COMMUTING RISK PERCEPTION AMONG RAILWAY EMPLOYEES: INFLUENCE OF TRAVEL PATTERN, ACCIDENT EXPERIENCE AND PREVENTIVE MEASURES

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ABSTRAK

Persepsi risiko ulang-alik ke tempat kerja merupakan aspek penting dalam keselamatan pekerjaan, khususnya dalam kalangan pekerja kereta api yang sering melakukan perjalanan pada waktu tidak menentu. Kajian ini meneliti pengaruh Corak Perjalanan, Pengalaman Kemalangan, dan Keberkesanan Langkah Pencegahan terhadap persepsi risiko ulang-alik ke tempat kerja dalam kalangan pekerja kereta api di Malaysia. Menggunakan pendekatan kuantitatif, data dikumpul daripada 193 responden melalui soal selidik. Analisis deskriptif, korelasi Pearson, ANOVA, dan regresi berganda digunakan untuk mengkaji hubungan antara pemboleh ubah.

Dapatan kajian menunjukkan bahawa Corak Perjalanan dan Pengalaman Kemalangan merupakan peramal signifikan terhadap persepsi risiko berulang-alik, dengan pengalaman kemalangan muncul sebagai peramal paling kuat. Keberkesanan langkah pencegahan menunjukkan hubungan positif yang kecil tetapi signifikan dengan persepsi risiko, mencadangkan bahawa pekerja yang menghargai intervensi keselamatan lebih peka terhadap bahaya ketika berulang-alik. Model regresi menjelaskan beberapa varians dalam persepsi risiko, menunjukkan bahawa faktor lain seperti tekanan, keletihan, dan budaya keselamatan organisasi juga mungkin memainkan peranan.

Kajian ini menyumbang kepada teori persepsi risiko dengan mengintegrasikan faktor struktur, pengalaman, dan organisasi dalam konteks berulang-alik ke dan dari tempat kerja. Implikasi praktikal termasuk pelaksanaan pengaturan kerja fleksibel, program keselamatan yang disasarkan untuk pekerja berisiko tinggi, dan penilaian berterusan terhadap langkah pencegahan. Dapatan ini memberikan panduan yang boleh dilaksanakan oleh syarikat keretapi dan pembuat dasar dalam meningkatkan keselamatan berulang-alik ke dan dari tempat kerja serta kesejahteraan pekerja.

Kata kunci: persepsi risiko ulang-alik ke tempat kerja, corak perjalanan, pengalaman kemalangan, langkah pencegahan, pekerja kereta api.

ABSTRACT

Commuting risk perception is an important aspect of occupational safety, particularly among railway employees who often travel at irregular hours. This study investigates the influence of Travel Pattern, Accident Experience, and Preventive Measures Effectiveness on perceived commuting risk among railway employees in Malaysia. Using a quantitative approach, data were collected from 193 respondents through structured questionnaires. Descriptive analysis, Pearson correlation, ANOVA, and multiple regression were employed to examine relationships between variables.

The findings reveal that Travel Pattern and Accident Experience significantly predict commuting risk perception, with accident experience emerging as the strongest predictor. Preventive measures effectiveness showed a small but significant positive association with risk perception, suggesting that employees who value safety interventions are more aware of commuting hazards. The regression model explained some of the variance in risk perception, indicating that other factors such as stress, fatigue, and organizational safety culture may also play a role.

The study contributes to risk perception theory by integrating structural, experiential, and organizational factors in the commuting context. Practical implications include implementing flexible work arrangements, targeted safety programs for high-risk employees, and continuous evaluation of preventive measures. These findings provide actionable insights for railway organizations and policymakers to enhance commuting safety and employee well-being.

Keywords: commuting risk perception, travel pattern, accident experience, preventive measures, railway employees.

DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and any editorial work, paid or unpaid, carried out by a third party is acknowledged.

