Geneva. Its goal is to analyse and address complex, intertwined problem groups. DEMATEL has been instrumental in solving various global issues in science, economics, and politics by incorporating the insights and attitudes of relevant experts. It is now widely recognized as one of the most effective tools for determining causality between assessment criteria.

e) Institutional Theory

Institutional Theory elucidates how personnel encounter pressures from the external environment, including coercive pressures (e.g., enforcement of regulations by authorities), normative pressures (e.g., values, beliefs, or norms), and mimetic pressures (e.g., imitation of practices by firms to respond to competitors). The main elements of Institutional Theory will be further discussed in Chapter 2.

1.10 Summary

This chapter introduces the definition of key terms, background of study, problem statement, research objectives, research questions, scope of study and significance of study. Construction field is still one of the riskiest industries, improving workplace safety is crucial for reducing accidents as there are more than 1.3 million people employed in the construction industry. The purpose of this research is to create a model to formulate the macro-micro safety predictors in predicting safety compliance intention and safety participation among construction workers using DEMATEL method.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents the literature review about the overview of construction industry in Malaysia, safety issues in construction industry, which including worker's unsafe behaviour, accidents, previous studies and behavioural measures. On the other hand, safety behaviour, safety compliance, safety participation and macro-micro safety predictors affecting safety compliance intention and safety participation will also be discussed in this chapter. In this study, we will apply Theory of Planned Behaviour (TPB) to find out the safety predictors affecting safety compliance intention. Thus, our literature review will go through all the elements in TPB which are intention, attitude, subjective norms and perceived behavioural control towards safety compliance. Besides, Institutional Theory will be applied to describe how three different kinds of institutional pressures (i.e., coercive, mimetic, and normative pressures) positively affect safety behaviour on construction sites as macro safety predictors.

2.2 Overview of Construction Industry in Malaysia

Construction is a key sector of the Malaysian economy, though it remains smaller compared to other areas such as services, manufacturing, and agriculture. Within the country's Vision 2020, introduced in 1990, the goal was to elevate Malaysia from a developing country to a dynamic, prosperous, robust, competitive, and resilient nation. The construction sector plays a vital role in enhancing the economy due to its dynamic nature and its extensive forward and backward linkages with other industries (Dehdasht et al., 2022).

The construction industry in Malaysia plays a crucial role in the country's economic development (Albarkani & Shafii, 2021). It contributes significantly to the GDP, infrastructure development, and employment. This industry encompasses a wide range of activities, from residential and commercial buildings to large-scale infrastructure projects such as highways, bridges, and airports (Intelligence, 2022). In Malaysia, construction projects are divided into two categories: public sector and private sector. The Public Works Department (PWD) is in charge of public sector projects, while the Construction Industry Development Board (CIDB) is in charge of both public and private construction projects (Manzoor et al., 2021).

The Construction Industry Development Board (CIDB), established in 1994 under the Malaysian Ministry of Works, is responsible for ensuring safety and quality within the construction industry. Its core duties include registering construction companies on behalf of the Malaysian government across seven primary grades from G1 to G7. Additionally, CIDB promotes the growth and development of the construction industry by encouraging training, applying new technologies, and modern methods to advance sustainable development. It also provides recommendations to the government on construction-related issues, offers advisory and consultancy services, develops construction industry information systems, and regulates the industrial building system (Dehdasht et al., 2022).

The Malaysian construction industry is broadly divided into two main areas. The first area, general construction, includes three key sectors: civil engineering, residential buildings, and non-residential buildings. Civil engineering focuses on the construction of public infrastructure, such as highways and bridges. The residential buildings sector involves the construction of condominiums, houses, and apartments. Non-residential buildings cover all types of construction other than residential, including industrial and commercial structures. The second area, known as the special trade sector, encompasses specialized activities such as metal works, plumbing, painting, air-conditioning and refrigeration, tiling and flooring, carpentry, glasswork, and sewerage and sanitary work (Masyhur et al., 2024).

2.2.1 Economic Contribution

The Malaysian construction industry is recovering after a two-year stagnation during the COVID-19 pandemic, with new skyscrapers and residential properties planned for 2024. The value of construction work increased by over ten billion Malaysian ringgit from 2022 to 2023 and is expected to rise again this year. With more than 1.3 million people employed in the construction industry, improving workplace safety is crucial for reducing accidents (Statista, 2024b).

In 2023, the gross domestic product (GDP) from construction in Malaysia amounted to approximately 56.66 billion Malaysian ringgit, up from 53.43 billion Malaysian ringgit in the previous year. The GDP from construction had experienced a decline from 2020 to 2021, likely due to the restrictions imposed during the COVID-19 pandemic. The construction industry in Malaysia accounted for an estimated 3.6 percent of the country's gross domestic product (GDP) in 2023, an increase from the previous year. This sector has been in decline since 2020, dropping from 4.7 percent in 2019 to 4.1 percent (Statista, 2024a).

In 2021, the public sector's residential building construction in Malaysia was valued at approximately RM1.02 billion (DOSM, 2022). However, until 2019, Malaysia's public residential building construction market was valued at RM1.9 billion, rise from RM1.46 billion. The private residential building construction value in Malaysia was approximated to be around RM25.22 billion in the same year, down from RM27.26 billion in 2020 (Intelligence, 2022). In 2023, the value of residential building construction in Malaysia was approximately 28.78 billion Malaysian ringgit, marking an increase from the previous year. The construction sector in Malaysia grew at a slower pace in 2020 and 2021 due to the COVID-19 pandemic (Statista, 2024a).

2.2.2 Challenges and Issues

Malaysia's transition from a developing country to a developed one was envisioned in Vision 2020, which aimed for an average annual construction contribution of 6.0% to the gross domestic product (GDP). Despite this goal's significance, the Malaysian construction industry has yet to achieve the target (Dehdasht et al., 2022). The COVID-19 pandemic significantly impacted the construction industry in Malaysia, with contractors struggling to meet deadlines and construction budgets due to a lack of resources and manpower during the national lockdowns. This disruption over the past few years led to delays in construction progress and increased overall construction costs (Chew, 2023).

As the construction market begins to recover, many contractors are still contending with various challenges, including labour shortages, rising costs of materials and equipment, delays in obtaining project permits and approvals, and the need to improve building and material quality to minimize losses in terms of profits and time (Chew, 2023). Besides, weaker domestic currency leads to higher prices for foreign goods. Among the construction materials affected are cement and steel. Additionally, the price of mechanical and electrical (M&E) components has increased since many of these components are imported from the United States (Bernama, 2022).

The construction industry in Malaysia is critical to the nation's economic growth. On the contrary, the alarmingly high number of deaths and accidents in construction project sites is cause for concern. Although the construction sector is a very proactive and booming business that is contributing to the country's development, high accident and mortality rates not only stifle the industry's growth and development but also have a negative impact on it (Manzoor et al., 2021). Furthermore, construction of high-rise building projects is a risky activity due to the distinctiveness and condition of the activities, along with the variability of the working environment; however, safety issues maintain critical in the construction sector. (Bavafa et al., 2018).

Workplace safety is crucial and regulated by the 1994 Malaysian Occupational Safety and Health Act. Construction site workers face heightened risks due to working at high elevations, handling heavy tools, and exposure to loud noises (Manzoor et al., 2021). The Malaysian Department of Occupational Safety and Health (DOSH) has indicated that employers may often overlook common workplace hazards, leading to injuries or even fatalities. In 2023, 45 of these construction accidents resulted in deaths (Statista, 2024b).

2.3 Safety Issue in Construction Industries

2.3.1 Accidents in Construction Industries

Due to the dynamic nature of the industry and transient on-site activities, construction is claimed as one of the most dangerous industries (Li et al., 2015). It had a 71% greater risk of non-fatal injuries than all other industries (Li et al., 2019b). Substantial injury rates imply high compensation, loss, pain and suffering in the event of an accident. Due to the obvious large number of occupational accidents, the construction sector has a poor safety record (Mohandes et al., 2022). As the complexity and risk involved in high-rise construction make safety an even more critical consideration. High-rise projects typically involve working at great heights, the use of heavy machinery, and complex scaffolding and lifting operations, all of which heighten the risk of accidents (Manzoor et al., 2022).

High accident rates occur across the world. According to Occupational Safety and Health Administration (2021), construction sector had the largest proportion of mortalities among all industries in the United States. There are 5,333 people lost their life on the job in 2019 (3.5 per 100,000 full-time equivalent workers), averaging more than 100 deaths per week, or about 15 deaths per day. In calendar year 2019, construction contributed nearly 20% (1,061) of worker deaths in private industry, taking account for one out of every five workplace fatalities (United States Department of Labor, 2021).

The situation is particularly dire in developing countries. The construction sector accounts for 20% to 40% of all occupational injuries in these countries, however, only 6-10% of the workforce is involved in the industry (Sadeghi et al., 2020). For example, between 2007 and 2016, documented accidents in Turkey's construction sector revealed a fatality rate of roughly 22.35 per 1000 employees, compared to 6.2 in the manufacturing sector (Ayhan & Tokdemir, 2020).

While back to Malaysia, the construction industry fatalities rate had expanded by 125% between 2009 to 2015. It's worth noting that Malaysia has seen an increase in the amount of death injuries after 2015, with a 30 percent increase in just four years (Muhamad Zaini et al., 2020). According to the Occupational Safety and Health Act 1994 (OSHA), the Malaysia Construction industry had 3,958 cases of occupational accidents in 2020, placing third after Manufacturing (10,303 cases) and Services sector (8,008 cases). Details also reveal that in 2020, the number and rate of occupational deaths decreased in all sectors. However, the construction industry remained the highest risk for work-related fatal accidents, with a mortality rate of 6.90 per 100,000 workers (81 cases) (Mahidin, 2021).

Falling from heights is the most common accidents caused by unsafe behaviour in construction industry in Malaysia. Some of the causes are lack of safety occupational procedure by onsite workers and ignorance of safety and health standards which contribute to fall-related casualties. There are 26 and 15 reported cases in 2014 and 2015 respectively. The second leading cause of death on construction sites is being crushed by objects and materials, with an overall of 17.36% of deaths from 2013 to 2016. The third most common accidents cause by unsafe behaviour is being crushed vehicles, which accounts for approximately 9.09% of all cases (Ayob et al., 2018).

In Malaysia's construction industry, the amount of workplace accidents was less than the previous year as several construction projects were halted due to the COVID-19 pandemic (Hirschmann, 2021). Same situation also happened in other nations for example the Singapore, United Kingdom and United States. The influence of COVID-19 pandemic on construction firms, which resulted in a major decline in employment, with many workers being temporarily laid off, may be to blame for the significant decrease in fall accidents in 2020 (Brown et al., 2020). In 2023, 159 accidents occurred in the construction sector in Malaysia, an increase compared to the previous year. Despite this rise, Malaysia has experienced fewer accidents over the past four years, following a record high of 326 accidents in 2019 (Statista, 2024b).

Unfortunately, in many other nations, the construction business is known for its high risk and large overall amount of mortalities (Halabi et al., 2022). Cos of the dangerous nature of construction accidents, they frequently have a number of unintended consequences, such as project delays and worker absenteeism (Fung et al., 2010; Hu et al., 2011). Additionally, fatal accidents cost individuals and society a tremendous amount of money (Forteza et al., 2017). Therefore, ensuring safety in such projects is of utmost importance to prevent falls, structural collapses, and other potential hazards that can lead to severe injuries or fatalities. Safety measures, such as proper use of personal protective equipment (PPE), safety training for workers, and rigorous safety protocols, are essential to manage these risks (Halabi et al., 2022).

In high-rise projects, the potential for accidents increases with each additional floor, and even small oversights can have catastrophic consequences (Muhamad Zaini et al., 2020). For these reasons, safety planning, monitoring, and compliance should be top priorities for project managers and contractors involved in high-rise construction to safeguard workers and ensure the successful completion of projects without incidents (Manzoor et al., 2022). Thus, in recent years, persistent efforts have been put forth to improve the construction industry's safety record. (Shao et al., 2019). Sadly, the construction industry is still plagued by fatal accidents. (Halabi et al., 2022).

2.3.2 Previous Studies on Construction Accidents

Accidents are considered discrete events having a variable frequency of occurrence, and their occurrence is difficult to anticipate due to unknown contributing factors (Fung et al., 2010). Various safety associations throughout the world are focusing on the construction incident type distribution and statistics. Unfortunately, comparing the different statistics is problematic because several situations define the accidents (Winge & Albrechtsen, 2018). In general, eliminating construction accidents has long been a top priority in the realm of safety studies. However, a thorough grasp of the components that play a major role in causation is required (Sawacha et al., 1999).

Academics have put out and developed accident causation theories in order to prevent accidents and mitigate their consequences (Smillie & Ayoub, 1976). Most of these theories claimed that accidents can happen when a series of contributing factors interact, and that many accidents can be avoided by identifying and eliminating these components in theory (Hu et al., 2011). When an accident occurs, the organization investigates the cause of the accident. Most investigations focus on immediate causes, such as employee non-compliant safety behaviour or unsafe equipment conditions, while ignoring root causes to a certain extent (Liu et al., 2020).

Khosravi et al. (2014) found insufficient study on the primary causes and contributing variables of risky behaviours and construction site mishaps after reviewing the literature on the subject. Accidents in the construction industry can be avoided by understanding the root causes of accidents, which have been investigated by accident causation theory. Accidents are caused by a variety of factors, one of which is unsafe behaviour (Guo et al., 2020). Unsafe behaviour refers to construction operations against the rules (Xu et al., 2021). These risk-taking behaviours admit, endure, or completely disregard safety risks during construction in order for individual site workers to complete a pertinent task(s) or achieve a specific goal(s). Construction workers contravene practices, requirements, instructions, safety criteria and safety rules during the process (Mohammadfam et al., 2017).

Construction accidents are more likely to occur when workers' unsafe behaviours are accompanied with unsafe working circumstances (Lee et al., 2021). To govern workers' unsafe behaviours, traditional safety management techniques generally depend on individual-oriented regulatory tools, like sanctions (Choi & Lee, 2018). However, rather than criticising construction workers, researchers have recently focused on the factors that influence their safety behaviours in order to find better strategies to enhance their safety behaviours. For instance, many earlier research have found links among construction site workers' safety behaviours and personal characteristics like personality (Hasanzadeh et al., 2019; Sun et al., 2020), type of work (Choudhry & Fang, 2008), age and gender (Shuang et al., 2019), experience on the job (Cooper & Phillips, 2004) and safety knowledge (Hasanzadeh et al., 2017).

Furthermore, the effects of management factors have been empirically supported from previous researches like leadership (Grill et al., 2017; Sheehan et al., 2016), supervisors (Fang et al., 2015), communication (Kines et al., 2010), group norms (Choi et al., 2017a), training (Namian et al., 2016) as well as safety climate (Fugas et al., 2012; Jiang et al., 2010) on safety behaviours.

2.3.3 Behavioural Measures

Accidents do not happen; they are caused, and the majority of them are the results of unsafe acts or conditions (Ridley & Channing, 2008). According to reports, people who spend their days working on construction sites have a one in 300 probability of being killed on the job due to a lack of safety compliance and safety participation (Bavafa et al., 2018). When employees fail to comply safety rules, procedures, standards, instructions, and specified project standards, unsafe behaviours are established. Such actions may adversely affect the performance of employees and / or endanger others in the construction sites (Ding et al., 2018).

Li et al. (2019a) also agreed that construction worker safety should be enhanced, especially for self-employed individuals and workers linked with small businesses. A mandatory safety course may also be necessary to enhance safety compliance among these workers. Generally, unsafe behaviour is interpreted as the result of an “unsafe or lazy attitude” or “lack of safety knowledge or skills”. If workers are found to be violating safety regulations, they are sent to the office for consultation or retraining (Goh et al., 2018).

Both safety compliance and safety participation have the potential to significantly minimise negative safety outcomes. As an example, improving construction workers’ safety behaviours can reduce the risk of accidents (Aryee & Hsiung, 2016; Leung et al., 2016). Safety compliance behaviours (for example, wearing personal protective equipment) act as a buffer among the safety climate and injuries (Liu et al., 2015) and have an immediate impact on safety performances (Fernández-Muñiz et al., 2014). To date, studies have unquestionably demonstrated that safety behaviour plays a critical role in avoiding injuries and accidents.

2.3.4 Workers’ Unsafe Behaviour

The accident and fatality rates in the construction industry are notably higher compared to other industrialized sectors, with rates being twice as high for accidents and five times higher for fatalities (Fang et al., 2020). Over the past decade, global economic and industrial development has significantly increased industry demands, leading to a rise in the number of unskilled and accident-prone workers (Shi et al., 2019). Research indicates that approximately 80% of accidents in the construction industry are related to workers’ unsafe behaviours. Therefore, implementing effective safety management strategies is crucial to preventing unsafe behaviours among workers. Addressing these unsafe behaviours proactively within the safety management system can help mitigate workplace hazards and reduce the risk of harm (Khoshnava et al., 2020).

Workers' unsafe behaviours are still widespread on construction sites, and they are influenced by negative factors associated with individuals and organizations. Migrant workers with inadequate workforce education and upskilling have increased the number of risky behaviours in developed countries (Xu et al., 2019). Many employees have not obtained any professional skills training, resulting in their low sensitivity of unsafe behaviour. As a result, workers develop distinct behaviour patterns, which increases the likelihood of risky behaviour occurring.

When employees fail to comply with safety rules, standards, procedures, instructions, and specified project standards, unsafe behaviours are established. Such actions may adversely affect the performance of employees and / or endanger others in the construction sites (Ding et al., 2018). It indicates intentional deviation from the recommended safety behaviours (Mason, 1997). Generally, unsafe behaviour is interpreted as the result of an "unsafe or lazy attitude" or "lack of safety knowledge or skills." If workers are found to be violating safety regulations, they are sent to the office for consultation or retraining (Goh et al., 2018).

2.4 Safety Behaviour

Safety-related behaviour in general occupational safety literature is defined as "workplace behaviours that influence the degree to which people or the workplace as a whole are safe from violent threat or damage". This includes behaviours that (a) reduce physical threat or harm (i.e., safe behaviour), whether rule-mandated or discretionary, as well as behaviours that (b) expose workers or the workplace to a higher level of physical risk or injury (i.e., unsafe behaviour), whether unintentional or intentional (Beus et al., 2015). Safe behaviour, also known as safety behaviour (Griffin & Neal, 2000) refers to "individual's actions or behaviours that demonstrated among all tasks to enhance the safety and health of employees, clients, the general public and the atmosphere" (Burke et al., 2002).

Safety behaviour refers to job performance that is focused on safety, and it is also one of the most important variables in preventing accidents (Sampson et al., 2014). According to Seo et al. (2015), safety behaviours are personal measures undertaken for self-defence, including adhering to regulations for safety to avoid harm to themselves and others, as well as wearing protective gear. Safety behaviour has been identified as a key performance indicator for safety (Hinze et al., 2013) as it has been demonstrated to reduce the likelihood of dangerous events, injuries, mishaps and other critical safety outcomes (Aryee & Hsiung, 2016; Leung et al., 2016). As a result, safety behaviour is a critical factor in regulating and enhancing safety in construction site (Fang et al., 2015).

According to work performance theory, two components of safety behaviour (performance) are established, which are safety compliance and safety participation (Walter C. Borman, 1993). Safety compliance behaviour refers to employees' proclivity to follow safety regulations, norms, and processes, which are frequently mandatory. Safety compliance entails following safety protocols and executing tasks in a safety manner. On the other hand, safety participation behaviour refers to the actions that employees voluntarily implement to achieve safety goals. For example, demonstrating initiative, promoting workplace safety programmes, helping colleagues and working to improve safety in workplace. Safety compliance behaviour contributes to personal safety, whereas safety participation behaviour contributes to improve group safety performance (Griffin & Neal, 2000).

According to Clarke (2013), safety compliance entails behaviours that could be considered to be a part of the employee's job, whereas safety participation entails a more voluntary component, such as behaviours that go beyond the official role of an employee or can be addressed as organizational citizenship behaviours. This broadly acknowledged two-dimensional safety behaviour structure was used in this study.

In high-risk industries especially come to construction, safety behaviour has been linked to injuries in numerous studies (Seo et al., 2015). Therefore, exploring the antecedents of safety behaviour is critical for accident prevention. Safety behaviour can be forecasted from individual's intentions, and the effects of intentions can be mitigated through practical controls such as abilities, skills and environmental factors. Intention can be determined by attitudes towards behaviour, norms of perception, and control of perceived behaviour (Goh et al., 2018). Construction workers' safety behaviour could be a significant component in improving the safety performance of the construction sector. Controlling worker safety behaviour can help prevent mishaps and encourages practitioners and researchers to identify the individual and organizational predictors that influence safety behaviour. (He et al., 2021).

Construction workers' safety behaviour is affected by teamwork atmosphere. The atmosphere of teamwork has a clear positive impact on the workgroup members' roles, additional roles and respectful behaviour (Choi & Lee, 2017). While behaviour is not related directly to perceived notion, the probability of a person who takes an attitude-determined course of action cannot be ignored. We would be allowed to better and more confidently predict whether workers will adopt the necessary and essential steps to ensure workplace safety if we understand their perceptions of overall organizational safety culture (S. & Jr., 1994).