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Commuting to and from work plays a big role in how people move around cities every day. Most employees need to travel to their workplace regularly, and the way they choose to travel whether by a car, bus, train, or other means can make traffic worse, especially in busy urban areas. Heavy traffic not only slows down movement but also affects the overall quality of life for people living in these cities (Ceccato, Gaudelet, & Graf, 2022). Because of this, companies have an important responsibility to encourage workers to use sustainable and eco-friendly ways of commuting, such as carpooling, cycling, walking, or using public transport. Promoting these options can help reduce traffic jams, lower pollution, and make cities safer and healthier places to live.

In addition, daily commuting is linked to road safety issues. These routine trips increase the chances of accidents happening on city roads and even crashes on highways between cities. Reducing the number of private vehicles on the road and promoting safer travel options can help minimize these risks and create a safer environment for everyone (Fernandez et al., 2024).

The mode of travel is another determinant of safety outcomes. The modes of public transport, such as trains and buses, in most cases tend to be a safer choice than a personal vehicles (Ceccato, Gaudelet, & Graf, 2022). Public transportation safety is compromised by factors like delay, poor infrastructure, and low-quality of services (Ceccato, Gaudelet, & Graf, 2022). Otherwise, eventhough personal vehicles such as cars and motorcycle are more convenient and more adaptable, they are linked to a higher accident frequencies, which are mostly due to factors like the behavior of drivers, road conditions, and the vehicle conditions when kept (Zuwairy, 2020). For railway

workers, the risk was even more higher due to the commuting routes frequently involve accessing rural or remote areas with uneven roads, potholes and limited lighting. Therefore, the selection of a commuting mode is a critical element that influences the overall safety especially to the railway employees when commuting to work daily.

According to the statistics provided by a railway company in Malaysia, there has been a noticeable increase in commuting accidents over the past few years. In 2022, a total of 23 incidents were reported. This number rose significantly in 2023, reaching 40 cases. On 2024, the number of reported commuting accidents is rise even further, with 54 cases already documented. While on 2025, the number significantly increase to 62 reported cases from January until October 2025 (KTMB, 2025).

Commuting accident also negatively impacts the company, as injured workers may be absent from work for prolonged periods, leading to a decreased efficiency, thereby impacting the productivity and stability of companies (Fernandez et al., 2024).

This study aims to provide an empirical analysis of commuting habits and how these habits are shaped by perceived risks. By focusing on the experiences of commuters within a specific railway company in Malaysia, this research will contribute to a better understanding of the factors influencing travel behavior and safety concerns, ultimately informing strategies to improve the safety and overall experience of passengers.

1.2 Problem Statement

Safety of rail workers during their daily commute to and from work is a serious concern in Malaysia, where rapid urbanization and economic development have caused increased reliance on all types of transportation. Despite the availability of public transport facilities, many rail workers continue to use private vehicles and motorbikes, which carry a higher rate of accidents. The lack of adequate vehicle maintenance and

the widespread culture of hazardous driving behavior also contribute to the safety risks faced by these employees.

The number of commuting accidents reported by a railway company in Malaysia has been steadily increasing over the past few years, raising concerns about the safety of workers. According to the number of commuting accident provided by one of the railway company in Malaysia, in 2022, there were 23 reported incidents, which are 21 cases from the total number are injury and other 2 cases was a fatal accident. The number increased to 40 cases in 2023, marking a 86% rise accumulate 39 cases injury and 1 cases of fatal accident. Number of accident reached to 54 cases in 2024, showing an additional 38% increase and 62 cases in 2025 which is 15% more than the previous year (KTMB, 2025). The growing number of commuting accidents calls for urgent attention and the implementation of effective safety measures to prevent further harm to passengers and ensure the integrity of the railway system.

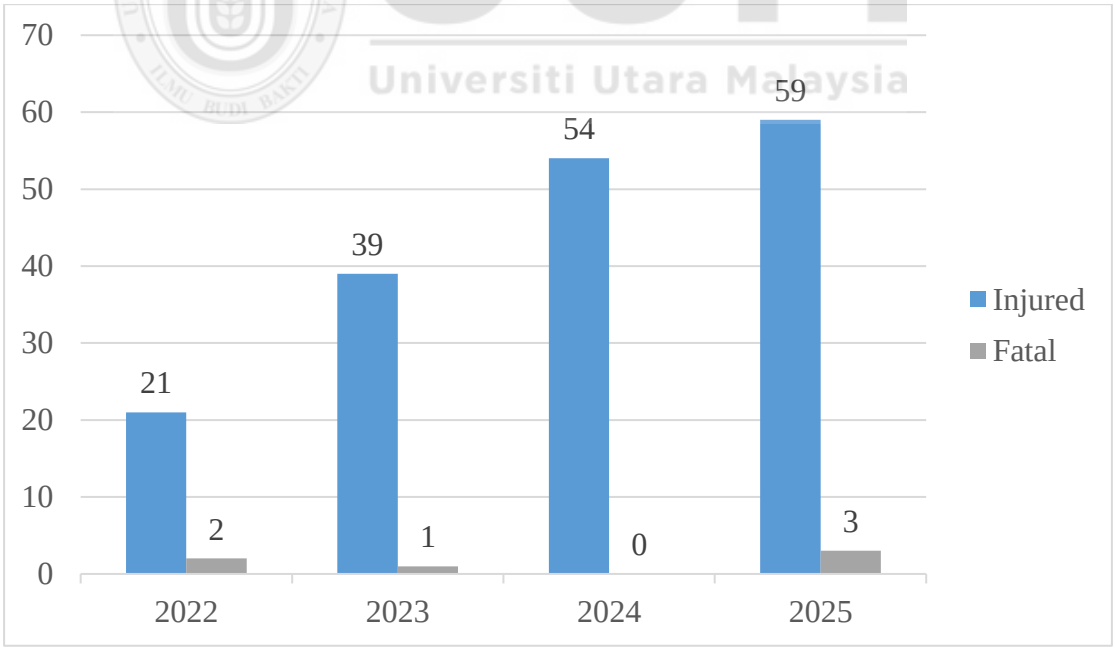

Figure 1.1

Cases of Commuting Accident at Railway Company from 2022 to 2025

Source: KTMB, 2025

As the rate of accidents is on the rise, it is necessary to explore whether such commuting accidents influence the behavior and perception of the risks associated with railway workers commuting to and from work. In addition, study on the commuting habit toward safety measures and their intention to engage in precautionary actions can provide insight into how safety measures can be better communicated or enhanced.

According to statistics reported by the Social Security Organization (SOCSO) on Annual Report of SOCSO 2022, trend of commuting accidents in Malaysia from 2019 to 2022 shows significant fluctuations, with a rising trend in recent years. The highest commuting accidents in the four years were recorded in 2019, with a total of 37,846 accidents. But the number of commuting accidents fell to 30,618 in 2020 because of the lockdowns and reducing movement during the COVID-19 pandemic.

As the restrictions eased and commuting was resumed by workers, the accident figures began to rise again. A total number of 24,714 cases was recorded in 2021. While in 2022, the figure was increase to 33,421 cases stipulated 34.9% spike from the previous year. This recent spike indicates an alarming trend in the commuting accident.