Safety behaviours are the actions that ensure that individual people or organizations are not physically threatened or harmed (Beus et al., 2015). According to Asilian-Mahabadi et al. (2020), employees' unsafe behaviour is the leading cause of industrial accidents. Haslam et al. (2005) studied 100 construction accidents and discovered that 70% of them were caused by human factors, specifically unsafe employee behaviour. Thus, lowering occupational injuries and mishaps are heavily dependent on improving safety behaviour among employees.

As a result, safety behaviour is a type of personal job performance that is frequently referred to as "safety performance" (Burke et al., 2002; Griffin & Neal, 2000). Personal job performance is defined by detectable behaviours as opposed to motivational, cognitive or other psychological states (Schmitt et al., 2003) like intention to behave safely or the outcomes of behaviour (Campbell & Wiernik, 2015) as in safety outcomes (e.g., accidents and injuries).

Independently, both safety compliance and safety participation behaviours can be assessed by assessing the likelihood in which a person is involved in those behaviours (Burke et al., 2002). Individual behaviours can be also consolidated to the team stage (Neal & Griffin, 2006) based on a reasonable level of consensus. Similarly, it is possible that there will be some similarities among safety compliance and safety participation. Prior study has frequently discovered strong associations among both safety compliance and safety participation, and they have found a correlation between safety compliance and safety participation (Barbaranelli et al., 2015; Guo et al., 2016; Neal & Griffin, 2006).

Many literatures on occupational health and safety demonstrate that human behaviour is a significant contributor to construction mishaps. Safety compliance and safety participation are reflected in the presence of good safety behaviour. Worker interference with a specific pattern of behaviour as an important condition for changing worker behaviour cannot be properly addressed as a safety concern (Zin & Ismail, 2012). As an outcome, the primary objective of this study is to determine what are the macro and micro safety predictors affecting workers' behavioural safety compliance intention and safety participation.

2.4.1 Safety Compliance

Safety compliance refers to one of two components of the term "safety behaviour" and is more frequently applied to study safety performance systems, with safety participation being the other component. The term "safety compliance" refers to "the main actions that an individual must perform to sustain the safety at workplace" (Griffin & Neal, 2000). "I apply all required protective gear to conduct my work" for example, is a sample predictor for determining safety compliance. Inness et al. (2010) explained safety compliance as workplace behaviours aimed at meeting minimum safety standards.

Rules and safety procedures with specified compliance requirements have been demonstrated to be useful in ensuring workplace safety (A.Kvalheim & ØyvindDahl, 2016). A range of safety regulations and procedures are in place in many organizations, particularly those in high-risk industries to guarantee safety atmosphere and reduce unsafe behaviour (Hale & Borys, 2013). These behaviours include activities such as adhering to safety procedures, carrying personal protection gear and performing work in a secure manner. Extensive research evidence shows that accidents and injuries are less likely to occur if workers demonstrate greater compliance to safety policies and guidelines. (Nahrgang et al., 2011).

According to Hu et al. (2020), safety compliance can be classify into deep compliance and surface compliance which depict two distinct ways that employees comply with organizational requirements. Deep compliance as a form of safety compliance involves the intent and strategy to accomplish the required tasks in a safety manner. Employees participate in deep compliance with the objective of guaranteeing workplace safety, and they make the necessary efforts to adopt risk management strategies that are expected to accomplish organizationally desired safety outcomes. By contrast, surface compliance is a type of safety compliance that represents the goal and approach of simply demonstrating adherence to safety regulations and procedures. In other words, employees participate in surface compliance with the goal of meeting organizational standards, focusing their work and attention on proving compliance.

Individual safety performance (behaviour) significantly affects safety outcomes in high-risk workplaces like construction project sites (Xia et al., 2018). Previous literature has shown that the leading cause of workplace accidents is unsafe behaviour (Goh et al., 2018; Weili Fang, 2020; Yu et al., 2017). The implementation of "generally obligatory" safety behaviours is referred to as safety compliance (Neal et al., 2000). Because safety compliance as defined by "the basic safety actions that personals must conduct to ensure the safety of workplace" (Griffin & Neal, 2000) and is thus mandatory and obligatory. While according to TPB, behaviour can be forecasted from individual's intentions, and the effects of intentions can be mitigated through practical controls such as abilities, skills and environmental factors. Intention can be determined by attitudes towards behaviour, norms of perception, and control of perceived behaviour (Goh et al., 2018).

2.4.2 Safety Participation

Safety participation is referred to workers' additional contribution in safety practices, including involving actively in safety meetings, passionately assisting co-workers to accomplish safety work activities and constructively providing safety suggestions (Liu et al., 2019). Given that safety participation extends beyond the formal responsibility of workers in safety (such as safety compliance - adhering to safety regulations and guidelines), safety participation can be interpreted as Organizational Citizenship Behaviour (OCB) within the context of safety (Fugas et al., 2012; Jiang et al., 2010). OCB is referred to as individual behaviour which is voluntary in nature, not expressly or impliedly recognised by the official system of rewards, and promotes the effective and efficient functioning of the organization (Organ, 1988). In previous studies, safety participation was referred to as Safety Citizenship Behaviour (Hofmann et al., 2003; Jiang et al., 2017).

Safety participation is becoming more widely recognised as a key aspect of construction workers' safety behaviours (Choi & Lee, 2022). Safety participation correlates directly to situational performance and corresponds to "behaviours that do not directly affect a person's personal safety but contribute to the development of an environment that promotes safety". It refers to the types of voluntary actions employees take to improve safety, including such aiding colleagues, voicing safety concerns, and providing suggestions to improve safety (Griffin & Neal, 2000). "I go above and beyond to improve workplace safety" is a sample indicator for measuring safety participation.

Although conventional safety research has concentrated on strategies to enhance workers compliance to safety regulations and guidelines, a growing corpus of study is recognising the importance of workers' safety participation. While safety compliance refers to the execution of prescribed safety-related behaviours (e.g., wearing personal protective equipment), safety participation refers to additional actions (e.g., organizational citizenship or stewardship behaviours) that go beyond compliance to promote workplace safety. For example, proactively assisting co-workers with safety issues, taking part in voluntary safety-related operations and tutoring (Neal et al., 2000), expressing safety concerns to management (Mullen, 2005) and taking part in safety meetings (Neal & Griffin, 2006).

Participation of workers in safety behaviour is critical for sustaining occupational safety, lowering accident and injury rates, and increasing leader-member communication (Kath et al., 2010). If employees do not attend safety training and actively learn, they may handle or operate equipment and machinery improperly or incorrectly. Furthermore, if they do not participate in safety inspections and safety discussions, unsafe conditions of machinery cannot be resolved and potential hazards cannot be predicted (Liu et al., 2020).

Previous meta-analytical studies have shown that both safety motivation and safety knowledge are associated with elevated levels of employee participation in safety (Christian et al., 2009). Several factors, including different leadership styles, safety knowledge, safety motivation, safety climate, employees' safety risk perception, and communication climate, have been proven to affect safety participation behaviours among workers (Choi & Lee, 2022; He et al., 2019; Martínez-Córcoles et al., 2012; Mullen et al., 2017; Neal et al., 2000; Xia et al., 2020).

Employees' psychological safety experience, sense of belonging, and safety behaviour are all influenced by the organization-employee relationship. Employee trust in their employer is a critical aspect in this connection since it promotes safety performance. According to the Reciprocity Theory, when employees gain trust in the organisation, they believe they are part of the "family". As a result, employees reward their employers by actively participating in safety-related actions such as assisting, cooperating, self-reporting, and expressing safety issues (Liu et al., 2020).

Safety participation was associated to fewer accidents and injuries as part of a meta-analysis (Christian et al., 2009). Extra-role or organisational citizenship behaviours related to safety are linked to safety participation (including such, constructively assisting others, initiating positive changes in safety and safety stewardship). Safety participation is voluntary in nature, but it aids in the development of an atmosphere that promotes safety and enhances the working environment for a larger group of workers than the personal performing the behaviours (Neal & Griffin, 2006).

2.5 Theory of Planned Behaviour: Explaining Safety Compliance Behaviour

Ajzen (1991) first proposed the theory of planned behaviour to explain general individual behaviours. Three fundamental elements, which are attitude toward a behaviour, subjective norm, and perceived behavioural control, motivate a behavioural intention, which then influences the individual's actual behaviour. The theory of planned behaviour was indeed a generic design, the constructs in this research were adjusted to suit better into the construction industry. Behavioural intention (BI) is combination of three determinants (Attitude (A), Subjective Norm (SN), and Perceived Behavioural Control (PBC). The TPB framework connects individuals' attitudes, subjective norms, and perceived behaviour control to their BI and actual behaviour (Swarna et al., 2022). It has long been used to anticipate and explain individual behaviour.

Human action is guided by three factors, according to the TPB: the extent to which the behaviour's execution is evaluated positively or negatively (Attitude), the perceived social pressure to participate or not participate in the behaviour (Subjective Norm), and one's own perceived capability to carry out the behaviour successfully (Perceived Behavioural Control). These elements work together to produce a positive or negative intention to conduct the desired behaviour, which effectively predicts the actual behaviour. TPB can describe risky behaviours, that are identified as deliberate non-compliance with a recommended safe method of performing a task (Fogarty & Shaw, 2010).

The Theory of Planned Behaviour (TPB) is indeed a belief-based social cognition theory that evolved from the Theory of Reasoned Action (Fishbein & Ajzen, 1975). According to the TPB (Ajzen, 1991), people's behavioural, normative, and control beliefs are formed by their expectations and ideals about engaging in a behaviour. People's attitudes, subjective norms, and perceived behavioural influence toward their intention, eventually, their behaviour, are influenced by these beliefs. Each of these elements is supposed to sum up a set of salient beliefs. Attitudinal beliefs concerning anticipated behavioural outcomes underpin attitudes; subjective norms are supposed to be underpinned by sets of normative beliefs about important others' perceived opinions, while perceived behavioural control is proposed to be underpinned by sets of control beliefs about elements that promote or inhibit behaviour (Rowe et al., 2016).

The theory of planned behaviour was chosen because it has been widely employed in a variety of research fields to demonstrate technology acceptance and human behaviour, including construction safety (Choi et al., 2017b; Fogarty & Shaw, 2010) and transportation

(Larue et al., 2015; Rowe et al., 2016). Due to the theory of planned behaviour was a generic model, the constructs in this study were adjusted to suit better the domain of construction (Man et al., 2021).

By adapting the generic constructs of TPB to the construction domain, this research aims to provide a deeper understanding of the factors that drive safety compliance and participation among construction workers. Specifically, the study explores how construction workers' attitudes, subjective norms, and perceived behavioural control influence their safety intentions and behaviours on high-risk projects. These insights can then be used to design more effective safety interventions, such as training programs, safety campaigns, and management policies that align with the beliefs and perceptions of workers, ultimately fostering a culture of safety in the construction industry.

The favourable or unfavourable judgement of the safety compliance by construction workers is referred to as attitude toward safety compliance. Construction workers seem to be more inclined to comply to safety requirements when they have a positive attitude toward it. Construction workers' subjective norm is that persons who are important to them believe they should comply to safety requirements. Construction workers are more inclined to follow to safety requirements if they perceive that who are important to them agree. Construction workers' perceptions of how simple or challenging it is to comply to safety requirements are known as perceived behavioural control. Construction workers with a stronger perceived level of behavioural control over the safety compliance are more likely to do so. Figure 2.1 below is the Theory of Planned Behaviour Model:

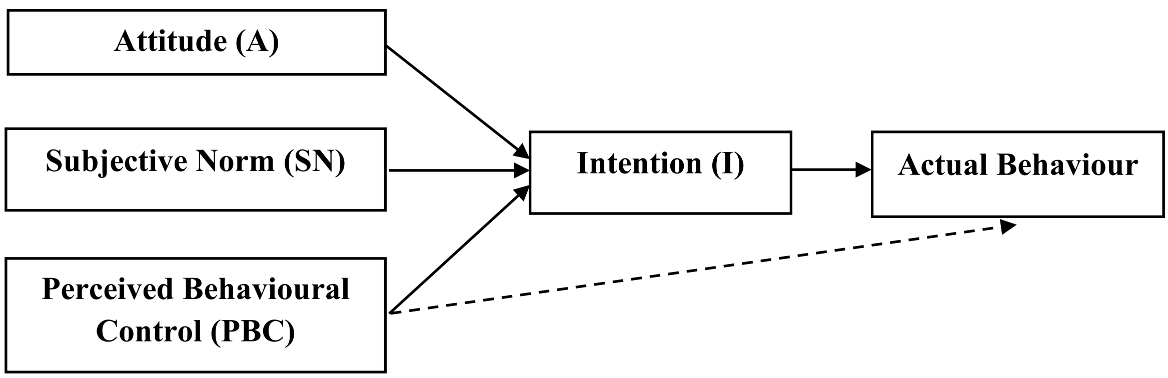

Figure 2.1 : Theory of Planned Behaviour Model

Source: Adapted from Ajzen (1991)

2.5.1 Intention Towards Safety Compliance

Intention is the most immediate behaviour predictor. Individual's intentions indicate how difficult they are prepared to attempt or the amount of effort they are ready to put into accomplishing a behaviour (Lee et al., 2018a). The intention to act is analogous to a person's decision to act. Intention to comply with safety requirements, also known as "strength of intention" refers to a person's likelihood of complying with safety requirements on the job and can be expressed in questions like "I have an intention to comply with the safety requirements", "I would commit to comply with the safety requirements" or even "I would be likely to refrain from unsafe behaviour". The motivational elements that impact behaviour are encapsulated by intentions. Intentions and behaviours must be congruent with one another.

According to the Theory of Planned Behaviour, engaging in actual behaviour is driven by an intention to perform in actual behaviour. As a result, three constructs influence intention: (a) attitudes, which are individuals' positive or negative assessments of actual behaviour in action; (b) subjective norms, that are beliefs about how important/significant individuals agree or disagree of conducting that actual behaviour; and (c) perceived behavioural control, which are subjective impressions of control over conducting the actual behaviour (Fishbein & Ajzen, 2011; Fogarty & Shaw, 2010).

According to Fishbein and Ajzen (2011), determining the behavioural intention construct is the same as assessing the actual behaviour construct of multiple behaviours, including such construction workers who do not wear safety shoes, helmet and protective gloves. Safety behaviour can be forecasted from individual's intentions, and the effects of intentions can be mitigated through practical controls such as abilities, skills and environmental factors. Intention towards safety compliance can be determined by attitudes towards safety compliance, subjective norms towards safety compliance and control of perceived behaviour towards safety compliance (Goh et al., 2018).

2.5.2 Attitude Towards Safety Compliance

To give a concrete definition of an attitude, it is worth noting that a general emotion, belief, or a certain behaviour towards an object produces an attitude toward the object (Baron & Byrne, 2008). Strong personal beliefs about the outcome and the repercussions of the outcome shape an individual's attitude toward behaviour (Wong & Lee, 2016).

Attitude can be defined as one's positive or negative feelings toward a specific behaviour (Lee et al., 2018a, 2018b). An individual's attitude toward the attributes of a behaviour is formed by his belief about that behaviour. The total of one's beliefs about the outcomes of executing a particular action, including the outcome of compliance with requirements for safety, in the context of investigations like "Compliance with safety requirements will ensure my safety" multiplied by the assessment of the repercussions (e.g., desirability of compliance in the form of questions like "Compliance with safety requirements and ensure my safety is Good/Bad"). People's attitudes are said to be driven by their attitudinal beliefs. They are influenced by the perceived repercussions of a behaviour as well as people's assessments of these repercussions (Fishbein & Ajzen, 1980).

We are studying employee safety attitudes in this research, which are defined as an employee's beliefs and feelings about safety (Neal & Griffin, 2004). Safety attitudes reflect an employee's perspectives on the significance of safety and therefore should be distinguished from the well-studied notion of safety climate, which can be explained as shared perceived organizational safety practises and policies (Neal & Griffin, 2006). Each worker has their own beliefs about what causes occupational accidents and what factors are essential in preventing them. These beliefs shape attitudes toward workplace hazard prevention activities and their safety compliance (Kouabenan, 2009).

The attitude of a worker toward safety determines not only do they act safely in the worksite, but also whether they comply with and accept to formal worksite guidelines, and take initiatives when it is necessary to apply informal practices that accomplish the same objective (Loosemore & Malouf, 2019).

Decision-makers' behaviour is heavily influenced by their attitudes (Wang et al., 2016). For example, workers who are risk averse frequently overestimate risks thus they are more likely to engage in safe behaviour. Workers who are prone to risk seeking, on the other hand, frequently underestimate risks and are more inclined to participate in dangerous behaviour (Choi & Lee, 2018). The safety attitudes of construction workers are significant safety attitudes that affects construction site workers to participate in risky behaviours. The most serious safety attitudes involve workers in site acting like "tough guys" when facing the safety risks in order to stay away from being a bother to their colleagues (Danso et al., 2022).

When an employee undertakes a step, the outcomes of that step will affect the worker's experience and attitude (Ye et al., 2020). Goles et al. (2008) discovered that past behaviour resulted in positive experience. Furthermore, past behaviour leads to individuals having a more positive attitude toward such behaviours, which increases their willingness to implement the behaviour again. Danso et al. (2022) found that construction workers in Ghana ignoring safety risks in order to complete their tasks due to prior experiences involving similar risks, attempting to take safety risks in to obtain respect from other work colleagues, and completing their tasks quickly.

It was confirmed that workers' safety awareness and attitudes are also positively correlated with their level of education and safety knowledge (Siu et al., 2000). However, it is also crucial to distinguish among both safety perception and safety attitude, with the former being directly related to safety knowledge and the latter being more subjective attribute. As an example, workers with comprehensive safety training and proper knowledge, breaking protocols for safety reflects their poor safety compliance attitude (He et al., 2016).

2.5.3 Subjective Norms Towards Safety Compliance

Subjective norm is identified as the person's social pressure to perform or refrain from performing that specific intended act (Lee et al., 2018a, 2018b). It is determined through adding the result of normative beliefs, representing the site personnel's perception of the importance of other people/groups (for example, the probability that the site personnel's peers, important friends, and families will support, agree, or assert pressure on his decision to complete and comply with the safety requirements), by the intention to comply, that also refers to the motivation to conform to people's or group's perceived expectations. For instance, a site employee may feel strong pressure from essential family or friends to comply with safety rules, and the site personnel has a strong and essential feeling to comply. The function of this normative belief is to convey to site personnel the perceptions of other significant persons.

Subjective norms are built on normative beliefs, which are shaped by whether important others believe an individual should and should not participate in a behaviour, as well as the motivation of a person to follow these essential others' wishes (Ajzen, 1985). Influential groups or individuals play a significant role in deciding whether or not a worker takes a specific action (Ye et al., 2020). Non-work social influences have been found to shape employees' beliefs about workplace safety, such as parental safety attitudes (Kelloway et al., 2005) and institutional influences, for example, employee perceptions of management's safety concern (McLain, 2014).

Subjective norms refer to the collective beliefs and practices of supervisors, immediate subordinates and managers in the workplace. For instance, If a workgroup's safety culture is weak, an individual worker inside the group is less likely to go against the group's collective norms (Ajzen, 1991). The safety attitudes of co-workers and management were identified as the main causal variables affecting construction workers to participate in dangerous working behaviours using grounded theory approach and semi-structured interviews (Choudhry & Fang, 2008). When a work group has a strong safety culture, social conformity can create favourable results (Mullen, 2004). Even if an employee intends to work safely, it was discovered that beliefs regarding social norms at work are an important cognitive component that may cause the employee to work unsafely. For those managers seeking to enhance safety behaviours must therefore devise interventions to influence intentions and social norms (Goh et al., 2018).

A substantial amount study suggests that social groups (managers, foremen and co-workers) have an important effect on safety behaviour among construction workers. Co-workers have a two-way influence on employees. On the one hand, co-workers can alert their colleagues not to engage in unsafe behaviour so that employees will behave safely. On the other hand, co-workers' violations of safety regulations or requirements, could be emulated by their peer group, having a significantly negative effect on personal safety behaviour (Liang et al., 2018). Zhang and Fang (2013) discovered a consistent and significant relationship between gang leaders and fellow employees encouraging other construction workers to participate in the risky practise by not wearing or using safety gear.

Managers and foremen frequently manage and control employees' safety behaviours through a variety of social organizational factors (Goh et al., 2018; Wang et al., 2016). Previous study has emphasized the importance of organizational social factors like worker communication, safety training and behaviour feedback (Pandit et al., 2019; Xu et al., 2019). Workers' salaries are closely correlated with the manager's assessment of their job performances, therefore they must choose their behaviour based on the safety attitude of their managers (Lombardi et al., 2009). Furthermore, managers' verbal care and feedback on safety have a significant effect on employees' safety behaviour (Grill & Nielsen, 2019).

The foreman is the leader of the construction worker on site who examines the worker every single day. He/she in charge of construction progress and team safety. Empowering foremen's training in safety communication and fall prevention will drastically enhance worker safety performance (Kaskutas et al., 2013). Furthermore, the foreman serves not only as a front-line manager but also as a role model for all the employees. When the foreman's role as a demonstrator is removed, the percentage of unsafe behaviour among workers is 6.13 percent greater than in the base model (Ye et al., 2020). It further means that disregarding the foremen's demonstration role undervalues their contribution to safety management in construction site.