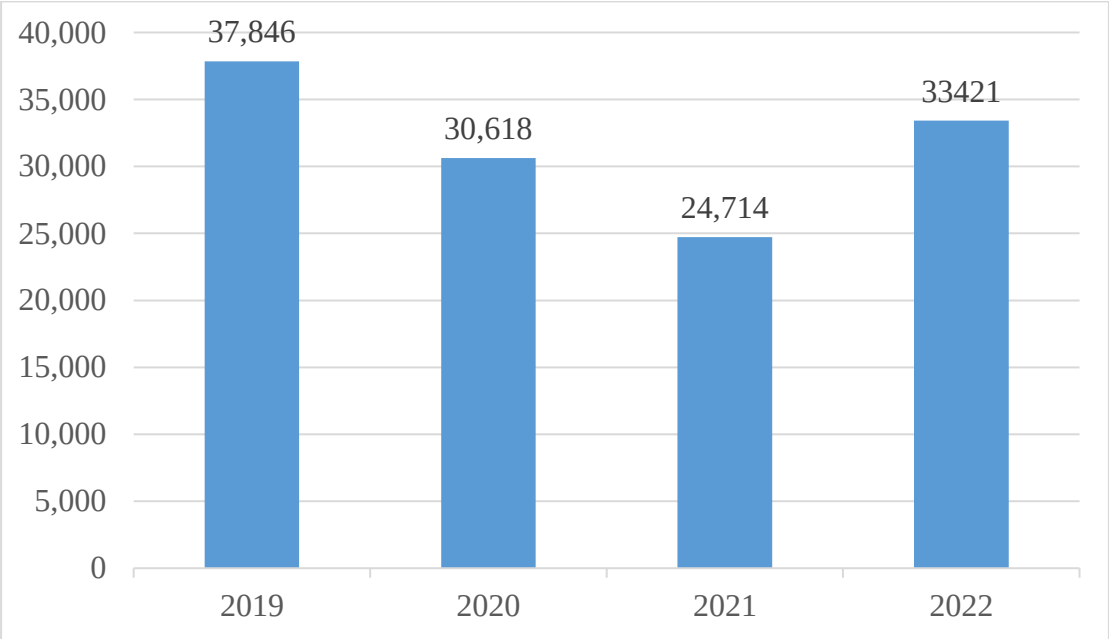

Figure 1.2
SOCSO data on commuting accident at Malaysia from 2019 to 2022.
Source: SOCSO, 2022

Commuting trips undertaken by nonprofessional drivers have been relatively underresearched in academic literature. Likewise, there are scarce data in the gray literature, i.e., company reports or other documents of this type (Fernandez et al., 2024). The fact that there is limited literature indicates that particular research must be carried out in order to understand the specific challenges and dangers to which this working population is subjected.

Commuting duration and timing are the main ideas to perceived risk. In a large United State (US) freight rail survey, the Federal Railroad Administration (FRA) Rail Fatigue Survey reported that locomotive engineers and conductors workers with extra-long commutes which is more than 60 minutes were 3 to 6 times more likely to have fatigue related driving events such as lane drifting, falling asleep at signals and near-crash than those with short commutes. From all the survey, nearly 40% were classified as highly fatigued. Long commutes also decrease resting windows, from a 12 hours duty into 14 to 15 hours a day and thereby increasing both actual risk and danger during ride or drive to home (FRA, 2023).

Morgan, Abbott, Furness, and Ramsay (2016) explored United Kingdom (UK) rail workers perceptions of accident risk factors through interviews with On Track Machine operator. The study suggest two main ideas which are pressure/fatigue and decision making/errors. Workers reported that long commutes after night shifts, called "transition time," made them feel unsafe, especially when tired and eager to get home. Many admitted will riding or driving even while fatigued rather than staying overnight, increasing perceived risk. Fatigue and time pressure also led to mistakes, bending rules, and under reporting incidents. These findings show that commuting after irregular shifts

and long hours is a significant safety concern, and that fatigue management and reporting culture are critical for reducing both actual and perceived risk.

This study aims to close this gap with the exploration of variables related to commuting safety of a railway workers. Through clarifying the highest risks and implications for targeted intervention, this study aims to contribute to the development of safer commuting policy and practice, and therefore improve the safety and well-being of railway workers.

1.3 Research Questions

1.3.1 What is the level of commuting risk perception among railway employees?

1.3.2 Is there a relationship between travel pattern (journey time and distance) and commuting risk perception among railway employees?

1.3.3 Does accident experience influence commuting risk perception among railway employees?

1.3.4 Does perceived effectiveness of preventive measures influence commuting risk perception among railway employees?

1.4 Research Objectives

1.4.1 To assess the level of commuting risk perception among railway employees.

1.4.2 To examine the relationship between travel pattern (journey time and distance) and commuting risk perception among railway employees.

1.4.3 To determine the influence of accident experience on commuting risk perception among railway employees.

1.4.4 To evaluate the influence of perceived effectiveness of preventive measures on commuting risk perception among railway employees.

1.5 Significance of the Study

Below outline the significance of the study.

1.5.1 Promoting safe and sustainable mobility strategies in companies

The study carried out made it possible to examine those factors that influence workers' perception of risk, which helps to identify the variables that should be the focus of the campaigns, measures, and actions developed by prevention services to contribute to the reduction in this type of accident (Fernandez et al., 2024). This understanding not only aids in enhancing the effectiveness of safety interventions but also promotes a culture of prevention within the organization. Moreover, by addressing the specific concerns and behaviors of employees related to mobility, companies can implement more sustainable and employee-centered transportation policies. Ultimately, these strategies contribute to safer commuting experiences, reduced workplace disruptions due to traffic-related incidents, and support broader corporate goals related to occupational health, safety, and environmental sustainability.

1.5.2 Addressing risk perceptions in variety of travel pattern

The study reveals how different modes of transport such as private vehicles, public transport, bicycle or walking are perceived differently by employees in terms of safety. Road traffic accidents are an important public health and safety concern globally, and Malaysia is no exception (Mohd Azami et al., 2024). By identifying the determinants

of such attitudes, organizations can redefine their policy for even closer alignment to workers safety concerns. This allows for more active and efficient commuting plans with attention both to safety and workers satisfaction. In addition, selective education and communications can be built to overcome misperceptions or lack of awareness about individual transport modes so that safer transport modes will be favored among employees.

1.5.3 Optimizing Workforce Mobility and Logistics

Findings from the research can also be used to optimize employee travel within and outside work facilities through coordination of risk information and transport modes with employees conduct. Besides eliminating occurrences that occur on travel, this optimizes overall operating effectiveness. Company can plan logistics more effectively by taking into account factors such as rush hour travel duration, mode of travel, and risk areas. Urban areas have increased traffic jams along with environmental pollution problems that are being triggered by an increased number of motor vehicles (Liu, Gao, Ni, & Ye, 2020). Additionally, the application of safety principles in mobility planning improves business resilience through decreased shocks from transport-related accidents, leading to a better workforce mobility system with increased resilience.

1.6 Scope of the Study

This study aims at the rail workers who commuting to and from work, focusing closely on how the travel pattern, accident experience and preventive measure influence the safety outcome. As railway employees tend to commuting to and from their workplace

destinations, it is important to identify the risks behind their travel pattern for the sake of their overall safety and wellbeing. Through a study of such factors, this research expects to identify significant threats and recommend avenues for commuting safety improvement.

The population of the study comprises employees of a selected railway company in Malaysia, specifically in Operation Control department, totaling 2,106 workers. This includes train crews, station manager, and administrative staff. They were chosen since they represent diverse modes of commuting and face unique safety hazards on their daily commute to and from the workplace. The fact that they come from a single railway company makes it easier to analyze that company's specific commuting hazards in-depth.

With one organization as the focus, the study shall provide specific results that can be directly used by the company and employees to apply practical safety measures as recommended by the study.

The research explores several variables of commuting safety. The dependent variable for this study is commuting risk perception, which is how employees experience the risk of commuting. While, the independent variables includes travel pattern, accident experience and preventive measure.

Through these areas, this study aims to contribute towards improved commuting safety policies and procedures in the selected railway company with the end result being a safer working environment for all railway employees.