The demonstration role indicates that workers frequently look up to the courageous workers and foreman as influencers. Workers will pay attention and replicate the foremen and co-workers' behaviours in order to build their own subjective norm. For example, Lombardi et al. (2009) noticed that some workers performed their tasks unsafely simply to demonstrate that they were "tough guys" on the construction site. The "tough guy" serves as a role model for other workers. Foremen served as safety role models for their fellow: if foremen fail to address a safety issue, other workers are more likely to follow suit.

Social identity can be explained as "a component of a people's self-concept derived from his/her awareness of his affiliation in a social group, as well as its value and psychological significance" (Choi & Lee, 2017). According to Ye et al. (2020), if construction crews have a strong social identity with their managers and foremen, manager's or foremen's behaviour feedback and demonstration roles can help them form a subjective norm in a better way.

2.5.4 Perceived Behavioural Control Towards Safety Compliance

The last predictor of behaviour is perceived behavioural control (PBC), which assesses how easy or difficult it is to conduct a certain behaviour. PBC is founded on a person's perception of control over internal and external factors that prevent them from achieving their goals. PBC is based on a person's self-evaluation of his or her capability to carry out the behaviour (Ajzen, 1991). Actual behavioural control demonstrates how well a person has the necessary abilities and resources to carry out the behaviour. PBC becomes a proxy predictor for behaviour when it closely resembles genuine behaviour control (Wong & Lee, 2016). Workers may feel helpless to follow safety standards owing to extrinsic circumstances such as a lack of time, money, equipment, or production pressure (Fogarty, 2004).

Perceived behavioural control (PBC) refers to one's belief and confidence in one's capacity to execute an action. It is consistent with the concept of self-efficacy. It refers to the perceived ease or difficulty in performing a behaviour. PBC relates with beliefs according to previous behaviour, prior experience, secondary information, and the opportunities and resources availability, in addition to four self-efficacy theory sources such as performance accomplishments, verbal persuasion, emotional arousal and vicarious experience. Fewer resources and a lack of opportunity will reduce the perceived control over behaviour. PBC can be illustrated with the following. As an example, a site personnel might feel a lack of availability, time and control in complying with the safety requirement, and the site personnel thinks that being in control with availability and time is very important in compliance with the project. The greater the perceived control over the action, the more serious the intention which the particular site personnel would act on it (Lee et al., 2018a, 2018b).

The framework for perceived behavioural control is provided by control beliefs. They are based on people's assessments of whether a behaviour will be difficult or easy to adopt, as well as their perceived power over the behaviour's resources, talents, and opportunities (Ajzen, 1991).

Wong and Lee (2016) concluded that Safety interventions that are aimed at encouraging PBC and subjective norms will be more effective when they are simulating the intention predictors in a multi-ethnic workforce's workplace safety compliance. Curcuruto et al. (2016) also discovered that self-efficacy and perceived behavioural control were motivational drivers of proactive safety behaviour. Workers are motivated to change their behaviours to adhere to a cultural norm if all of them believe those changes can result in desired results (Vredenburgh, 2002).

2.6 Safety Predictors Affecting Safety Participation

2.6.1 Types of Leadership Styles

Andriessen (1978) stated that leadership and the leader's safety standards have a strong influence on workers' safety behaviour and safety motivation. The leader's role in promoting workplace safety is referred to as "Leadership/influence tactics" (Hedlund et al., 2010). Undoubtedly, leaders can enhance employee safety participation and performance, as well as create a safe environment, by adopting empowering attitudes (Martínez-Córcoles et al., 2012). Leadership is a nebulous concept that is hard to define precisely. Northouse (2021) explained leadership as "a progress by which one person influences a team of people to accomplish a shared objective". Martínez-Córcoles et al. (2011) examine various definitions of leadership and conclude that "a consistent element is existent among all of them, which is that the leader does through others as well as encourages everyone else to participate in tasks which they would never do if this influence did not actually exist".

One of the sociocultural variables affecting safety performance in any workplace is leadership (Christian et al., 2009), it has been applied to discuss work behaviour in construction industry (Jitwasinkul et al., 2016). Burns (2012) distinguishes two leadership styles through which leaders can impact the behaviours of their followers namely: transactional leadership and transformational leadership. A third leadership style, laissez-faire was added according to the Multifactor Leadership Theory (Bass & Avolio, 2004) which also refers to passive leadership or lack of leadership (McFadden et al., 2009).

According to Bass (1999), the exchange relationship among a leader with his or her co-workers in which both parties pursue their own self-interest is referred to as transactional leadership. This leadership style focuses on contract compliance by defining the goals and monitoring and controlling the results (Bass & Avolio, 2004). It can lead to the formation of contingent reward, in which the leader instructs the co-workers on how they can be honoured for their initiatives. In other words, the leader sets the objectives and determines the honours and punishments that should be given to followers if the goals are met (Bass, 1985). Thus, transactional leadership helps organizations in more effectively reaching their current objectives by tying job performance to valuable incentives and guaranteeing that resources they required are in place to accomplish their assignments (Zhu et al., 2005).

Rather than merely obtaining compliance, transformational leadership on the other hand, motivates followers to improve performance by adjusting their beliefs, attitudes and values (Bass, 1985). Transformational leadership can be explained as "The leader uplifting their subordinates to implement the organization's vision as their own and devote their efforts to achieving common group goals" (Moriano et al., 2014). Indeed, there has been persistent evidence of a beneficial association between transformative leadership with both safety compliance and safety participation among employees (Clarke, 2013). According to the data, transformational leadership is more associated with safety participation than with safety compliance. Employees are motivated to involve in extra-role behaviours in a company as transformational leaders urge them to go beyond accomplishing their desired objectives and achieve common goals (Choi & Lee, 2022). Transformational leadership consists of an integrated set of behaviours including inspirational motivation, intellectual stimulation, individualized consideration and idealized influence (Barling et al., 2002).

First and foremost, transformational leaders act as examples for their employees. These leaders want to improve employees' safety awareness and instil in them the conviction that safety is a mutual collaborative effort by highlighting the importance of safety and showing idealised behaviours. As a result, employees are more inclined to take part in safety participation. Second, inspirational motivation is provided by transformative leaders. Employees who are energised by their leaders are more willing to put the group's interests ahead of their own. Third, the intellectual stimulation provided by the leaders motivates employees to express their concerns, come up with new and improved insights, as well as try novel ways to resolving difficulties related to safety. Eventually, individualised consideration encourages leaders to behave as influencers, paying extra awareness to the safety, growth, and well-being of their employees. As a result, employees are more inclined to take part in safety participation as a kind of reciprocation (Jiang & Probst, 2016).

Despite the benefits of transformative leadership, an individual leader may switch between passive and transformational leadership styles or demonstrate both styles of leadership to independent workers (Mullen et al., 2011). Passive leadership is widely regarded as a less successful kind of leadership behaviour styles (Cole & Bedeian, 2007) and it is frequently alluded to as "absence of leadership" (Hartog et al., 1997), albeit this is a misleading term since it refers to a responsive leadership style instead of a proactive one.

Management-by-exception leadership (Howell & Avolio, 1993) and laissez-faire leadership (Avolio, 1999; Hater & Bass, 1988) are both examples of passive leadership. According to (Jiang & Probst, 2016), management-by-exception leaders are completely ignorant of safety-related concerns until they are acknowledged by someone else, while leaders with laissez-faire styles avoid making decisions as well as taking responsibility, omit to define quality requirements and respond to complaints and are missing when employees need them. In contrast to transformational leadership (Clarke, 2013).

But then again, safety researchers have generally overlooked the potential consequences of passive leadership on safety behaviours. According to preliminary research, Zohar (2003) noticed that passive leadership was associated with a priority for production efficiency over safety, which was associated with a rise in occupational injuries. Kelloway et al. (2006) found that passive and transformational leadership styles were two distinct constructs, with passive leadership having a negative, individual and cumulative influence on safety participation, safety climate, safety consciousness, safety-related incidents, and incidents though after influencing from transformational leadership.

Passive leadership was found to be negatively associated to the strength of the safety climate according to Luria (2008), whereas group cohesion reduced the link among both passive leadership and strength of climate. Mullen et al. (2011) observed that passive leadership lessened the favourable effects of transformational leadership on safety participation and safety compliance. Jiang and Probst (2016) discovered that passive leadership weakened the favourable connection among safety participation and safety knowledge, implying that passive leaders could “dampen” workers’ motivation to use their safety knowledge to enhance workplace safety proactively.

As opposed to that, transformational leadership empowered motivated workers to participate in voluntary safety behaviours. It was found that in the nonattendance of a transformational leader, employees with strong of safety motivation did not take part in proactive safety participation behaviours. These findings demonstrate the relevance of an individual’s leadership in encouraging workers to behave on their safety motivation, safety knowledge and participation (Jiang & Probst, 2016).

2.6.2 Safety Knowledge

Safety knowledge encompasses to the aptness and skills to understand, master, and apply associated guidelines or restrictions (Ajzen, 1991). An inexperienced worker may be unable to detect and recognise a surrounding hazard with a lack of safety knowledge (Jiang et al., 2015). When performing on-site operations, construction workers must anticipate and analyse hazardous situations. This procedure necessitates sufficient safety knowledge and attitudes. They cannot completely understand the risks if their safety knowledge is insufficient. As a result, it is critical to enhance safety knowledge among construction workers regarding corresponding dangers as well as how to prevent them (Ye et al., 2020).

Construction sites are organized in a hierarchical manner, with site managers, foremen, and construction crews. The construction sector is defined by traditional masculine ideas of liberty, resourcefulness, independence and toughness, as well as a risk culture that is often informal and oral, wherein the safety knowledge is implicitly comprehended but not openly declared (Wadick, 2010). Construction workers’ professional training typically consists of on-the-job training. Work practices are often passed down through foremen and more experienced colleagues, who are also self-taught, because much of the training is based on hands-on experiences (Kines et al., 2010).

Employee safety knowledge is explained as an comprehension of safety operating procedures as well as appropriate safety education and training (Hofmann et al., 1995).

Previous research has identified a lack of occupational safety training as being among the primary reasons of poor occupational safety in the construction industry (Guo et al., 2012; Pinto et al., 2011). Previous review articles have also emphasized the significance of safety training in improving workers' safety competencies, safety perceptions, safety climate and safety behaviour in construction project sites. (Ricci et al., 2016; Robson et al., 2012). The improvement in safety knowledge following mandatory safety training in the construction sector of Hong Kong was noticeable and linked to the trainees' background in education (Chan et al., 2017). Besides, Albert and Hallowel (2013) found that construction workers' compliance with necessities for health and safety is improved by health and safety training programmes, and trainees responded more constructively when adult learning theories are integrated into these programmes.

Safety training is referred to the frequency, efficiency and thoroughness with which workers are trained to avoid safety accidents (Jiang et al., 2015). Safety training can enhance safety knowledge and awareness among workers. They can understand the actual site information better and strengthen their safety awareness by participating in manager safety training. Furthermore, training has been proven to be a valuable resource of information (Chmutina & Rose, 2018). Managers go through safety manuals and safety requirements with workers during safety meetings so that they have better understanding on which behaviours are unsafe and hence enhanced their safety participation (Ye et al., 2020).

Training improves safety performance in a variety of ways, according to research. For instance, Lingard and Yesilyurt (2003) discovered that first aid training in construction increased workers' awareness that their own behaviour was a crucial factor in avoiding occupational incident and popped up to lessen their acceptance readiness on current safety risk levels on site. Besides, work-based training that gives people real life experience with procedures in the worksite and hazardous conditions could be a specially effective way to enhance construction industry safety attitudes (Shin et al., 2014). As example, Hung et al. (2011) discovered that interventions like instituting informal training to support formal training, could lead to obvious distinctions in workers' risk perceptions and safety attitudes.

Despite widespread acknowledgment which safety training is a significant element in avoiding construction accidents, it can be indicated that safety knowledge has a significant impact in employees' safety behaviour (van der Molen et al., 2018). Namian et al. (2016), who discovered that knowledge gained through a variety of training programmes is frequently not used in the worksite, emphasized the significance of utilizing innovative educational technology to increase participation in safety training.

However, according to Jiang and Probst (2016), an elevated level of safety knowledge does not guarantee that workers will engage in discretionary safety behaviours; rather, the connection among safety participation and safety knowledge may be affected if the supervisor employs a passive leadership style.

2.6.3 Safety Climate

Safety climate is the shared perception of organizational safety beliefs, procedures and values (Zohar, 1980). The safety climate has a significant impact on safety performance (Yuting Chen, 2017) because it is an antecedent variable of safety behaviour (Fang et al., 2006) which can represent the actual condition of the fundamental safety culture and point out potential aspects for overall safety enhancement. Research on workplace safety has frequently concentrating on the safety climate as a determinant of safety performance, i.e., safety compliance and safety participation since the 1990s, defining safety climate as employees' shared perspectives on safety procedures, practices and policies. It could be studied at two different levels of hierarchy: organizational level and group level (Brondino et al., 2012). Safety climate frequently refers to the supervisor's role at the group level (Meliá & Sesé, 2007).

According to Zohar and Luria (2005), the basic definition of safety climate is sociologically constructed indicators of preferred role behaviour as a result of top management's procedural decisions and policy, as well as supervisory practices. Thus, safety climate relates to employee perceptions of top management's procedures and policies at the organizational level, whereas at the group level, safety climate relates to employee perceptions of how supervisors put these procedures and policies on a regular basis. Furthermore, the impact of organizational safety climate on work group safety behaviours is mediated by the group (supervisor) safety climate.

Some research has shown that the in the construction context, the safety climate can impact both safety compliance and safety participation behaviour (He et al., 2020; Shin et al., 2015). The impact channels among safety climate and safety behaviour are controversial. Plenty of researchers believe that the safety climate directly influences safety behaviour (He et al., 2020; Seo et al., 2015). Others hold that safety climate influences safety behaviour via variable mediators like stress (Leung et al., 2016), or moderating factors like site layout and work-group identity (Choi & Lee, 2017; Fang & Wu, 2013). In the centre, there are beliefs that both direct and indirect impact channels exist between safety climate and safety behaviour (Neal et al., 2000).

The safety climate is a critical environmental component in high-risk settings, and it has been extensively affirmed to influence safety behaviour (Zohar & Polachek, 2014). Three safety climate components were proposed by Brondino et al. (2012) which are top management's safety climate, supervisor's safety climate, and co-workers' safety climate, which reflect the accurate preference placed on safety by top management, supervisors, and co-workers, separately.

The safety climate concept is significant because it anticipates the safety performance of the organization (Andersen et al., 2018). Contractors, specialist contractors, and construction industry owners can gain advantages from the safety climate through finding out about attitudes and views that might assist them regularly accomplish greater safety performance (Choudhry et al., 2009). Plenty of studies have investigated the influence of safety climate on safety behaviour and have concluded that safety climate can influence safety behaviour, lowering the number of unsafe occurrences, concussions and fatalities in order to enhance safety performance (Choudhry & Fang, 2008).

A seven-month observational investigation in the Swedish construction industry discovered that self-reported safety behaviour was expected by the safety climate (Pousette et al., 2008). Next, multiple regression analysis revealed that "improper safety procedures and work operations" and "employee participation and management commitment" were major antecedents for perceptions of employees' safety performance. The results revealed an inverse connection among perceived safety performance and "improper safety procedures and work operations" (Choudhry et al., 2009) suggest that safety climate can be applied as an efficacious instrument for assessing and improving construction site safety. Finally, it was discovered that Improving the safety climate over three months with a management-based interference reduced the risk of fatal incidents and increased safety participation (Kines et al., 2010).

Construction crews are more likely to losing connection with upper management due to their short tenure on project sites, intricate subcontracting, and the construction industry's project timeliness (Schwatka & Rosecrance, 2016). Management's influence may be only indirect, and research has revealed that the connection among organizational safety climate and colleagues' safety performance is mediated by safety climate. (Brondino et al., 2012). Many construction crews work in teams and have frequent interactions with their supervisors and colleagues in reality. According to research, the safety climate of both supervisors and colleagues has a significant impact on construction workers' safety behaviour (Liang et al., 2018). Group safety climate might be a more accurate indicator of safety performance on the construction site than organizational safety climate, because many employees have almost no contact with upper management and are more inclined to be influenced by conversations with members of their direct work team on a daily basis (Andersen et al., 2018).

Despite the fact that safety climate is linked to safety behaviour and safety performance, its benefits cannot always outweigh the challenges of creating a more secure environment, which requires all individuals in the organization's efforts and should always be associated by structural changes in the organization (Kheni et al., 2010). As a result, organizations have largely ignored the creation of a safety climate because of practical considerations including project timeline implications and cost (He et al., 2016).

Previous studies have revealed that individual components, as well as internal organizational characteristics, influence the construction industry's safety climate (Mohamed & Chinda, 2011), for example, leadership pattern (Clarke, 2013), group orientation and cohesion (Burt et al., 2008) and supervisors' safety response (He et al., 2020; Xia et al., 2018). According to additional research, there is a mutual connection among the organizational safety climate of construction project participants (Fang & Wu, 2013) and external organizations' approaches. External organizations, for example the government, can encourage significant improvements in safety climate. A positive safety climate is driven by two equally powerful forces: the government and the market (He et al., 2016).

The quantitative research done by He et al. (2016) described the safety climate's structure and the external pressures sources to demonstrate that the safety climate consists of three elements: employee involvement and commitment to safety; appropriateness of workplace safety operations and practises; as well as the sense of obligation for one's safety and health. Employee involvement and commitment to safety indicate individual and organizational safety awareness. Positive initiatives to improve construction safety, for example, indicate a positive attitude toward safety. The sense of obligation for one's safety and health assess how well individuals and organizations understand their safety responsibilities.

The involvement of multiple stakeholders in construction projects raises the difficulty of decision-making procedures since the safety climates in these organizations stakeholders are replicated (Fang & Wu, 2013). To gain institutional legitimacy, project participants may, for example, follow government regulations, consult with similar organisations, as well as heed the advice of consulting groups or other specialists (He et al., 2016).

2.6.4 Safety Motivation

Previous research has shown that simply enacting safety regulations or legislation is insufficient to shift behaviour and attitudes to the preferred orientation (Lehtola et al., 2008). Employees might lack of motivation to demonstrate the behaviours which related to safety that they have picked up (Ford & Tetrick, 2008). People motivation is described as "the variety of psychological progress that result in the preparation, orientation, concentration and consistency of behaviour" (Klein, 1989). Theories of motivation concentrate according to how people's values, goals and beliefs influence their accomplishment behaviours (Eccles & Wigfield, 2002). In the field of safety studies, motivation has been also identified as a critical research topic.

Understanding what motivates workers in the operational line to work safely (i.e., safety motivation) is critical for addressing unsafe behaviour and increasing their safety participation (Griffin & Curcuruto, 2016). Motivation theories explain why people make decisions to participate in various safety-related practises, as well as how their safety behaviour influenced by their beliefs (Nykänen et al., 2019). Safety motivation, according to Neal and Griffin (2006), is described as "a person's desire to put forth efforts to participate in safety behaviours and the valence affiliated with all those behaviours". Prior research has found that safety motivation affects whether employees are following safety rules as well as engaging in operations regarding safety (Neal & Griffin, 2006).

According to Neal et al. (2000), the connection among safety climate and safety behaviours, i.e., safety participation and safety compliance, is underpinned by safety motivation, which are later confirmed by numerous studies (Barbaranelli et al., 2015; Peker et al., 2022). Christian et al. (2009) discovered that safety motivation does have a positive relationship with safety behaviours but a negative relationship with accidents in a meta-analysis. Therefore, there is a causal relationship between safety motivation and behaviour; thus, the higher the level of employees' safety motivation, the more inclined they are to perform safety behaviours (Chen & Chen, 2014).

According to this broad definition, motivation, defined as the desire to act which could be extrinsic or intrinsic (Locke & Latham, 2004). Extrinsic motivation is described as "a structure that applies when an activity is performed with the goal of achieving some distinct outcome" as it differs from intrinsic motivation, which is described as "conducting an action for its intrinsic gratifications instead of for some distinct outcome" (Ryan & Deci, 2000). In general, intrinsic safety motivation encompasses an employee's understanding of the value of assets, participation, initiative and consultation in enterprises, as well as improvements in safety (Hedlund et al., 2010). Extrinsic motivation can influence intrinsic motivation, for example, when workers receive both positive and constructive comments from management, resulting in intrinsic motivation. As a leader, they can encourage and recognise workers' performance through instilling a sense of achievement and adhering to the organization, which can also result in intrinsic motivation as well (Hedlund et al., 2016).

Leadership and the leader's safety standards have a strong influence on safety motivation according to studies (Andriessen, 1978). Jiang and Probst (2016) later confirmed this, their findings suggest that individual safety motivation itself might not be enough to motivate people to engage in voluntary safety behaviours; rather, one's direct supervisor should be transformational as well. Leadership has an impact on safety motivation indirectly and directly by influencing the safety climate (Hedlund et al., 2010). A requirement, however, is that leaders recognise the need for change (Rydell et al., 2014). As a result, workers and leader safety motivation is critical for creating a safe working atmosphere (Helander, 1991).

2.6.5 Risk Perception

Risk is defined as "unpredictability about the nature and extent of the repercussions (or consequences) of a human-valued activity" while risk perception is defined as individual people's subjective assessment of the particular risk (Aven & Renn, 2009). Due to risk perception is subjective and is influenced by a set of values, concerns, or knowledge (ISO, 2009), when employees perceive risk, they are more likely to use different risk assessment methods. One possibility encompasses people's deliberative, analytical, rational and verbal perceptions of reality (Epstein, 1994).

Risk perception is the ability of individuals, groups, or organizations to determine the degree of risk based on their attitudes, beliefs, feelings and judgments in the face of natural, technological, or social risks and hazards (Inouye, 2014; Slovic, 2000). There are three categories of risk perception factors in the literature: Individual, peer-to-peer, and institutional psychological factors (Inouye, 2014). Some scholars have named these factors as safety risk perception factors in the construction industry, and they have been categorized from three main perspectives, which are: (i) personal safety attitudes (PSA); (ii) management's safety attitudes (MSA); and (iii) co-workers' safety attitudes (CWSA) (Choudhry & Fang, 2008; Hallowell, 2010; Hung et al., 2011). The above factors have been heavily publicised in order to empirically impact the risk-taking behaviours of construction workers.

Risk is more likely to be perceived rationally through clearly intentional measurements of risk criticality by employees. This type of risk perception is frequently expressed as (i) the likelihood of risk happening, (ii) the intensity of risk influence, and (iii) the estimated effectiveness of risk, which is the product of the risk's probabilities and severity (Lehtiranta, 2014; Micic, 2016). This is known as "rational risk perception" which means that employees will perceive risk using the three rational risk compositions. These judgments or perceptions serve as the foundation for daily decision making progress (Epstein, 1994) which also able to impact safety behaviour while making decision.

Nevertheless, rational risk perception could be challenging. Sociologists and psychologists have illustrated that only experts in a specific sector can have such a rational approach to risk whereas risk is perceived by laypeople primarily through emotions, and through direct and intuitive judgement (Rundmo, 2002). This type of risk perception could be irrational and affected by a variety of factors, including risk characteristics (Slovic et al., 1981), cultural and socioeconomic background (Vaughan, 1995) and personal variables (Gyekye, 2006). Despite its complexities, emotional risk perception can be measured by eliciting a person's direct risk perceptions, or his/her immediate and instinctive reaction to a particular risk (Lu & Yan, 2013). Slovic et al. (2013) have also argued that decision makers' emotional and intuitive risk judgments have a significant impact on actual actions in risky situations. To conclude, workers who are not risk management experts have a direct and emotional risk perception, and this immediate risk perception influences their safety behaviour and course of action (Xia et al., 2017).

Internal and external factors can motivate unsafe behaviour, with risk perception being an important internal one (Wang et al., 2016). Safety risk perception is one of the predictors that has been identified as influencing construction workers' risk-taking behaviours (Chan et al., 2017). Employees as the organization's front-line personnel, are exposed directly to occupational hazards, incidents, and fatalities. Only when they believe their job is dangerous, they will more inclined to act safely in order to protect the safety of themselves and others (Didla et al., 2010). They will significantly raise their chances of worksite incidents and fatalities if they do not behave safely (Christian et al., 2009). Some research had identified a connection among safety behaviour and risk perception (Kouabenan et al., 2015; Xia et al., 2017; Xia et al., 2020).

Studies have shown that risk perception influences various types of safety behaviour, including the use of devices for hearing protection (Arezes & Miguel, 2008) as well as participation in safety management (Kouabenan et al., 2015). Understanding risk perception is critical seeing as initiatives in risky or unsafe behaviour rely largely on a clear insights into how people believe regarding risk (Weber et al., 2002).

As Targoutzidis and Antonopoulou (2009) contend, due to human acts, materials, and procedures interact frequently in the workplace, different perspectives from social sciences and engineering can be useful in studying employees' perceptions, attitudes and behaviours. Considering this, neither emotional risk perception obtained from social sciences and rational risk perception obtained from engineering can be useful in understanding what employees consider regarding risk and react in risky situations. By combining the two perspectives on risk perception, Xia et al. (2017) identify four types of risk perception: (i) perceived severity, (ii) perceived probability, (iii) direct risk perception and (iv) perceived negative utility.

2.6.6 Communication Climate

Communication climate is another predictor included in the research model. Efficient internal communication is widely acknowledged as being critical to the success of any institution. A subset of the psychological climate is the communication climate, which is described as a person's interpretation and perception of workplace communication in terms of psychological meaning and significance (Smidts et al., 2017). Supportiveness, open mindedness and candour, confidence and credibility, participatory decision making, and trust are all characteristics of a satisfactory communication climate (Bartels et al., 2007).

Safety communication is referred to the degree, frequency, and efficiency with which workers and management exchange information about safety issues (Probst, 2004). Griffin and Neal (2000) stated that safety communication has a significant influence on safety knowledge. Workers will understand the significance of safety whereas which behaviours are unsafe if they talk to foremen, managers and co-workers regarding safety issues. This can improve their understanding of safety knowledge. Furthermore, seeing as repetition of safety remembrances and advisories, as well as encouragement, are critical to improving employees' safety awareness, which leads to greater safety participation performance, face-to-face communication can significantly enhance employees' safety awareness (Fang et al., 2015).

He et al. (2019) stated that construction workers' communication skills are an important tool for improving safety performance (safety participation and safety compliance) which is frequently overlooked in previous studies. In Malaysia, the construction sector is largely reliant on Nepalese, Indonesians, Bangladeshis, and Filipinos to complete projects on the ground. These foreign construction workers, among other things, two-way communication is required for the construction firm to apply appropriate safety practices to improve performance of safety (Mohammad & Hadikusumo, 2019).

Employees' interactions with upper management have an important influence on their selection of behaviour in any institution. Work conditions (e.g., tasks or environment) and interactions with management will influence worker safety behaviours (Fang et al., 2015). Since safety participation entails voluntary actions that go beyond the requirements for in-role safety (i.e., safety compliance), communication with leaders of organizations is crucial in motivating workers to engage in safety participation (Choi & Lee, 2022). According to the findings of a randomised intervention site research published by Zohar and Polachek (2014), worker reports of perceived safety priority rises when leaders communicate the safety responsibilities in regular meetings (a character trait of transformational leadership), as do perceptions of safety climate level and employee safety behaviour.

Behaviour feedback is defined as the management feedback on employees' behaviour with monetary compensation, verbal praise, criticism or punishment (Jiang et al., 2015). Through behaviour feedback, workers can comprehend what foremen and managers are thinking, which would be useful for establishing subjective norms for them. Behaviour feedback can also influence construction workers' safety attitudes and help them understand the foreman's and manager's risk tolerance. If an employee's safety behaviour is rewarded with constructive response, like a monetary reward or appreciation, the employee will believe that it is even more valuable to behave safely, then the safety behaviour will be enhanced. In contrast, if a worker obtains few frequent constructive reactions, he/she may be unsure whether his/her behaviour is accurate, hence may affected his/her safety performance (Zhang & Fang, 2013).

A positive communication climate in management prioritises workers' opinions in an institution. Workers may have more chances to generate and develop information as they discuss organizational issues and make decisions (Neill et al., 2019). Due to extra-role behaviours go beyond the nature of the role, efficient information communication within organizations is critical for empowering workers' safety participation. Workers' self-efficacy and extra-role behaviours improve with effective communication. A positive communication climate provides workers confidence that their extra-role behaviours will make a genuine value to the institution. For instance, if management pays more attention to workers' feedback, they will be more willing to make recommendations to enhance organizational performance (Choi & Lee, 2022).

Furthermore, workers' self-esteem may rise as a result of open communication with management because they believe they are being treated with respect (Smidts et al., 2017). As a result, workers in an effective communication environment are expected to acknowledge themselves as valuable organizational members. A positive communication climate also could motivate workers to commit to their jobs and go above and beyond work requirements in order to achieve organizational visions and objectives (Choi & Lee, 2022).

2.7 Identifying Macro Safety Predictors through Institutional Theory

According to previous research, human behaviour is very complicated and no single model can capture it. Though the basic Theory of Planned Behaviour adequately explains fundamental behavioural patterns, it must be customized for specific purposes in order to achieve greater accuracy and reliability (Jain et al., 2020). A stronger comprehension of human behaviour and the predictors that affect workers' safety behaviour can help the construction industry improve its safety performance.

Making use of institutional theory (DiMaggio & Powell, 1983) that recognizes external pressures in explaining a variety of organisational behaviours and conditions, current research proposed and empirically validate a simple theory to describe how three different kinds of institutional pressures (i.e., coercive, mimetic, and normative pressures) positively affect safety behaviour on construction sites. A better comprehension of the macro safety predictors that impact construction workers' safety compliance and participation will provide organizations and researchers with information on how to create a safer working environment in the industry.

Organizations are open systems that are influenced by their surroundings according to institutional theory. It highlights the necessity of the institutional environment in influencing organisational decisions, behaviours, and evolves in order to gain social legitimacy (DiMaggio

& Powell, 1983). Indeed, numerous prior research have demonstrated that institutional theory could provide impactful interpretations for a variety of organizational behaviours, including acknowledgement of innovation and strategic transform (Bhakoo & Choi, 2013; Cao et al., 2014). Relying on these practical uses of institutional theory, this research contends that the institutional framework provides comprehensive knowledge and insight into the various degrees of safety behaviour among construction workers.

Organizations, according to institutional theory, have a tendency to adhere to widely acceptable norms and behaviours in sequence to be architecturally compatible with their precise institutional setting (DiMaggio & Powell, 1983). Institutional pressures, it is argued, can arise through both informal constrictions (norms, conventions, and beliefs) and formal rules (mandates and regulations), and how organizations react to these pressures determines their institutional legitimacy (Scott, 2013). DiMaggio and Powell (1983) research stated that, three kinds of basic pressures shape organizational behaviours, namely: coercive, mimetic, and normative pressures.

2.7.1 Coercive Pressures

Coercive pressures are described as “informal and formal pressures applied to an organization by other organizations on which they rely” (DiMaggio & Powell, 1983). In emerging economies transitioning from a decentralised to a market-based mechanism, governmental organizations and business associations regularly interfere with normal design and other construction activities (Xu et al., 2005). Coercive pressures are primarily caused by mandatory safety requirements imposed by government organizations and construction sector associations. In other words, the mandatory power of law and order generates coercive pressures. (He et al., 2016).

In Malaysia, many federal departments, including the Minister of Works, Ministry of Housing and Local Government, and the Department of Occupational Safety and Health (DOSH), oversee developing safety requirements as well as monitoring construction safety performance; and organizations, such as the Construction Industry Development Board (CIDB), frequently create more specific project regulatory standards. The CIDB Green Card Program, for instance, is one of the coercive strategies adopted by federal agencies and business associations (CIDB, 2015).

Safety organizations have emerged in the last decade. They are primarily in charge of inspecting construction projects for safety. These organizations advocate for government safety laws and regulations, construction site safety performance monitoring, and corporate communication promotion. They are also typically in charge of inspecting construction plans, determining feasibility before construction begins, and controlling construction site safety during work in progress. Only organizations with authorized building plans could begin work, demonstrating the coercive pressure exerted by safety organizations (Mohammad & Hadikusumo, 2019). These authority operations, either in the form of public regulatory frameworks or construction prerequisites, can have an important effect on organizational participants' level of safety behaviour.

To regulate construction safety and penalize unsafe behaviours, several safety laws and regulations have been enacted. For instance, the Occupational Safety and Health Act 1994 was applied throughout Malaysia to the industries specified in the First Schedule, which includes construction (OSH, 1994). Aside from penalizing unsafe behaviour, the government has initiated measures to prevent potential safety issues. For example, CIDB organizes the current Green Card Program to require safety training courses. Construction workers must enrol in these training programmes and pass written examination before they are qualified to work on construction sites (CIDB, 2015).

2.7.2 Mimetic Pressures

Mimetic pressures, the second element of institutional pressure encourages people to prevent unwarranted dangers and to feel like they belong to an organization. Companies are made up of individuals who interact with one another, mimic one another, and learn from one another. Safety associations, as an efficient instrument for organizational communication, regularly host seminars and competitions in safety to improve corporate communication and competitiveness. Some companies' elevated safety performance level serves as a motivation for others, resulting in mimetic pressure (He et al., 2016).

Mimetic pressures are those pressures that push institutions to mimic the effective behaviour of other hierarchically comparable institutions (DiMaggio & Powell, 1983). Uncertainty is the root cause of mimetic pressures. When the environment is uncertain or the dangerous situation is unclear, institutions are more likely to compare their actions to those of peers and emulate those that seem progressive and legitimate. Since each construction project is unique to some extent owing to variation in project scope, tasks, sophistication, and stakeholders, there is no universal safety strategy for all projects (Newaz et al., 2016).

Furthermore, since construction-related incidents are often unexpected and accidental, there is growing doubt about the efficiency of safety management. Due to the obvious high degree of risk, project stakeholder organisations may be more freely influenced by peer organisations' or peer projects' behaviour with institutional environments and previous related characteristics (He et al., 2016). Organizations are typically encouraged to emulate effective techniques in peer projects or the successful practises of other organisations to effectively manage risk and against the risks posed by early implementers, as well as to eliminate slowing down behind their peers and hence losing credibility. Other project stakeholders benefit from the credibility gained through mimicry in maintaining their competitiveness in upcoming projects. These mimicking behaviours will eventually result in a safer environment in their very own organizations and projects.

2.7.3 Normative Pressures

The third and lightest institutional pressure is normative pressure. This category of pressure is primarily brought on by safety recommendations that emphasize the safety importance. As an example, research institutions or consulting firms at the leading edge of safety studies may advocate for cutting-edge technology and innovative safety methods. In turn, this advocacy can put organizations under pressure to upgrade their innovation and stay on top of cutting-edge safety developments (He et al., 2016).

According to DiMaggio and Powell (1983), professionalization is the most important source of normative pressures. Professional bodies in the field of safety develop shared norms and collective expectations of what constitutes desirable behaviour over time. Through exchange of information procedures, like proper education, association membership, professional consultation and conference communication, these guidelines and preconceptions could be disseminated and reinforced within professional fields. Organizations engrained among these professional areas can progressively enhance their knowledge of widely accepted professional values and beliefs, and afterwards modify their behaviours in accordance with their specific organizational characteristics (He et al., 2016).

Normative pressures generally have a much weaker impact on organizational attitudes and behaviours compared to coercive pressures. When it comes to the construction industry's safety performance, normative pressures can originate from a number of sources. Construction industry trade associations, as quasi-government organizations, not only possess the ability to exacerbate coercive pressures on organizational attitudes and behaviours. Moreover, by providing safety training classes, organizing seminars and advocating the significance of safety publicly, they can also serve as significant norm-diffusion forms of media (He et al., 2016). Correspondingly, through specialized training, professional certification and conference communication, normative pressures could be imposed on practitioners by industrial professionals and universities. Construction workers can improve their comprehension of the methods and values required to create a safer environment through interactions with safety professionals, whether directly or indirectly.

2.8 Proposed Conceptualized Safety Behaviour Model

Figure 2.2 below shows a conceptual safety behaviour model. This is the estimated result of this study according to the papers reviewed. It shows how the macro and micro predictors of safety behaviour in construction project sites can be linked together or mapped to each other. The 3 macro predictors are Coercive Pressure, Mimetic Pressure and Normative Pressure while the 9 micro predictors are Attitudes, Subjective Norms, Perceived Behavioural Control, Types of Leadership Styles, Safety Knowledge, Safety Climate, Safety Motivation, Risk Perception and Communication Climate. It can help to identify the interrelationships between the micro safety predictors and safety compliance intention in construction project sites. Furthermore, it can also be used to ascertain the interrelationships among the micro safety predictors and safety participation in construction project sites.

It should be noted that the DEMATEL method can be applied to determine the most critical safety predictor. Future research can focus on the problem and determine solutions to improve safety behaviour on construction sites by understanding the most influential elements.

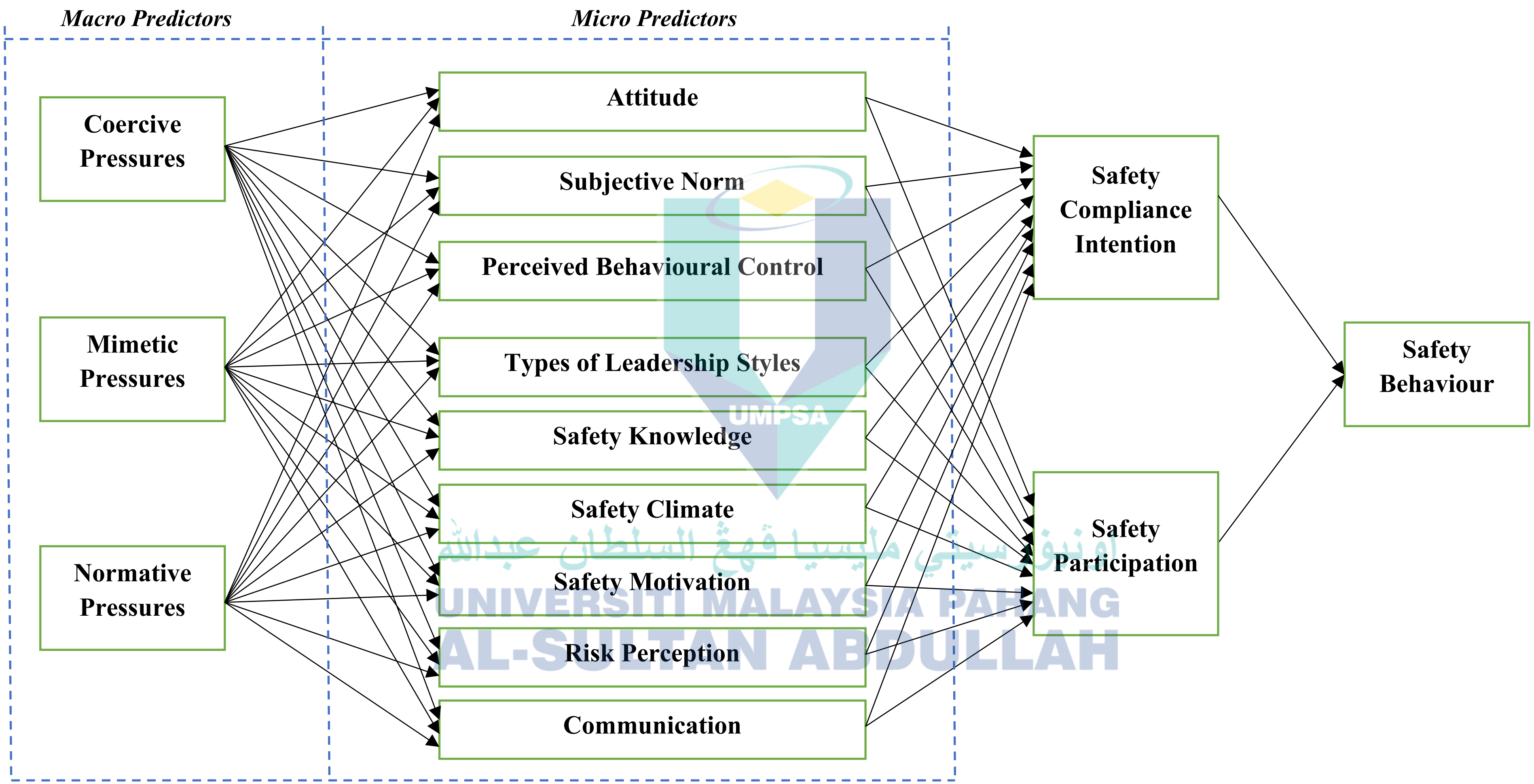

Figure 2.2: Conceptual Safety Behaviour Model

2.9 Summary

This chapter elaborates and justifies past research results and classifies the identified macro and micro safety predictors by integrating a small number of past studies for each safety predictor category. As a result, total of 3 macro predictors and 9 micro predictors will be applied in this study.

Previous studies have extensively explored various aspects of safety compliance and safety participation in the construction industry. Researchers have focused on identifying key safety predictors using different analytical techniques. However, despite these advancements, several gaps remain. Despite the posited framework considering TPB, there is scarce literature on the study of institutional pressures (coercive, mimetic, and normative pressures) and the cognitive domains (subjective norms, attitude, and perceived behavioural control), and there is no evidence to prove the correlation between intention to comply with safety and macro-micro safety predictors in construction project sites.

The need to study on the interrelation and 'rank' these predictors have been realized through literature review. Based on the predictors gathered through the literature and experts' opinion, the study has been advanced through employing DEMATEL as described in Chapter 3. The results will be captured in Chapter 4.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will provide a detailed overview of the methodologies employed in this research, outlining the research framework, systematic reviews, the Decision-Making Trial and Evaluation Laboratory (DEMATEL) technique, and the data collection methods. Each of these components plays a crucial role in ensuring the research is conducted systematically and effectively. The research framework will present the conceptual structure that guides the study, identifying the key variables and their relationships. Systematic reviews will be utilized to synthesize relevant literature, ensuring that the research is grounded in existing knowledge and identifying gaps that this study aims to fill.