1.7 Definition of Key Terms

1.7.1 Commuting Risk Perception

Perceived risk was defined as a judgements of people or workers when they are asked to characterize and evaluate hazardous activities and technologies (Slovic, 2016).

1.7.2 Travel Pattern

Method or means by which individuals regularly travel between their home and workplace. This can include various forms of transportation such as driving, public transit, cycling, or walking (Cambridge Dictionary, n.d.).

1.7.3 Accident Experience

Accident experience refers to an individual's prior involvement in workplace incidents, including both actual accidents (moments when injury or damage occurred) and near misses (incidents that could have caused harm but did not). It is understood as a "harmful and unexpected event" from which workers construct meaning and which can influence future safety behavior and risk perception. (Niza et al., 2008)

1.7.4 Preventive Measure

Preventive measures are defined as organized interventions such as legislative initiatives, enforcement, safety focused road designs, driver education, and public awareness campaigns aimed at reducing the likelihood of road traffic collisions and related injuries during the commute. (Akbari et al.,2024)

1.8 The Organisation of the Study

This study is organised in several chapters to encompass essential aspects of the study on travel pattern, accident experience and preventive measures with commuting risk perception of Malaysian railway workers. The organisation is as follows:

1.8.1 Chapter 1: Introduction

The first chapter provides an overview of the study, including the background of the study, research problem, and objectives. It also introduces the research questions, significance, and scope of the study. This chapter sets the stage for the research by outlining the importance of studying commuting safety for railway workers and the key variables which are travel pattern, accident experience and preventive measures that can impacting their safety during commutes.

1.8.2 Chapter 2: Literature Review

Chapter 2 will present a comprehensive review of the literature on commuting risk perception among railway employees, travel pattern, accident experience and preventive measure in a context of occupational safety and health in the railway industry. The chapter will set out relevant theory, models, and existing research findings that will inform the study's framework. It will identify gaps in the literature and serve as the basis for the research questions and hypotheses, demonstrating the rationale for the current study in the Malaysian context.

1.8.3 Chapter 3: Research Methodology

In this chapter, the study's research design and methodology will be expounded. It will explain how data was gathered, sampling methods, data gathering instruments (using questionnaires) and how the data gathered was analyzed. The chapter will also detail

the research instrument, explaining how validity, reliability, and ethical concerns are addressed in the study.

1.8.4 Chapter 4: Results and Discussion

The findings of the research based on data obtained through survey and will be presented and analyzed in Chapter 4. Chapter 4 will be concerned with answering the research questions and hypotheses testing developed while framing hypotheses in the initial phase of the research.

1.8.5 Chapter 5: Recommendation and Conclusion

The final chapter will be an interpretive chapter that connects the findings in Chapter 4 with the literature reviewed in Chapter 2. The chapter will interpret the implications of findings, establish patterns or trends, and suggest practical applications of the study. It will address the research questions in view of Travel Pattern, Accident Experience, and Preventive Measure Effectiveness impact commuting safety of railway workers.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

For railway employees, commuting frequently occurs at irregular hours, often after extended work shifts, and under conditions that may contribute to physical and mental fatigue. This section presents a review of existing literature based on commuting risk perception represent as dependant variable, and three independent variables, namely travel patterns, accident experience, and preventive measures. These variables are critically examined to explain how they influence and shape railway employees perceptions of commuting related risk.

2.2 Commuting Risk Perception

Commuting risk perception refers to commuters subjective evaluation of danger, safety, and vulnerability during daily travel, and it represents a crucial psychological mechanism linking travel conditions to behaviour, stress, and wellbeing. Importantly, this perception does not always align with objective risk levels, as it is shaped by prior experience, familiarity, perceived control, and situational context. Psychological research on traffic and safety behaviour indicates that repeated exposure to commuting risks can lead to habituation rather than heightened caution. Ngueutsa and Kouabenan (2017) demonstrate that individuals with extensive accident histories, including those involved in severe or multiple accidents, often perceive road travel as less risky and report lower levels of safe behaviour. This counterintuitive finding suggests a process of risk normalisation, whereby frequent exposure reduces emotional salience and fosters a sense of invulnerability or fatalistic beliefs, ultimately weakening self-protective responses.