3.2 Methodological Framework of Study

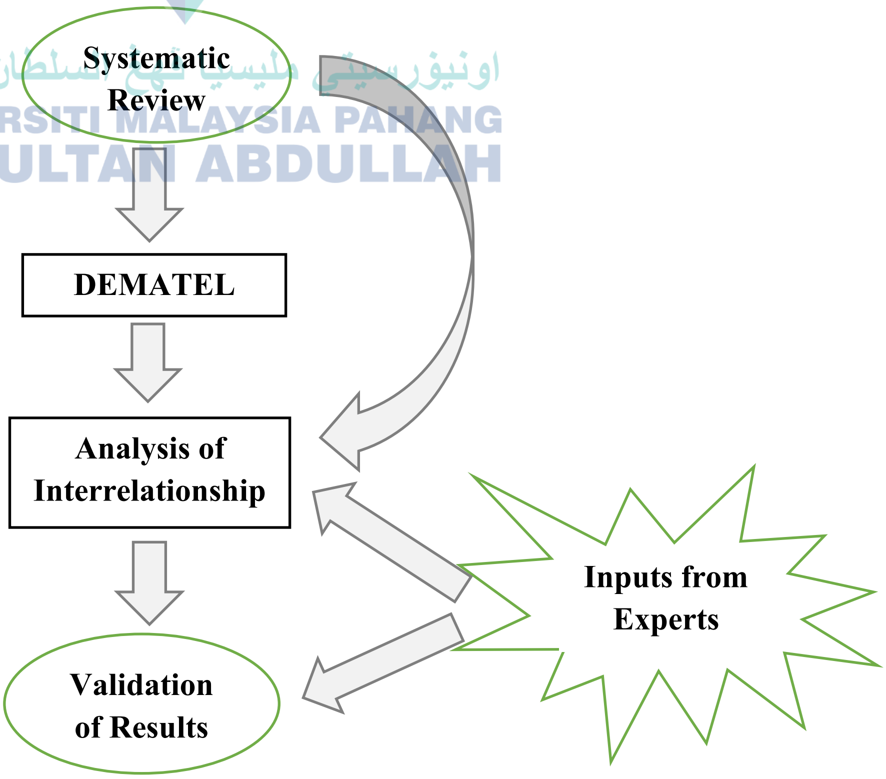

Figure 3.1: Methodological Framework of Study

Figure 3.1 above shows the Methodological Framework of Study. The methodology will be applied in this research began with a literature review to recognise and collect the details regarding the relative macro-micro safety predictors which will affecting safety compliance intention and safety participation in the construction project site. After that, the systematic review method will be used to filter all the journals scientifically. The safety predictors affecting safety compliance intention in construction project site are being filtered out of 609 papers while 219 papers are being filtered for the safety predictors affecting safety participation in the construction project site. Next, a questionnaire will be designed to collect data by conducting interviews with the potential respondents. The questionnaire draft will be revised from time to time to reduce the error probability during the preparation process. The data gathered during the interviews with all of the potential respondents would be evaluated using the DEMATEL method. The DEMATEL method is a widespread integrated method for obtaining structural models that afford casual relationships between intricacy real-world causes. The DEMATEL method is surpass then other techniques for example Analytic Hierarchy Process (AHP), because it illustrates the interdependence between system factors through a causal diagram, which is being ignored in traditional techniques (Lin, 2013). Causality diagrams will be used to map the macro-micro safety predictors of the safety compliance intention and safety participation in the construction project site to determine their interrelationships. Eventually, the research findings will be reviewed and concluded.

3.3 Research Paradigm: Positivist Approach

Positivism, as a philosophy, holds that only “factual” knowledge gained through observation (the senses), including measurement, is reliable. The researcher’s role in positivism studies is limited to data collection and objective interpretation. In other words, the researcher is an objective analyst who separates herself from personal values while carrying out the research. The research findings in these types of studies are usually observable and quantifiable (Dudovskiy, 2022). In business and management disciplines, positivism has been extensively used to study various phenomena such as consumer behaviour, organizational performance, and market trends. Researchers employing this paradigm typically use surveys, experiments, and longitudinal studies to collect data that can be quantified and analysed statistically (Alzhrani, 2022).

Positivism is based on quantifiable observations that result in statistical analyses. For decades, it has been the dominant form of research in business and management disciplines. It has been stated that “positivism, as a philosophy, is consistent with the empiricist view that knowledge is derived from human experience”. It takes an atomistic, ontological view of the world, seeing it as a collection of discrete, observable elements and events that interact in observable, determined, and regular ways (Collins, 2018). According to the researchers, “If you take a positivist approach to your study, you will believe that you are independent of your research and that your research can be purely objective”. When conducting research, being independent means interacting with your research participants as little as possible. In other words, positivist studies are based solely on facts and regard the world as external and objective (Wilson, 2010).

Positivist research emphasizes the importance of objectivity, where the researcher maintains a detached and neutral stance throughout the research process. This ensures that the findings are not influenced by personal biases or subjective interpretations (Alzhrani, 2022). Central to positivism is the use of quantitative methods, which involve the collection and analysis of numerical data. This allows for statistical analysis and the derivation of generalizable conclusions. Positivism relies on empirical evidence gathered through observation and experimentation. It posits that only through sensory experience can we obtain reliable knowledge about the world (Dudovskiy, 2022).

To conclude, positivism remains a powerful and widely used research paradigm in various fields, including business and management. Its emphasis on objectivity, empirical evidence, and statistical analysis provides a robust framework for understanding and predicting phenomena. However, researchers must be mindful of its limitations and consider complementary approaches to capture the full complexity of the subjects under study (Collins, 2018). By balancing the strengths of positivism with other paradigms, researchers can achieve a more comprehensive and nuanced understanding of the world.

3.4 Research Propositions

This research paper does not involve with any research hypothesis as the dependent and independent variables are not available in this research. The research results will be mapped or linked to each other and a chart based on DEMATEL will be obtained. The results will be divided into two main sections. The first section will explain the relationships among micro safety predictors, safety compliance intention and safety participation in construction project sites, while the second section will explain the relationship between macro and micro safety predictors in construction project sites. The results will help to determine the most critical elements (safety predictors) that affecting the safety behaviour (safety compliance and safety participation) within construction workers in the project site.

3.5 Systematic Review

Systematic review provides a thorough and unbiased summary of all available evidence on a particular topic or research question. This comprehensive overview helps researchers and practitioners understand the breadth and depth of the current knowledge in a specific area. By systematically reviewing existing literature, researchers can identify gaps in the current research. These gaps can guide future research directions and ensure that new studies address unanswered questions or unresolved issues. Besides, systematic review can reveal consistencies or inconsistencies across various studies. Understanding these patterns can help explain the reasons behind different study outcomes and lead to more nuanced conclusions. Systematic reviews follow a predefined and transparent methodology to search for, select, and analyse studies. This process minimizes the risk of bias and ensures that the review's findings are reliable and valid. By analysing the strengths and weaknesses of existing studies, systematic reviews can inform better design and methodology for future research, enhancing the quality and robustness of new studies.

A systematic review and analysis of academic journal publications is required to comprehensively review and analyse the findings of previous research on a specific topic or area of research. The "Scopus" database is primarily used to review the entire system. "Scopus" is the world's largest abstract and citation database, with over 16,000 peer-reviewed journals from over 5,000 publishers, 1,200 open-access journals, 600 business publications, 350 book series, and 350 reference proceedings. "Scopus" is the most comprehensive database of social science, medical, technical and scientific literature.

Initially, a thorough search was carried out in the "Title/Abstract/Keyword" field of the "Scopus" search engine. This research's keywords included "Safety Predictors", "Safety Behaviour", "Construction Project", "Safety Compliance" and "Safety Participation" with the document type of "Article or Review". This is due to the fact that the papers containing these specific terms were evaluated in order to satisfy the criteria for this research and total of 185 papers as a result of the first search. The search was again narrowed down to specific topics which including "Engineering", "Social Science", "Business, Management and Accounting", "Psychology", "Environmental Science", "Decision Sciences", "Energy" and "Economics, Econometrics and Finance". The full search code is as follows:

TITLE-ABS-KEY ("Safety Predictors" OR "Safety Behaviours" OR "Construction Project") AND TITLE-ABS-KEY ("Safety Compliance" OR "Safety Participation")) AND (LIMIT-TO (SUBJAREA , "ENGI") OR LIMIT-TO (SUBJAREA , "SOCI")

OR LIMIT-TO (SUBJAREA , “BUSI”) OR LIMIT-TO (SUBJAREA , “PSYC”) OR LIMIT-TO (SUBJAREA , “ENVI”) OR LIMIT-TO (SUBJAREA , “DECI”) OR LIMIT-TO (SUBJAREA , “ENER”) OR LIMIT-TO (SUBJAREA , “ECON”)) AND (LIMIT-TO (LANGUAGE , “English”) .

The results were narrowed down to 160 papers after they were restricted to a specific subject area. Regardless of the search, these results may contain articles or papers that are unrelated to this research. This is due to the fact that while those papers may have exactly matched the search keywords, they did not really discuss the macro and micro safety predictors influencing safety compliance and safety participation on the construction project site. In any case, it is difficult to completely rule out undesirable outcomes. As a result, the search results were scientifically filtered and reduced to 160 papers, approximately 80 of which were related to the macro and micro safety predictors affecting safety compliance and safety participation in the construction project site. Table 3.1 below are some papers downloaded from “Scopus” after filtering and classification.

Table 3.1 Classification of Papers

Safety Predictors Affecting Safety Compliance Intention		
YEAR	**TITLE**	**METHOD**
2020	Psychological Driving Mechanism of Safety Citizenship Behaviours of Construction Workers: Application of the Theory of Planned Behaviour and Norm Activation Model.	Structural Equation Modelling (SEM)
2020	More to safety compliance than meets the eye: Differentiating deep compliance from surface compliance.	Structural Equation Modelling (SEM)
2022	Analysis of safety climate factors and safety compliance relationships in the oil and gas industry.	Exploratory Factor Analysis (EFA)

Table 3.1 Continued

Safety Predictors Affecting Safety Participation

YEAR	TITLE	METHOD
2020	An adjusted behaviour-based safety program with the observation by front-line workers for mitigating construction accident rate.	Regression Analyses
2022	Impact of mindfulness on construction workers' safety performance: The mediating roles of psychological contract and coping behaviours.	Structural Equation Modelling (SEM)
2022	The psychological mechanism of construction workers' safety participation: The social identity theory perspective.	Exploratory Factor Analysis (EFA)

Safety Predictors Affecting Safety Compliance Intention and Safety Participation

YEAR	TITLE	METHOD
2019	Impact of psychological capital on construction worker safety behaviour: Communication competence as a mediator.	Confirmatory Factor Analyses (CFA)
2019	Causes of fatal construction accidents in Malaysia.	Frequency Analysis and Content Analysis.
2021	Evaluating the critical safety factors causing accidents in high-rise building projects.	Relative Important Index (RII)
2022	Role of Supervisor Behavioural Integrity for Safety in the Relationship Between Top-Management Safety Climate, Safety Motivation, and Safety Performance.	Structural Equation Modelling (SEM)

3.6 Corrected Item-total Correlation Method

The corrected item-total correlation method is applied in the test structure to determine the relationship between the item and the total score of other items (Eva A. O. Zijlmans, 2019). Apart from internal reliability and consistency, it is critical to assess the item-total correlation, which can be defined as the degree to which an item has a linear relationship with its scale total (Gandek B, 1998). The stronger the correlation between each item and the entire questionnaire, the stronger the correlation between all items. The item-total correlation method has a flaw: redundancy. The correlated item is removed from the scale total to calibrate for redundancy (Ware, 1980). That would be relationship among a single item and the total score in the absence of that specific item (Wu, 2014). For instance, if a questionnaire contains 20 items, there will be 20 item-total correlations. It would be the correlation among item 1 and the total amount of the other 19 items for item 1. To put it mathematically, let X_1, X_2, X_3,..., X_{20} represent questionnaire items, and the formula of corrected item-total correlation for item *i* is as follows:

$$\text{corrected item} - \text{total correlation } (X_i) = \text{corr}\left(X_1, \sum_{j=1}^{20} X_j - X_i\right)$$

where "corr" is Pearson product-moment correlation coefficient and $1 \leq i, j \leq 20$.

It should be noted that a corrected item-total correlation test is conducted to determine whether any items in the questionnaire set deviate from the averaged behaviour of the other items. So then, that specific item can be taken down. In other words, this method is a measure of removing "junk" items before identifying the structural factors (Gilbert A. Churchill, 1979). In this study, once an item is chosen to be removed from the test, the decision is final.

3.7 Cronbach's Alpha (α)

Cronbach's alpha was applied to calculate the correlation among the scores of items in an instrument or test (Cortina, 1993). In theory, when there is no correlation between the scores, α is 0; When there is a perfect correlation, α is 1. Since the coefficient's value is determined by the correlation of the item scores, it was thought to be the most comprehensive method of internal consistency evaluation (Jan Kottner, 2010). The formula used is as follows:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum V_i}{V_t}\right)$$

where k is the number of questions,

$\sum V_i$ *is the* Sum of Item Variances, *i*,

V_t is the Variances of Total Scores, *t*

3.8 Data Collection Method

Many methods have been developed over the years to determine the safety predictors affecting safety compliance intention and safety participation among construction workers in project sites. The method will be applied in this research is quantitative approach and the research paradigm is positivist approach.

3.8.1 Quantitative Approach

Quantitative research was applied to answer the questions by producing digital data or data that could be converted into statistically useful information. It is employed to quantify behaviours, attitudes, suggestions and other determined variables, as well as to summarise outcome of bigger sample sizes. Quantitative research employs measurable data to present findings and reveal research trends. When compared to qualitative data collection methods, methods for collecting quantitative data are significantly more structured. Mobile surveys, online surveys, kiosk surveys, paper surveys, telephone interviews, face-to-face interviews, website blockers, longitudinal studies, systematic reviews, and online polls are all illustrations of quantitative data collection methods (DeFranzo, 2011).

To obtain results, quantitative research employs quantitative and analytical variables. It uses statistical methods for answering questions including who, when, where, what, and how by utilising and analysing digital data (Apuke, 2017). Questionnaires are one of the methods used in quantitative methods to collect data from sample sizes that represent populations. Quantitative methods frequently use numbers in data collection, and researchers typically use mathematical models or query methods to analyse the data to ensure consistency with statistical data collection methods (Samad, 2013).

3.8.2 DEMATEL Methods Approach

The structured interview for this research will be divided into three main parts. The first part of the structured interview will be conducted to collect demographic information from the targeted participants, the second section will deal with the micro safety predictors affecting safety compliance intention and safety participation on construction sites, while the third section will deal with macro predictors that affecting those micro safety predictors listed in second section. Based on their experience on construction project sites, all respondents will be required to evaluate the severity level of the safety predictors affecting safety compliance intention and safety participation. The survey tools will be applied in this section are based on indexes of 0 (no impact), 1 (low impact), 2 (moderate impact), 3 (high impact), and 4 (very high impact).

A total of 25 construction industry professionals will be invited to participate in the data collection phase of this study, where they will receive the questionnaire during interviews. This sample size was selected based on prior research that suggests there is no strict minimum participant requirement for the DEMATEL method. Studies employing DEMATEL have commonly involved between 3 and 30 respondents, demonstrating that the method is flexible in terms of sample size. Therefore, the selection of 25 participants is well within the accepted range for ensuring meaningful and reliable results. By gathering insights from a diverse group of professionals, the study aims to capture a comprehensive understanding of the safety predictors influencing safety compliance and participation in high-rise construction projects. Table 3.2 shows the number of respondents who participated in previous studies which using the DEMATEL method.

Table 3.2 Previous Researches of DEMATEL

Author	***Year***	***Title***	***No. of Respondents***
Chia-Li Lin, Gwo-Hshiung Tzeng	2009	A value-created system of science (technology) park by using DEMATEL.	11
Jiunn-I Shieh, Hsin-Hung Wu, Kuan-Kai Huang	2010	A DEMATEL method in identifying key success factors of hospital service quality.	19
Ya-Ti Lin, Yeou-Herng Yang, Jin-Su Kang, Hsiao-Cheng Yua	2011	Using DEMATEL method to explore the core competences and causal effect of the IC design service company: An empirical case study.	7
Detcharat Sumrit, Pongpun Anuntavoranich	2012	Using DEMATEL Method to Analyse the Causal Relations on Technological Innovation Capability Evaluation Factors in Thai Technology-Based Firms.	11
Ru-Jen Lin	2013	Using fuzzy DEMATEL to evaluate the green supply chain management practices.	8

Table 3.2: Continued

Author	*Year*	*Title*	*No. of Respondents*
Ya Li & Yong Hu, Xiao Ge Zhang, Yong Deng,	2014	An Evidential DEMATEL Method to Identify Critical Success Factors in Emergency Management.	3
Xinyi Zhou, Yangqiuyan Shi, Xinyang Deng	2016	D-DEMATEL: A New Method to Identify Critical Success Factors in Emergency Management.	3
Seker, Sukran Zavadskas, Edmundas	2017	Application of Fuzzy DEMATEL Method for Analysing Occupational Risks on Construction Sites.	5
Ashish Trivedi	2018	A Multi-Criteria Decision Approach Based on DEMATEL To Assess Determinants of Shelter Site Selection in Disaster Response.	16
Reza Kiana Mavi, Craig Standing	2018	Critical Success Factors of Sustainable Project Management in Construction: A Fuzzy DEMATEL-ANP Approach.	26
Ali Bavafa Amir, Mahdiyar Abdul, Kadir Marsono	2018	Identifying and Assessing the Critical Factors for Effective Implementation of Safety Programs in Construction Projects.	28
Mohammad Dalvi-Esfahani, Ali Niknafs, Daria J. Kuss	2019	Social media addiction: Applying the DEMATEL approach.	30
Yuan-Wei Du, Wen Zhou	2019	New improved DEMATEL method based on both subjective experience and objective data.	3
Alok Raja, Bhawesh Sah	2019	Analysing critical success factors for implementation of drones in the logistics sector using grey-DEMATEL based approach.	10

Table 3.2 Continued

Author	*Year*	*Title*	*No. of Respondents*
Zhihua Chen, Minglei Lu, Xianyu Zhang, Tongtong Zhou	2020	Explore and evaluate innovative value propositions for smart product service system: A novel graphics-based rough-fuzzy DEMATEL method.	8
Saeed Reza Mohandes, Haleh Sadeghi, Abdulwahed Fazeli, Tarek Zayed	2022	Causal analysis of accidents on construction sites: A hybrid fuzzy Delphi and DEMATEL approach.	23
Finn Günther Feldmann Hendrik Birkel Evi Hartmann	2022	Exploring barriers towards modular construction – A developer perspective using fuzzy DEMATEL	12

3.8.3 Sampling Technique

Purposive sampling will be applied as the sampling technique in this research. In comparison to sampling techniques used in quantitative research, sampling techniques used in qualitative research are frequently less clear and obvious. There are no clear guidelines for using purposive sampling in research. It remains a mystery for researchers to find out what form of target sampling is best for the design of mixed methods in research. The application of sampling techniques, on the other hand, is intended to enhance the effectiveness and reliability of the collected data (Niehaus, 2009). Purposive sampling is a non-probability sampling method that was chosen to acquire sound advice from specialists who are best placed or in the best position to provide the necessary information. It has been shown to be much more efficient than constructing a population list from which to randomly select samples. This technique is chosen because it is appropriate for the study, has the potential to yield reliable information, is cost efficient, and saves time.

One of the most used sampling strategies is purposeful sampling which can groups respondents based on pre-selected criteria related to a specific research question (for example, construction experts who have at least 10 years experiences). The number of samples collected before data collection may or may not be constant depending on resource availability, time available, and research objectives. Typically, the purposive sample size is determined by theoretical data saturation (when new data no longer brings more insights to the research question, information seems redundancy for data collection). As a result, purposeful sampling is most effective when data review and analysis are combined with data collection (Readings, 2002). In qualitative research, purposeful sampling is now widely utilised to identify and select informative cases due to a lack of resources. It entails recognising and choosing individuals or groups of people who have a specific understanding of or experience with a phenomenon of interest (Johnson, 2017).

3.8.4 Population

The population in current research concentrating on the construction experts with at least 10 years experiences and focus on high-rise building construction project in Selangor, Malaysia. The decision to focus the sampling exclusively in Selangor is primarily due to its significance as the most developed and industrialized state in Malaysia, with a high concentration of construction projects, particularly high-rise buildings. Selangor is home to numerous ongoing and completed high-rise construction projects, making it a prime location for studying safety compliance and participation in such environments. The state has a large pool of construction industry professionals with substantial experience in managing and overseeing high-rise projects, which ensures that the responses collected are both relevant and insightful.

By focusing on Selangor, the research can target highly qualified experts, including project managers, foremen, managers, safety and health officers, and other executive-level professionals with at least 10 years of experience. 25 construction industry professionals will receive the questionnaire via interviews during the actual stage of data collection in this study. Their expertise provides depth and credibility to the analysis of safety predictors in high-rise construction. Concentrating on one state allows for a more controlled and consistent data collection process, ensuring that regional variations do not skew the findings, while still providing a comprehensive view of safety issues relevant to construction projects across Malaysia.

3.9 Decision Making Trial & Evaluation Laboratory (DEMATEL)

The Science and Human Affairs Program at the Battelle Memorial Institute in Geneva pioneered the DEMATEL method in 1972. Its goal is to investigate problematic groups that are intertwined and complex. It has been used to help solve many global complex issues in science, economics, and politics by considering the attitudes of relevant experts. It is now widely regarded as one of the most effective tools for determining causality between assessment criteria (Lin, 2013; Seker, 2017). The DEMATEL method can be used to investigate and establish the causal relationship between evaluation criteria (Lin et al., 2011) or to assist in determining the interdependence of factors at the same level in the decision network structure (Gholamnia et al., 2019; Shieh et al., 2010). DEMATEL can be used to effectively generate the Influential Relation Map (IMR). Figure 3.2 depicts the DEMATEL procedure.

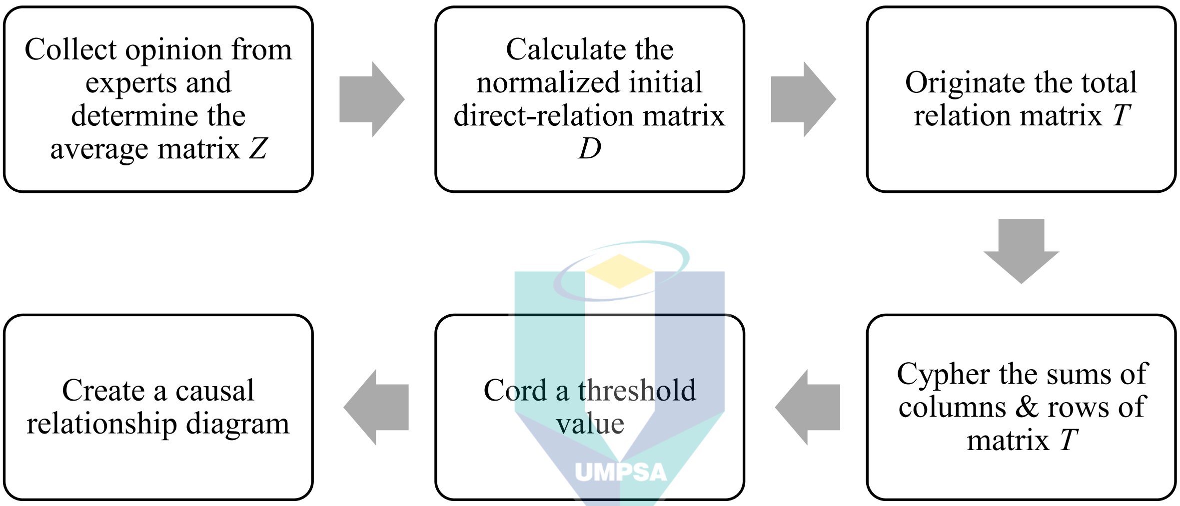

Figure 3.2: The procedure of DEMATEL method.

- **Step 1: Collect opinion from experts and determine the average matrix Z**

The opinions of experts or target respondents will be gathered through interviews with a specially designed questionnaire. Each expert will be inquired to assess the level of direct impact of two causes using integer scores based on a pair-wise comparison. The expert's perception of the influence of cause i on cause j will be recorded as x_{ij}. The integer score range will be classified into 0 (No impact), 1 (Low impact), 2 (Moderate impact), 3 (High impact) and 4 (Very high impact) individually. When $i = j$, the integer score was set to zero (0) automatically. An n x n non-negative matrix was derived as $X^k = [x_{ij}^k]$, where k is the number of respondents taking part in this assessment process with $1 \leqslant k \leqslant m$. A group of m experts and n causes will be used in this step. Thus, X^1, X^2, X^3,..., X^m are the matrices from m experts. To summarize all opinions from m experts, the average matrix Z = $[z_{ij}]$ is derived as below:

$$z_{ij} = \frac{1}{m}\sum\nolimits_{i=1}^{m} x_{ij}^{k}$$

A cause with a greater integer score means that a greater advancement in i is needed to enhance on j. The initial direct-relation matrix Z is another name for the average matrix. It aids in indicating the initial direct impact that each criterion has on and obtains from another.

- **Step 2: Calculate the normalized initial direct-relation matrix *D***

The normalized initial direct-relation matrix $D = [d_{ij}]$, with all of the resulting matrix D values ranging among [0,1]. The following is the formula:

$$D = \frac{z}{\lambda},$$

or

$$[d_{ij}]_{n\times n} = \lambda\,[z_{ij}]_{n\times n}$$

where

$$\lambda = Max\left[\max_{1\le i\le n}\sum_{j=1}^{n} z_{ij}\,,\ \max_{1\le j\le n}\sum_{i=1}^{n} z_{ij}\right]$$

All the elements in this normalized initial direct-relation matrix D will fall only in the range among zero (0) and one (1).

- **Step 3: Originate the total relation matrix T**

The equation $T = D\,(I - D)^{-1}$ will be used to calculate the total-influence matrix T where I is $n \times n$ identity matrices. The element T_{ij} demonstrates the indirect influence of cause i on cause j, and then matrix T represents the overall connection among each pair of system causes.

$$T = D\,(I - D)^{-1}$$

- **Step 4: Cypher the sums of columns & rows of matrix *T***

The row and column sums in the total-influence matrix T will be calculated using the formulas indicated by vectors r and c, respectively.

$$r = [r_i]_{n\times 1} = \left(\sum\nolimits_{j=1}^{n} t_{ij}\right)_{n\times 1},$$

$$c = [c_j]_{1\times n}^{\square} = \left(\sum\nolimits_{j=1}^{n} t_{ij}\right)_{1\times n}^{\square},$$

Where $[c_j]^{\square}$ is expressed as transposition matrix.

Let r_i be the sum of i^{th} row in matrix *T*. The value of r_i represents the sum given both directly and indirectly effects, that cause *i* has influence on the other causes.

Let c_j be the sum of the j^{th} column in matrix *T*. The value of c_j represents the sum of all other effects obtained indirectly and directly, that all other causes have on cause *j*. If *j=i,* the value of $(r_i + c_j)$ indicates the overall effects both given and received by cause *i*. The difference is that the value of $(r_i - c_j)$ shows the net contribution of the cause *i* to the system. Furthermore, cause *i* will be the net cause when $(r_i - c_j)$ is positive while cause *i* would be the net receiver when $(r_i - c_j)$ is negative (Lin & Tzeng, 2009; Shieh et al., 2010; Sumrit & Anuntavoranich, 2013).

- **Step 5: Cord a threshold value**

A threshold value will be set to obtain the directed graph. According to Gholamnia et al. (2019), the calculation goal is to extract some minor influence criteria in the matrix T, because setting the threshold value can filter out some inconsequential influences. As the directed graph demonstrates the overall of the criteria in the matrix T, it will only display effects that exceed the threshold. The calculation formula is shown below:

$$\alpha = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}[t_{ij}]}{N}$$

Where N is the total number of criteria in matrix *T*.

- **Step 6: Create a causal relationship diagram**

Mohandes et al. (2022) stated that all the coordinate sets of $(r_i + c_j, r_i - c_j)$ will be mapped to create the causal diagram to illustrate the intricate interdependence where $(r_i + c_j)$ represents the horizontal axis (*x*-axis) while $(r_i - c_j)$ represents the vertical axis (*y*-axis). It can also be utilized to supply details in order to determine what are the most significant causes and how to affect impacted causes. The factors for which t_{ij} is higher than α are selected shown in the causal graph. The graph of plot that appears as a result will clearly define the interdependence of the causes (Lin & Tzeng, 2009).

3.10 Summary

The overall Chapter 3 describes the whole process that is carried out for the research from the initial data gathering through literature reviews up to achieving the objectives of the research. The process of gathering the data starts from the literature review to identify the macro-micro safety predictors which affecting the safety compliance intention and safety participation among construction workers. The DEMATEL survey was being conducted to identify the interrelationship of each element. Finally, the inputs were analysed using the DEMATEL method to identify the most critical safety predictor and the impact relationship diagram.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter will present the results collected from the construction industry experts and their demographic profile. In order to evaluate the internal consistency of the questionnaire, corrected item-total correlation was applied and will be explained in this chapter. It will also include the discussion on the micro safety predictors, safety compliance intention and safety participation in construction project sites and the causal relationship between macro-micro safety predictors in construction project sites.

4.2 Demographic Profile

Data were collected from 25 professionals, including project managers, site managers, risk managers, safety and health managers, and construction managers. These individuals were considered experts in the construction industry due to their minimum of 10 years of experience. However, to ensure the reliability and consistency of the data, 7 respondents were excluded from the final analysis. To gather the necessary data, a structured questionnaire tailored to the DEMATEL method was developed. Virtual interviews were then conducted with the remaining 18 experts, where they were asked to evaluate the influence of macro-micro safety predictors, safety compliance intention, and safety participation on each other using a Likert-scale format. The background of the respondents is presented as Table 4.1 below.

Table 4.1 Respondents' Demographic Profile

	Frequency	Percentage (%)
Gender		
Male	14	78
Female	4	22
Age		
31-35	2	11

Table 4.1 Continued

	Frequency	Percentage (%)
36-40	6	33
41-45	7	39
46-50	2	11
Above 50 years	1	6
Experiences		
10-15	5	28
16-20	7	39
> 20	6	33
Position		
Safety and Health Manager	2	11
Project Managers	4	22
Site Managers	5	28
Risk Managers	5	28
Construction Managers	2	11
Total	18	

This research focus on the construction industry located in Selangor, Malaysia and concentrate on high-rise building construction project including residential buildings like houses, apartments, and condominiums and commercial buildings include office tower and hotels. The project details of respondents are listed in Table 4.2.

Table 4.2 Respondents' Project Details

	Frequency	Percentage (%)
Type of Company		
Main Contractor	11	61
Sub-Contractor	7	39
Project Funding		
Government funded	2	11
Private funded	14	78

Table 4.2 Continued

	Frequency	Percentage (%)
Both	2	11
Project Contract Sum (RM)		
< 1 Million	0	0
1 Million ≤ Contract sum < 10 Million	0	0
10 Million ≤ Contract sum < 50 Million	6	33
50 Million ≤ Contract sum < 100 Million	7	39
> 100 Million	5	28
Total	18	

4.3 Comprehensive Approach for Data Reliability and Consistency

In this research, the consistency between the survey results will be examined when a group of respondents are invited to participate in the DEMATEL survey. In order to evaluate the internal consistency of the questionnaire, corrected item-total correlation was used and considered acceptable for the standard of 0.30 (Bernstein, 1994). There are total of 25 respondents who joined this research and shared their opinions. The value of corrected item-total correlation can be computed by the Pearson product-moment correlation coefficient. The respondent with the smallest corrected item-total correlation value below 0.30 will be removed and the values of corrected item-total correlation will be calculated again until all the values of corrected item-total correlation for the remaining items are above 0.3. Through iterations, the 1st, 9th, 7th, 3rd, 8th, 10th and 6th values of corrected item-total correlation are less than 0.3 and will be removed in sequence with the respective 1st, 2nd, 3rd, 4th, 5th, 6th, and 7th trials. Finally, the values of corrected item-total correlation for the remaining 18 persons were listed in Table 4.3.

Table 4.3 Corrected Item-total Correlation Value of Validated Respondents

Respondents	Pearson
X2	0.3358
X4	0.497
X5	0.3657
X11	0.616
X12	0.6731
X13	0.6344

Table 4.3 Continued

Respondents	Pearson
X14	0.666
X15	0.5066
X16	0.4299
X17	0.6952
X18	0.7448
X19	0.6853
X20	0.7655
X21	0.725
X22	0.6513
X23	0.6381
X24	0.4885
X25	0.7594

There are total of 117 questions listed in the questionnaire to examine the interaction between the interrelationships among the macro-micro safety predictors, safety compliance intention and safety participation in construction project sites. According to the formula, the Cronbach's Alpha value we got from the results is 0.6581 which means the result is highly reliable.

$$\alpha = \frac{117}{117-1}\left(1 - \frac{28.574}{82.222}\right)$$

4.4 Micro Predictors

The micro predictors have been labelled by using acronyms.

A – Attitude

B – Subjective Norm

C – Perceived Behavioural Control

D – Types of Leadership Styles

E – Safety Knowledge

F – Safety Climate

G – Safety Motivation

H – Employees' Safety Risk Perception

I – Communication Climate

J – Safety Compliance Intention

K – Safety Participation

Step 1: Collect experts' opinion and calculate average matrix Z

At this stage, with the assistance of experts, DEMATEL was used to determine the essential causes and the interaction between the micro safety predictors, safety compliance intention and safety participation. As described in Chapter 3, the steps involved in DEMATEL will be performed. In this step, the experts evaluated the micro predictors found from the literature on a 0-4 scale. This level indicates the influence of one micro predictors on another and on safety compliance intention and safety participation. Based on these ratings, the average matrix Z can be obtained and listed in Table 4.4 below using Equation 1. All the following steps were conducted as outlined in the previous section as well.

Table 4.4 Average Matrix Z of Micro Safety Predictors, Safety Compliance Intention and Safety Participation

	A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***K***	***Sum***
A	0	2.7778	3.2778	2.8333	3.3889	3.7778	3.8333	3.6667	3.3333	3.8889	3.9444	34.722
B	3.7778	0	3.6667	2.5556	2.6667	3.1111	3.8333	3.2778	3.1667	3.6667	3.6667	33.389
C	3.7778	2.4444	0	2.2778	2.7222	3.2778	3.5	3.5556	2.8889	3.5556	3.5	31.5
D	3.8889	3.8889	3.8333	0	3.1111	3.6111	3.8333	3.3333	3.8333	3.8889	3.9444	**37.167**
E	3.7778	3.0556	3.8333	2.5556	0	3.5556	3.8333	3.8333	3.1111	3.8333	3.8333	35.222
F	3.9444	3.6111	3.6667	3	3.3333	0	3.7222	3.3889	3.7222	3.8889	3.7222	36
G	3.8333	2.8889	3.3333	2.1667	3.2778	3.5	0	3.6667	3	3.7778	3.7778	33.222
H	3.8889	2.4444	3.6667	2.3333	2.9444	3.7222	3.8889	0	3.1111	3.8889	3.8889	33.778
I	3.1111	3.2778	3.1667	2.7778	3	3.5556	3.6111	3.0556	0	3.3889	3.3333	32.278
J	0	0	0	0	0	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0	0	0	0	0	0
Sum	30	24.389	28.444	20.5	24.444	28.111	30.056	27.778	26.167	33.778	33.611	

Step 2: Create and compute normalized initial direct-relation matrix D

The direct-relation matrix D was normalized using equations 2, 3 and 4 and results were tabulated in Table 4.5.

Table 4.5 Normalized Direct-Relation Matrix D of Micro Safety Predictors, Safety Compliance Intention and Safety Participation

	A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***K***
A	0	0.07474	0.08819	0.07623	0.09118	0.10164	0.10314	0.09865	0.08969	0.10463	0.10613
B	0.10164	0	0.09865	0.06876	0.07175	0.08371	0.10314	0.08819	0.0852	0.09865	0.09865
C	0.10164	0.06577	0	0.06129	0.07324	0.08819	0.09417	0.09567	0.07773	0.09567	0.09417
D	0.10463	0.10463	0.10314	0	0.08371	0.09716	0.10314	0.08969	0.10314	0.10463	0.10613
E	0.10164	0.08221	0.10314	0.06876	0	0.09567	0.10314	0.10314	0.08371	0.10314	0.10314
F	0.10613	0.09716	0.09865	0.08072	0.08969	0	0.10015	0.09118	0.10015	0.10463	0.10015
G	0.10314	0.07773	0.08969	0.0583	0.08819	0.09417	0	0.09865	0.08072	0.10164	0.10164
H	0.10463	0.06577	0.09865	0.06278	0.07922	0.10015	0.10463	0	0.08371	0.10463	0.10463
I	0.08371	0.08819	0.0852	0.07474	0.08072	0.09567	0.09716	0.08221	0	0.09118	0.08969
J	0	0	0	0	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0	0	0	0	0

Step 3: Attain total relation matrix T

From the normalized matrix, total relation matrix T was computed using equation 5 and the result matrix is shown in Table 4.6 below.

Table 4.6 Total Relation Matrix T of Micro Safety Predictors, Safety Compliance Intention and Safety Participation

	A	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***J***	***K***
A	0.2329	0.2605	0.3020	0.2344	0.2771	0.3120	0.3265	0.3074	0.2870	0.3609	0.3608
B	0.3178	0.1845	0.3037	0.2228	0.2544	0.2900	0.3192	0.2918	0.2765	0.3472	0.3459
C	0.3053	0.2362	0.2020	0.2076	0.2455	0.2821	0.2992	0.2864	0.2593	0.3308	0.3281
D	0.3467	0.3018	0.3327	0.1772	0.2865	0.3261	0.3457	0.3175	0.3152	0.3818	0.3817
E	0.3300	0.2703	0.3191	0.2313	0.1975	0.3115	0.3313	0.3158	0.2859	0.3648	0.3634
F	0.3403	0.2890	0.3217	0.2465	0.2853	0.2305	0.3356	0.3118	0.3059	0.3735	0.3679
G	0.3164	0.2543	0.2937	0.2120	0.2662	0.2963	0.2230	0.2981	0.2704	0.3471	0.3457
H	0.3202	0.2464	0.3035	0.2177	0.2609	0.3038	0.3202	0.2107	0.2752	0.3526	0.3512
I	0.2994	0.2634	0.2894	0.2257	0.2592	0.2967	0.3108	0.2834	0.1953	0.3366	0.3339
J	0	0	0	0	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0	0	0	0	0

Step 4: Compute the sums of rows and columns of matrix T

Total influences received and given by each dimension was calculated using equations 6 and 7 and results were shown in Table 4.7.

Table 4.7 Sum of Influence Received of Micro Safety Predictors, Safety Compliance Intention and Safety Participation

	SUM R	SUM C	R + C	R - C
A	3.261552	2.808919	6.070471	0.452634
B	3.153817	2.306361	5.460178	0.847456
C	2.982661	2.667662	5.650323	0.314999
D	3.512821	1.97522	5.488041	1.537601
E	3.320927	2.33278	5.653707	0.988147
F	3.407802	2.649064	6.056866	0.758738
G	3.123196	2.811581	5.934777	0.311615
H	3.162449	2.622885	5.785334	0.539564
I	3.093792	2.470607	5.564399	0.623185
J	0	3.195415	3.195415	-3.19542
K	0	3.178522	3.178522	-3.17852

Step 5: Set a threshold value (α)

The threshold value was set to filter out some of the insignificant effects. The threshold value was calculated using equation 8 and obtained as value of α = 0.239827.

Step 6: Construct a cause-and-effect relationship diagram

An influence diagram was constructed based on influence of each dimension on others. It explained the role of each dimension in relation to others. The diagram is shown in Figure 4.1. The X-axis indicates the degree of influence exerted by a dimension while Y-axis indicates the extent of influence of a certain predictor on other predictors. The direction of arrows indicates the influence between various predictors.

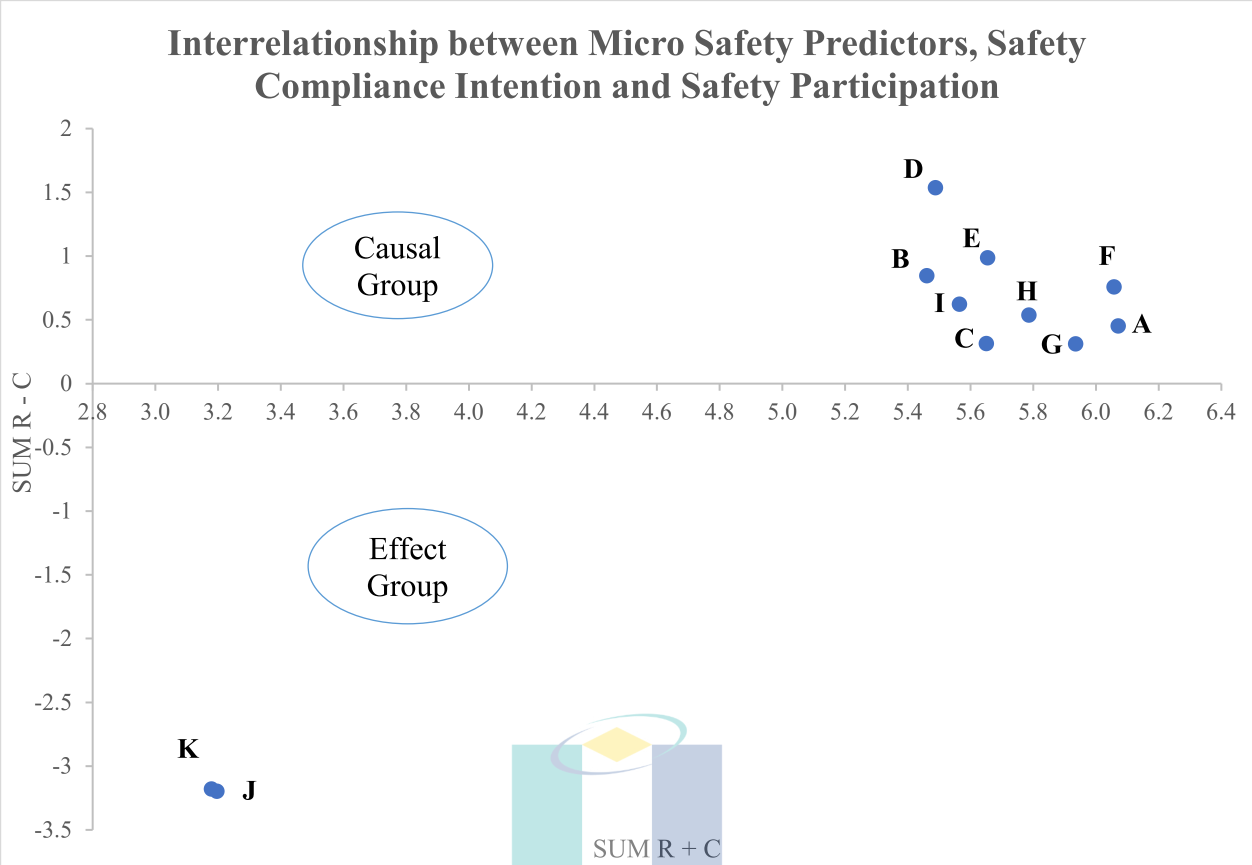

Figure 4.1: Impact-direction Diagram Among Micro Safety Predictors, Safety Compliance Intention and Safety Participation.