From a broader perspective, commuting risk perception is closely intertwined with subjective wellbeing. Chatterjee et al. (2020) identify perceived safety as a core affective dimension of the commuting experience, alongside stress and satisfaction. Their critical review highlights that congestion, unpredictability, crowding, and lack of control substantially elevate perceived risk during commuting, particularly when individuals feel unable to influence travel conditions. Such perceptions contribute to immediate negative emotional states, such as anxiety and stress, which can spill over into work performance, leisure satisfaction, and work life balance. Conversely, commuting environments perceived as safer often associated with active travel modes or supportive infrastructure tend to reduce perceived risk and enhance commute satisfaction.

Temporal and environmental factors further shape commuting risk perception. Kapitza (2024) shows that perceptions of safety vary markedly according to the time of day, with nighttime commuting consistently associated with higher levels of perceived unsafety. These heightened perceptions are especially pronounced among women and public transport users and are strongly influenced by contextual cues such as darkness, reduced visibility, fewer people present, and unfamiliar social interactions. Importantly, these perceptions are not solely based on actual crime or accident exposure but are socially and environmentally constructed through sensory and situational signals.

Taken together, the literature illustrates that commuting risk perception is dynamic, context dependent, and socially patterned. It is influenced by accumulated experience, perceived control, environmental conditions, and temporal context, and it plays a mediating role between objective commuting conditions, behavioural responses, and commuter wellbeing. Understanding how risk perception evolves is therefore essential

for designing effective transport safety interventions, improving commuting environments, and addressing wellbeing outcomes among regular commuters.

2.3 Travel Pattern and Perceived Risk

Road accidents are a significant public health and safety issue globally, and Malaysia is not an exception either (Mohd Azami et al., 2024). Travel patterns strongly influence how railway employees perceive risk during their commute. For railway employees, commuting often happens at odd hours, after long shifts, and sometimes over long distances. These factors increase fatigue and make the commute feel dangerous.

A United Kingdom (UK) study of On Track Machine (OTM), railway workers showed that long drives home after night shifts made workers feel unsafe. Many said they were very tired but still chose to drive home instead of staying in a hotel because they wanted to be with family. Some admitted to continuing to drive even when they felt their eyes closing, saying "it's only another 10 miles," even though they knew this was the most dangerous part of the trip (Morgan, Abbott, Furness, & Ramsay, 2016).

The Federal Railroad Administration (FRA) Rail Fatigue Survey (2023) found that locomotive engineers and conductors who had extra-long commutes (more than 60 minutes) were 3 to 6 times more likely to experience fatigue related driving condition compared to those with short commutes. These conditions includes drifting out of lanes, falling asleep at traffic lights, and near-crashes. Almost 40% of respondents were highly fatigued, and fatigue during commuting was linked to a higher crash risk. Long commutes also cut into rest time, turning from a 12 hours shift into 14 to 15 hours a day, which worsens fatigue and perceived risk. The survey also revealed extreme variability in start times (more than 4 to 8 hours day to day) and frequent day and night flips, which disrupt sleep and heighten perceived danger during commutes (FRA, 2023).

Other studies show similar patterns. Jain (2024) reported that during pandemic COVID-19, employees who could not work from home faced higher commuting stress and costs, especially when public transport was limited. For railway employees, who cannot work remotely, this means greater reliance on personal vehicles, longer trips, and higher perceived risk. Tan et al. (2023) found that workers relocating to car-dependent suburbs increased commute distances and shifted to driving, which raises fatigue and risk perception for rail staff living far from depots.