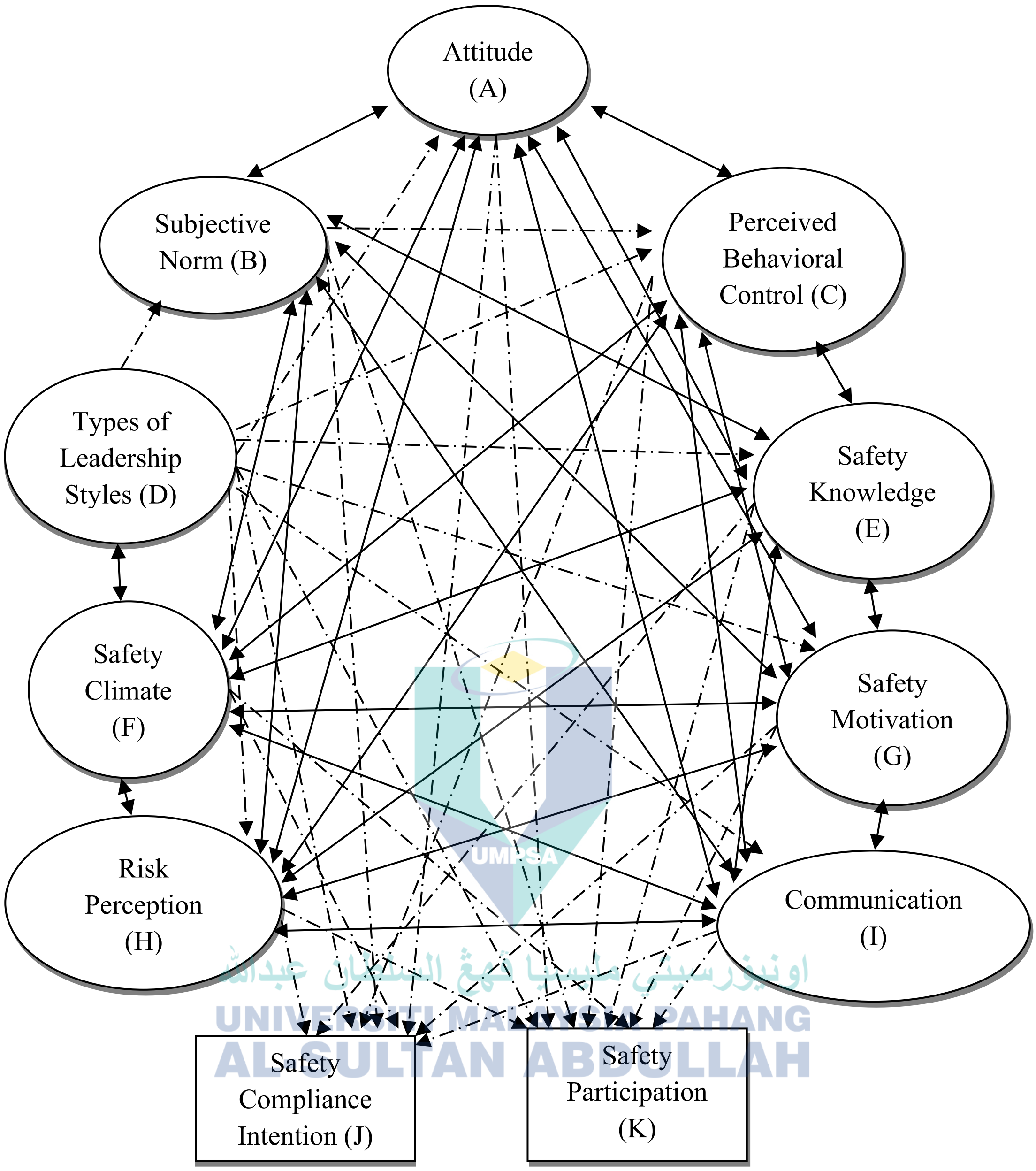

Figure 4.2: Relationship Diagraph Among Micro Safety Predictors, Safety Compliance Intention and Safety Participation.

The diagraphs presented in Figure 4.1 and Figure 4.2 reveal the relationships among the micro safety predictors, safety compliance intention, and safety participation in construction project sites. The term $r_i + c_j$ indicates the overall importance of a given predictor, while $r_i - c_j$ signifies whether the predictor belongs to the causal group (positive value) or the effect group (negative value).

According to the $r_i + c_j$ values in Table 4.7, Attitude (A) emerges as the most significant micro predictor for improving safety performance on construction project sites, with the highest $r_i + c_j$ value of 6.070471. Conversely, Subjective Norm (B), with the lowest $r_i + c_j$ value of 5.460178, is deemed the least important predictor and is positioned at the farthest left corner of the diagraph. The predictors, ranked by their $r_i + c_j$ values, are as follows: Attitude (A) > Safety Climate (F) > Safety Motivation (G) > Risk Perception (H) > Safety Knowledge (E) > Perceived Behavioural Control (C) > Communication (I) > Types of Leadership Styles (D) > Subjective Norm (B). Table 4.7 further demonstrates that, depending on their values exceeding the threshold value, α = 0.239827, every component in the causative group interacts with every element in the impact group.

4.4.1 Causal Group Analysis

Based on their positive $r_i - c_j$ values, all micro safety predictors in this study are categorized within the causative category. Types of Leadership Styles (D), which has the largest $r_i - c_j$ value of 1.537601, exerts the most significant direct impact on the effect group and has the strongest correlation. This finding underscores the pivotal role of leadership styles in shaping safety outcomes, suggesting that effective leadership can profoundly influence safety behaviours and attitudes on construction sites.

The influence of leadership styles aligns with previous research emphasizing the critical role of transformational and transactional leadership in promoting a positive safety culture and enhancing safety performance (Jiang et al., 2017). Transformational leaders, who inspire and motivate workers, can foster a proactive safety culture, whereas transactional leaders, who emphasize compliance and reward, can ensure adherence to safety protocols.

4.4.2 Effect Group Analysis

The effect group consists of Safety Compliance Intention (J) and Safety Participation (K), both having negative $r_i - c_j$ values of -3.19542 and -3.17852, respectively. Safety Compliance

Intention (J), with the lowest r_i - c_j value of -1.259, is the factor most affected by the other components. This suggests that while various predictors influence safety compliance intention, it remains the most susceptible to external factors.

The strong influence of Attitude (A) on safety compliance intention and participation indicates that workers' attitudes towards safety significantly impact their willingness to comply with safety guidelines and participate in safety initiatives. This finding is consistent with the Theory of Planned Behaviour, which posits that attitudes, along with subjective norms and perceived behavioural control, predict intentions and behaviours (Ajzen, 1991).

4.4.3 Practical Recommendations for Enhancing Safety Performance

Understanding the dominant role of Attitude (A) highlights the need for targeted interventions aimed at shaping positive safety attitudes among workers. This could involve comprehensive safety training programs that emphasize the importance of safety, sharing real-life incident reports to underline the consequences of unsafe behaviours, and fostering a supportive environment where safety is prioritized.

Additionally, improving Safety Climate (F) and Safety Motivation (G) can further enhance safety outcomes. A positive safety climate can be cultivated through consistent safety communication, demonstrating visible management commitment to safety, and ensuring that safety policies are not only in place but also actively followed. Furthermore, motivational strategies, such as recognizing and rewarding safe behaviours, can significantly boost safety performance and reinforce a culture of safety across the organization.

4.5 Macro Predictors

The macro predictors have been labelled by using acronyms.

L – Coercive Pressures

M – Mimetic Pressures

N – Normative Pressures

Under each perspective, the macro predictors in construction project sites were analysed by using the same DEMATEL procedures as described. Listed below are the tables and diagraph for interrelationships between the macro-micro safety predictors in construction project sites.

Table 4.8 Average Matrix Z of Macro and Micro Safety Predictors

	L	***M***	***N***	***A***	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***	***Sum***
L	0	0	0	3.88889	3.72222	3.77778	3.77778	3.5	3.77778	3.88889	3.66667	3.44444	**33.44444**
M	0	0	0	3.05556	2.94444	3.05556	3.27778	2.83333	3.27778	3.27778	3.22222	2.94444	27.88889
N	0	0	0	3.22222	3.27778	3.16667	3.33333	3.88889	3.33333	3.55556	3.5	3.11111	30.38889
A	0	0	0	0	0	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0	0	0	0	0	0
C	0	0	0	0	0	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0	0	0	0	0
G	0	0	0	0	0	0	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0	0	0	0	0	0
I	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	0	0	0	10.16667	9.944444	10	10.38889	10.22222	10.38889	10.72222	10.38889	9.5	

Table 4.9 Normalized Direct-Relation Matrix D of Macro and Micro Safety Predictors

	L	***M***	***N***	***A***	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***
L	0	0	0	0.116279	0.111296	0.112957	0.112957	0.104651	0.112957	0.116279	0.109635	0.10299
M	0	0	0	0.091362	0.08804	0.091362	0.098007	0.084718	0.098007	0.098007	0.096346	0.08804
N	0	0	0	0.096346	0.098007	0.094684	0.099668	0.116279	0.099668	0.106312	0.104651	0.093023
A	0	0	0	0	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0	0	0	0	0
C	0	0	0	0	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0	0	0	0
G	0	0	0	0	0	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0	0	0	0	0
I	0	0	0	0	0	0	0	0	0	0	0	0

Table 4.10 Total Relation Matrix T of Macro and Micro Safety Predictors

	L	***M***	***N***	***A***	***B***	***C***	***D***	***E***	***F***	***G***	***H***	***I***
L	0	0	0	0.116279	0.111296	0.112957	0.112957	0.104651	0.112957	0.116279	0.109635	0.10299
M	0	0	0	0.091362	0.08804	0.091362	0.098007	0.084718	0.098007	0.098007	0.096346	0.08804
N	0	0	0	0.096346	0.098007	0.094684	0.099668	0.116279	0.099668	0.106312	0.104651	0.093023
A	0	0	0	0	0	0	0	0	0	0	0	0
B	0	0	0	0	0	0	0	0	0	0	0	0
C	0	0	0	0	0	0	0	0	0	0	0	0
D	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	0
F	0	0	0	0	0	0	0	0	0	0	0	0
G	0	0	0	0	0	0	0	0	0	0	0	0
H	0	0	0	0	0	0	0	0	0	0	0	0
I	0	0	0	0	0	0	0	0	0	0	0	0

Table 4.11 Sum of Influence Received of Macro and Micro Safety Predictors

	Predictors	*SUM R*	*SUM C*	*R + C*	*R - C*
L	Coercive Pressures	1	0	1	1
M	Mimetic Pressures	0.833887	0	0.833887	0.833887
N	Normative Pressures	0.908638	0	0.908638	0.908638
A	Attitude	0	0.303987	0.303987	-0.30399
B	Subjective Norm	0	0.297342	0.297342	-0.29734
C	Perceived Behavioural Control	0	0.299003	0.299003	-0.299
D	Types of Leadership Styles	0	0.310631	0.310631	-0.31063
E	Safety Knowledge	0	0.305648	0.305648	-0.30565
F	Safety Climate	0	0.310631	0.310631	-0.31063
G	Safety Motivation	0	0.320598	0.320598	-0.3206
H	Risk Perception	0	0.310631	0.310631	-0.31063
I	Communication	0	0.284053	0.284053	-0.28405

Threshold Value, α = 0.01905

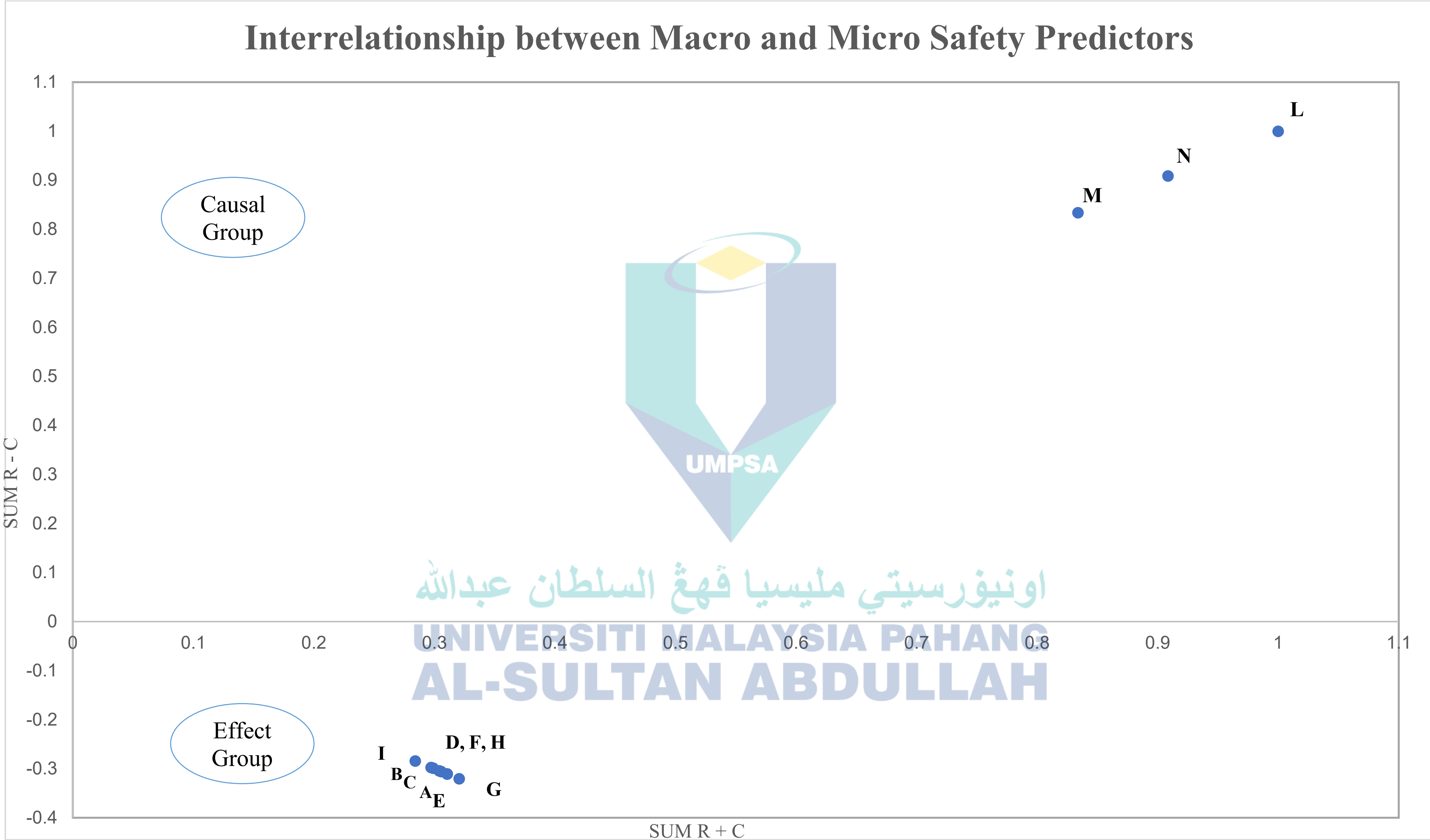

Figure 4.3: Impact-direction Diagram Among Macro and Micro Safety Predictors

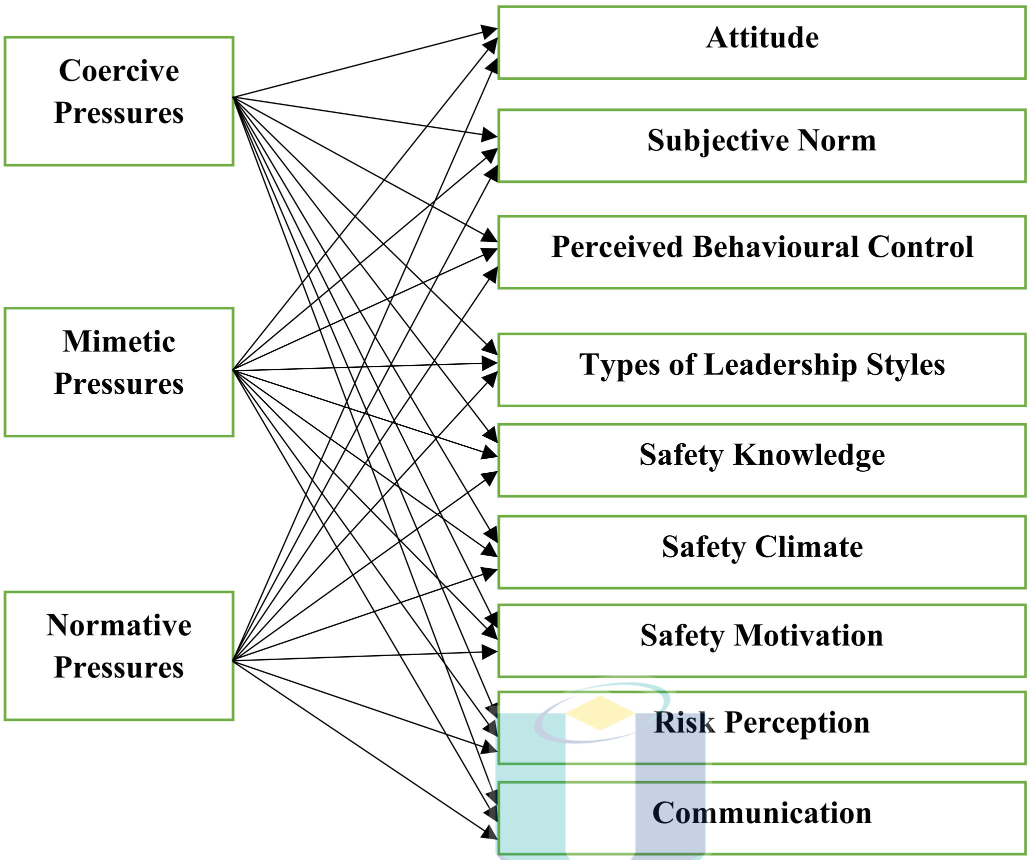

Figure 4.4: Relationship Diagraph Among Macro and Micro Safety Predictors

Table 4.11 reveals that Coercive Pressures (L) have the highest $r_i + c_j$ value of 1, identifying them as the most significant macro safety predictor in construction project sites. Positioned at the far right of the diagraph, Coercive Pressures are prioritized over other predictors, indicating their critical role in influencing safety behaviours. Conversely, Communication (I), with the lowest $r_i + c_j$ value of 0.2841 and positioned at the far left, is considered the least significant predictor in this study. The prioritization of these safety predictors is ordered as follows: Coercive Pressures (L) > Normative Pressures (N) > Mimetic Pressures (M) > Safety Motivation (G) > Types of Leadership Styles (D) = Safety Climate (F) = Risk Perception (H) > Safety Knowledge (E) > Attitude (A) > Perceived Behavioural Control (C) > Subjective Norm (B) > Communication (I).

Based on the $r_i - c_j$ values, safety predictors are categorized into two groups: (i) causal group and (ii) effect group. Table 4.11 also shows that all the macro safety predictors in causal group has interactions with all the micro safety predictors in effect group based on their values that are greater than the threshold value, $\alpha = 0.01905$.

4.5.1 Causal Group Analysis

All macro safety predictors in construction project sites fall under the causal group due to their positive $r_i - c_j$ values. Coercive Pressures (L) exert the greatest direct impact on the effect group, with the highest correlation and an $r_i - c_j$ value of 1. This finding underscores the dominant influence of regulatory and enforcement mechanisms in shaping safety outcomes on construction sites. It suggests that strict compliance with safety regulations and standards, driven by external pressures from authorities, can significantly enhance safety performance.

The importance of Coercive Pressures aligns with existing literature emphasizing the role of regulatory frameworks in enforcing safety standards (He et al., 2016). Regulatory compliance ensures that construction sites adhere to minimum safety requirements, reducing the risk of accidents and promoting a culture of safety.

4.5.2 Effect Group Analysis

The effect group consists of all micro safety predictors in construction project sites, each exhibiting negative $r_i - c_j$ values. It can be concluded that all the micro safety predictors in effect group are influenced by all the macro safety predictors in causal group and their interactions are shown in Table 4.11, Figure 4.3 and Figure 4.4. Safety Motivation (G) emerges as the most influenced predictor, with the lowest $r_i - c_j$ value of -0.3206. This indicates that Safety Motivation is highly susceptible to the influence of other predictors, highlighting the need for targeted interventions to maintain and enhance workers' motivation towards safety.

4.5.3 Recommendations for Practical Application

The findings suggest several practical implications for improving safety performance in construction settings. First, the significant impact of Coercive Pressures highlights the necessity for robust regulatory frameworks and stringent enforcement mechanisms. Construction firms should prioritize compliance with safety regulations to mitigate risks and foster a culture of safety. Regular inspections, audits, and penalties for non-compliance can ensure adherence to safety standards.

Besides, Normative Pressures (N) and Mimetic Pressures (M) also play crucial roles in shaping safety behaviours. Encouraging industry-wide best practices and fostering a shared commitment to safety can drive improvements. Construction firms can participate in industry associations, adopt safety certifications, and benchmark against leading organizations to enhance their safety culture by strengthening Normative and Mimetic Pressures.

On the other hand, given the susceptibility of Safety Motivation (G) to other predictors, targeted interventions are essential. Implementing motivational strategies, such as safety incentives, recognition programs, and continuous training, can sustain high levels of safety motivation among workers. Empowering workers to take ownership of safety and involving them in decision-making processes can further enhance motivation.

Despite being the least significant predictor, effective communication (I) remains vital for disseminating safety information and ensuring that all workers are aware of safety protocols. Construction firms should invest in clear and consistent communication channels, regular safety meetings, and feedback mechanisms to address safety concerns promptly.

4.6 Summary

The overall Chapter 4 describes the results collected from the construction industry experts and their demographic profile. Corrected item-total correlation was applied to evaluate the internal consistency of the questionnaire. The data obtained from DEMATEL survey was being used to identify the interrelationship of each element. Finally, the inputs were analysed using the DEMATEL method to identify the most critical safety predictor and the impact relationship diagram. The results show that the relationships among all macro-micro safety predictors, safety compliance intention and safety participation are significant. It also indicates that every safety predictor proposed can affect the safety performance in construction projects sites. In addition, it was found that Attitude is the most significant micro predictor to improve safety compliance intention and safety participation in construction projects sites. Furthermore, results indicate that Coercive Pressures is the most significant macro safety predictor in construction projects sites. It can be concluded that all the micro safety predictors in effect group are influenced by all the macro safety predictors in causal group, and Coercive Pressures has the greatest direct impact on the effect group and has the highest correlation due to the highest $r_i - c_j$ value.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter concludes the results presented in Chapter 4. It includes a summary based on the results and conclusion made for this research. The implications are also included in this chapter to improve safety performance in construction sites. Besides, the limitations for this research will be discussed and future research directions will be suggested to provide more valuable insights. The findings provide a foundation for developing targeted interventions and underscore the need for ongoing research to address the multifaceted nature of construction safety.

5.2 Overview of Findings

Malaysian major construction projects are vulnerable to hazardous circumstances, which can lead to accidents and undermine the project's safety results. As mentioned earlier, the previous studies done by the other researchers are focusing on identifying variables influencing safety participation among workers in construction project sites. However, it is unclear how any of these factors affect the mechanism of personal behaviour. There are also various studies focused on technology methods for enhancing safety, but none of them considered behavioural treatments on the job.

Very little research has been done to investigate the role of planned behaviour in intervening in safety compliance on construction sites. Despite the posited framework considering TPB, there is scarce literature on the study of macro predictors and the cognitive domains (subjective norms, attitude, and perceived behavioural control), and there is no evidence to prove the correlation between intention to comply with safety and macro-micro safety predictors in construction project sites.

Yet, there is not much attention given to consider the direct, indirect and interdependencies among the macro-micro safety predictors, safety compliance intention and safety participation in construction project sites using DEMATEL method. Besides that, these studies do not help to draw conclusion on which is the most significant macro and micro safety predictor to improve safety performance on construction project sites. Therefore, this research aims to proffer a better comprehension of the interrelationships between macro-micro safety predictors and empirical findings, develop new applied model and make stronger suggestions to improve safety performance in construction project sites.

To achieve the objectives of this study, a questionnaire that fit the requirements of DEMATEL was designed and distributed to 25 experts in the construction industry using purposive sampling technique. By using the DEMATEL method, this study has determined the interaction between micro safety predictors affecting safety compliance intention and safety participation on construction sites, the interaction between the macro-micro safety predictors in construction project sites in the form of diagraphs.

When using the DEMATEL method, the basic assumption is that the opinions of all respondents should be considered without further checking the reliability of the survey results. In this study, a comprehensive approach using corrected item-total correlation and Cronbach's alpha was proposed to assess the data consistency and reliability of the DEMATEL method applied. It is worth noting that seven survey results from the 1st, 3rd, 6th, 7th, 8th, 9th and 10th respondents were removed from this study. In fact, these respondents might have opinions that other did not have. Therefore, data consistency can be accessed through this approach.

The results show that the relationships among all macro-micro safety predictors, safety compliance intention and safety participation are significant. It also indicates that every safety predictor proposed can affect the safety performance in construction projects sites. In addition, it was found that Attitude is the most significant micro predictor to improve safety compliance intention and safety participation in construction projects sites. Therefore, organization should focus more on this issue to improve the safety performance and reduce the likelihood of accidents or incidents in construction projects sites.

The study underscores the critical role of micro safety predictors, particularly Attitude (A), in shaping safety compliance and participation on construction sites. By prioritizing efforts to improve workers' attitudes towards safety and fostering a positive safety climate, construction organizations can enhance overall safety performance and reduce the likelihood of accidents. The findings provide a foundation for developing targeted interventions and highlight the need for ongoing research to address the multifaceted nature of construction safety.

When r_i - c_j values are positive, it indicates that the degree of influenced impact (C) is less than the degree of influencing impact (R), and it is important to pay attention. This indicates that they are drivers since they have a greater impact on other predictors than other predictors have on themselves. With the highest r_i - c_j value, Types of Leadership Styles (D) is the most influential predictor driving safety performance.

Depicted in Figure 4.2, Types of Leadership Styles (D) can influence construction workers' Attitude (A), Subjective Norm (B) and Perceived Behavioural Control (C) while also improving their Safety Knowledge (E) and Safety Motivation (G). A good leadership style can influence the overall Communication (I) among the teammates and then impact the organization's Safety Climate (F). Risk Perception (H) will also be affected as the leader's safety attitudes will impact the actions of construction workers who take risks.

The study highlights the critical role of macro safety predictors, particularly Coercive Pressures, in shaping safety behaviours on construction sites. By prioritizing regulatory compliance, fostering industry-wide best practices, enhancing safety motivation, and improving communication, construction firms can significantly improve safety performance. The findings provide a foundation for developing targeted interventions and underscore the need for ongoing research to address the multifaceted nature of construction safety.

5.3 Implications and Interventions

The attitude of a worker toward safety determines not only do they act safely in the worksite, but also whether they comply with and accept to formal worksite guidelines and take initiatives when it is necessary to apply informal practices that accomplish the same objective. Each worker has their own beliefs about what causes occupational accidents and what factors are essential in preventing them. These beliefs shape attitudes toward workplace hazard prevention activities and their safety compliance intention and safety participation. Therefore, it is important for the organizations to improve safety communication among construction worker when they are conducting tasks in the project sites.

Understanding the dominant role of Attitude (A) highlights the need for targeted interventions aimed at shaping positive safety attitudes among workers. This could involve comprehensive safety training programs that emphasize the importance of safety, sharing real-life incident reports to underline the consequences of unsafe behaviours, and fostering a supportive environment where safety is prioritized.

Additionally, enhancing Safety Climate (F) and Safety Motivation (G) can further improve safety outcomes. Creating a positive safety climate involves consistent safety communication, visible management commitment to safety, and ensuring that safety policies are effectively implemented and followed. Motivational strategies, such as recognizing and rewarding safe behaviours, can also boost safety performance.

Depicted in Figure 4.2, Types of Leadership Styles (D) can influence construction workers' Attitude (A), Subjective Norm (B) and Perceived Behavioural Control (C) while also improving their Safety Knowledge (E) and Safety Motivation (G). A good leadership style can influence the overall Communication (I) among the teammates and then impact the organization's Safety Climate (F). Risk Perception (H) will also be affected as the leader's safety attitudes will impact the actions of construction workers who take risks.

Construction organizations should adopt effective leadership styles, such as transformational leadership, which empowers and motivates workers to voluntarily engage in safe behaviours on every construction project, to improve safety performance. Safety compliance intention and safety participation can be increased by positively influencing workers' attitudes, leading to accident prevention and reduction. This highlights the significance of leadership styles in cultivating a strong safety culture. In brief, through the implementation of effective leadership styles in every construction project, it can help to empower and motivate workers to voluntarily engage in safety behaviours and develop a strong safety culture. In addition, the enhancement in coercive pressure can further improve the safety performance of construction project sites.

Furthermore, results indicate that Coercive Pressures is the most significant macro safety predictor in construction projects sites. It can be concluded that all the micro safety predictors in effect group are influenced by all the macro safety predictors in causal group, and Coercive Pressures has the greatest direct impact on the effect group and has the highest correlation due to the highest $r_i - c_j$ value. Therefore, federal ministries and safety agencies should fulfil their responsibilities to ensure that Malaysian construction organizations conduct their projects within the mandatory safety requirements imposed by government and construction industry associations.

The findings of this research offer significant contributions to both the Theory of Planned Behaviour (TPB) and Institutional Theory, deepening our understanding of how safety behaviours can be influenced within the construction industry. From the perspective of TPB, this study confirms that workers' attitudes toward safety are not only essential in ensuring their compliance with formal safety guidelines but also in motivating them to engage in proactive, informal safety practices that can prevent accidents. The role of attitudes, subjective norms, and perceived behavioural control, as proposed by TPB, is evident in shaping workers' safety compliance intention and participation.

By applying TPB in this context, the study underscores that construction workers' attitudes toward safety are shaped by their individual beliefs about what causes occupational accidents and what measures are most effective in preventing them. This finding emphasizes the need for construction organizations to actively shape these attitudes through targeted interventions, such as safety training programs that address real-world risks and safety incidents, thereby fostering a positive safety culture. The strong influence of subjective norms, whereby workers are influenced by their perceptions of important others' safety expectations, also highlights the importance of creating an environment where safety is a shared value among all team members.

Perceived behavioural control, which refers to workers' perceptions of their ability to engage in safe practices, further supports the TPB framework in this study. Construction workers are more likely to engage in safety compliance when they feel confident in their ability to do so, which implies that organizations should provide the necessary tools, training, and resources to enhance this sense of control.

Institutional Theory provides another layer of understanding, particularly with regard to the macro-level pressures that shape safety behaviours in construction. The study's findings demonstrate that Coercive Pressures (the regulatory and legal requirements imposed on construction organizations) play the most significant role in influencing safety practices. This is consistent with Institutional Theory's assertion that organizations are often driven to conform to external pressures in order to maintain legitimacy. In this case, the study shows that coercive pressures are critical in shaping safety compliance, suggesting that stringent enforcement of safety regulations, regular inspections, and penalties for non-compliance are effective strategies for enhancing safety outcomes in construction sites.

In addition to coercive pressures, Normative and Mimetic Pressures also influence safety behaviours in construction. Normative pressures, which arise from industry standards and professional norms, encourage organizations to adopt best safety practices, while mimetic pressures push organizations to emulate the safety strategies of industry leaders. These findings suggest that construction firms can improve their safety performance by participating in industry associations, seeking certifications, and benchmarking their safety practices against leading organizations.

5.4 Limitations

This study was conducted using a hybrid method of DEMATEL and interviewing experts through questionnaire survey. The ranking of listed predictors may be subject to bias due to the personal judgments and opinions of the experts participating in the interviews. Expert opinions can vary widely based on their individual experiences and perspectives, potentially influencing the outcome of the study.

In addition, the participation rate of experts in this research was relatively small, only a total of 25 construction experts with at least 10 years' experience in this field were invited to share their insights which might limits the generalizability of the findings. The small sample size may not represent the total population of experts in the entire construction industry, thereby reducing the robustness and external validity of the results.

On the other hand, there are total of seven survey results were removed in this study to achieve data consistency using corrected item-total correlation method. But in practice these persons might have insights that the other persons did not have. Therefore, it may be difficult to say that these opinions should be removed from consideration when applying the DEMATEL method. The important part of this research is that a comprehensive method is applied to identify people with different opinions.

5.5 Future Research Directions

To address the limitations identified and build upon the findings of this study, several future research directions are suggested. Future studies should aim to include a larger and more diverse sample of experts from various sectors within the construction industry. This will enhance the accuracy and generalizability of the findings, providing a more comprehensive understanding of safety predictors.

Besides, implementing strategies to mitigate expert bias is crucial. Techniques such as Delphi method, which involves multiple rounds of surveys and feedback, can help achieve a more balanced and consensus-driven ranking of predictors. Complementing quantitative methods with qualitative research, such as in-depth interviews and focus groups, can capture nuanced insights and contextual factors influencing safety behaviours. This mixed-methods approach can enrich the understanding of safety predictors and their interactions.

Future research should explore the interplay between macro and micro safety predictors in greater detail. Longitudinal studies can provide insights into how these predictors evolve over time and their long-term impact on safety performance. Additionally, integrating qualitative methods, such as interviews and focus groups, can enrich quantitative findings by capturing workers' perceptions and experiences.

Future research should explore the interaction between micro safety predictors and macro factors such as organizational policies, regulatory environments, and cultural influences. Investigating how macro-level factors interact with individual attitudes and behaviours can provide a more comprehensive understanding of safety dynamics in construction settings. Examining the impact of policy changes and regulatory frameworks on safety predictors can provide insights into the effectiveness of coercive pressures. Future research can assess how different regulatory environments influence safety behaviours and outcomes.

Exploring the role of organizational culture and leadership in influencing safety behaviours can provide a more comprehensive understanding of the factors driving safety performance. Investigating the impact of technological advancements, such as digital tools and automation, on safety compliance and motivation can also offer valuable insights. By addressing these directions, future research can enhance the understanding of safety predictors, improve methodological rigor, and contribute to the development of effective safety interventions in the construction industry.

5.6 Summary

Overall, the integration of TPB and Institutional Theory provides a comprehensive framework for understanding how both individual-level factors (attitudes, subjective norms, perceived control) and institutional-level pressures (coercive, normative, mimetic) influence safety behaviours in construction. This theoretical contribution highlights the complex interplay between personal beliefs, organizational culture, and external regulatory pressures, offering new insights into how safety performance can be improved in high-risk construction environments. The study underscores the critical role of micro safety predictors, particularly Attitude (A), in shaping safety compliance and participation on construction sites. By prioritizing efforts to improve workers' attitudes towards safety and fostering a positive safety climate, construction organizations can enhance overall safety performance and reduce the likelihood of accidents. The findings provide a foundation for developing targeted interventions and highlight the need for ongoing research to address the multifaceted nature of construction safety. The study highlights the critical role of macro safety predictors, particularly Coercive Pressures, in shaping safety behaviours on construction sites. By prioritizing regulatory compliance, fostering industry-wide best practices, enhancing safety motivation, and improving communication, construction firms can significantly improve safety performance. The findings provide a foundation for developing targeted interventions and underscore the need for ongoing research to address the multifaceted nature of construction safety.

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APPENDIX A

DEMATEL Questionnaire

I am a Master of Science student from University Malaysia Pahang Al-Sultan Abdullah (UMPSA). I am currently conducting research on the topic of **FORMULATION OF MACRO-MICRO SAFETY PREDICTORS IN HIGH-RISE CONSTRUCTION SITES BASED ON DEMATEL ALGORITHM.**

The objectives of the study are:

i) To formulate the macro-micro predictors in predicting safety compliance intention and safety participation in construction sites.

ii) To investigate the interrelationships between the micro safety predictors and safety compliance intention in construction project sites.

iii) To examine the interrelationships between the micro safety predictors and safety participation in construction project sites.

iv) To evaluate the interrelationships between the macro-micro safety predictors in construction project sites.

Your participation in this questionnaire will be a huge contribution to the success of the survey and will be deeply appreciated. All the information collected will be treated with utmost confidentiality and will be strictly used for academic purposes only. Thank you for your cooperation and support towards this research.

Yours sincerely,

Kang Chun Xiang

Master of Science

Faculty of Industrial Management

University Malaysia Pahang Al-Sultan Abdullah

Part A: Demographic Information

Part A requires to be filled with general information about the respondent. Please answer all the questions. *Guidelines: Please answer the questions by putting a tick (✓) in the box provided.*

1. Gender

   ☐ Male ☐ Female

2. Age

   ☐ 21-25 years

   ☐ 26-30 years

   ☐ 31-35 years

   ☐ 36-40 years

   ☐ 41-45 years

   ☐ 46-50 years

   ☐ Above 50 years

3. Years of Experience in Construction Industry

   ☐ 1-5 years

   ☐ 6-10 years

   ☐ 11-15 years

   ☐ 16-20 years

   ☐ 21-25 years

   ☐ 26-30 years

   ☐ More than 30 years

4. Organization CIDB Grade

   ☐ G1

   ☐ G2

   ☐ G3

   ☐ G4

   ☐ G5

   ☐ G6

   ☐ G7

5. Your organization's main role for the project

☐ As Prime/Main contractor

☐ As Sub-contractor

6. What is the best description that suits your current position in the organization?

☐ Project Manager

☐ Risk Manager

☐ General Manager

☐ Site Manager

☐ Other (Please specify): ______________________

7. Type of project currently involved in

☐ Residential

☐ Institutional and Commercial

☐ Cultural

☐ Sporting

☐ Health-

☐ Specialized Industrial

☐ Civil & Infrastructures

☐ Other: ______________________

8. Location of project

☐ Johor

☐ Kedah

☐ Kelantan

☐ Melaka

☐ Negeri Sembilan

☐ Pahang

☐ Perak

☐ Perlis

☐ Penang

☐ Sabah

☐ Sarawak

☐ Sabah

☐ Terengganu

☐ Kuala Lumpur

☐ Putrajaya

☐ Labuan

☐ Other:______________________

9. Project Contract Sum (Ringgit Malaysia):

☐ Contract Sum less than 1 Million

☐ 1 Million ≤ Contract sum < 10 Million

☐ 10 Million ≤ Contract sum < 50 Million

☐ 50 Million ≤ Contract sum < 100 Million

☐ 100 Million ≤ Contract sum < 150 Million

☐ 150 Million ≤ Contract sum < 200 Million

☐ 200 Million ≤ Contract sum

10. Project Funding

☐ Government funded

☐ Private funded

☐ Both government and private funded

☐ Other: ______________________

Part B: Comparison of the Different Dimensions' Impact

Please rate the impact for following predictors based on your own experiences and knowledge in the industry.

Instructions for filling out the index:

0 (No impact) 1 (Low impact) 2 (Moderate impact)

3 (High impact) 4 (Very high impact)

Example: The impact of A on B is very low, therefore '1' is to be filled out at the corresponding pattern.

Causes	A	B	C	D	E	F	G	H	I	J	K
A		1									
B											
C											
D											
E											
F											
G											
H											
I											
J											
K											

Instructions for filling out the index:

0 (No impact) 1 (Low impact) 2 (Moderate impact)

3 (High impact) 4 (Very high impact)

Interrelationship between the micro safety predictors, safety compliance intention and safety participation in construction project sites.

Predictors	A	B	C	D	E	F	G	H	I	J	K
A											
B											
C											
D											
E											
F											
G											
H											
I											
J											
K											

<u>Micro Predictors</u>

A – Attitude

B – Subjective Norm

C – Perceived Behavioural Control

D – Types of Leadership Styles

E – Safety Knowledge

F – Safety Climate

G – Safety Motivation

H – Risk Perception

I – Communication

J – Safety Compliance Intention

K – Safety Participation

Instructions for filling out the index:

0 (No impact) 1 (Low impact) 2 (Moderate impact)

3 (High impact) 4 (Very high impact)

Interrelationships between the macro-micro safety predictors in construction project sites.

Micro / *Macro*	**L**	**M**	**N**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
L												
M												
N												
A												
B												
C												
D												
E												
F												
G												
H												
I												

Micro Predictors

A – Attitude

B – Subjective Norm

C – Perceived Behavioural Control

D – Types of Leadership Styles

E – Safety Knowledge

F – Safety Climate

G – Safety Motivation

H – Risk Perception

I – Communication

Macro Predictors

L – Coercive Pressures

M – Mimetic Pressures

N – Normative Pressures