Urban design also matters. Hatamzadeh (2021) showed that pedestrian-friendly routes and flexible work hours reduce stress and make commuting feel safer. For rail employees who walk near tracks or stations, safe walking paths and green spaces can lower perceived risk. Maghelal et al. (2025) added that poor road connectivity and too many bus stops increase travel time and uncertainty, which can make commuting feel more hazardous.

Sociodemographic factors also significantly shape travel patterns among working individuals (Babu and Anjaneyulu, 2021). Age positively influences the likelihood of complex travel patterns, while males tend to favor complex-independent trips compared to females. Marital status is a strong determinant, with married individuals being nearly three times more likely to engage in joint travel. Education level also plays a role, as workers with lower educational attainment are more inclined toward simple-independent patterns. Some of the strongest influences on commuters' travel mode choice, which involve socio-economic attributes such as income level and marital status, and travel-related attributes like household ownership of bicycle and car size, travel duration, and availability of transit stations (Liu, Gao, Ni and Ye, 2020).

2.4 Accident Experience and Perceived Risk

Past accidents and near-misses shape how employees think about commuting risk. Real accidents usually increase perceived risk because they are memorable and costly. However, whether behavior changes depends on how employees interpret the event.

The FRA survey revealed that fatigue not only affects train operation but also commuting safety. Highly fatigued engineers and conductors were up to six times more likely to crash or nearly crash during their commute. This experience likely increases their perception that commuting is dangerous. However, research shows that near-misses can have the opposite effect. Terum and Svartdal (2019) found that repeated near-accidents often make people feel safer, not riskier, unless they reflect on what they could have done differently. Terum and Svartdal (2019) investigated whether traffic accidents and near-accidents influence subsequent driving behavior and the cognitive-emotional mechanisms underlying these effects. Repeated near-accidents reduce safe driving behavior, supporting the near-miss bias theory, which posits that close calls can increase risk-taking rather than caution. Accidents did not significantly improve objective safe driving scores, though participants reported feeling more cautious, indicating a gap between perceived and actual behavioral change. Negative emotions such as regret and unpleasantness predict increased cautiousness, whereas relief and gratitude do not, emphasizing the role of affective discomfort in motivating safer behavior. Without this reflection, employees may underestimate commuting risk after "lucky escapes."

Other studies show how accident experience influences attitudes. Gonçalves et al. (2008) and Niza et al. (2008) found that workers who had accidents often blamed external factors (like the company or environment) instead of their own actions. They

are explored how personal experience of occupational accidents influences workers perceived risk, focusing on causal attributions and definitions of accidents. Workers with prior accident experience tend to adopt defensive attribution patterns, focusing on external causes and minimizing personal responsibility, consistent with the defensive attribution hypothesis.This defensive thinking can reduce motivation to change behavior, even if perceived risk is high. For railway employees, if a crash is seen as "bad luck," they may continue risky commuting habits.

Mode of transport also matters. Konkor (2021) showed that motorcycle users had much higher accident than car users. At Malaysia, motorcycles continue to be the most active road user in crashes, with Selangor having the highest number of crashes (Mohd Azami et al., 2024). On the term of risk perception among motorcyclists, they feel more safer when they travel on straight roads and non-access junction roads as these road conditions reduce the likelihood of unexpected turns by other vehicles (Saibin et al., 2023). If rail staff use motorcycles to reach remote sites, their perceived risk should be high but if they normalize this risk, they may not take precautions. Other than that, alcohol consumption and poor knowledge of speed limits emerged as strong predictors of accident involvement, while positive road safety perceptions mitigated risk. Male and married individuals were more likely to experience accidents, reflecting cultural norms and risk-taking behaviors prevalent in the region.

2.5 Preventive Measures and Perceived Risk

Preventive measures can reduce perceived risk and actual danger to the commuters. Irregular start times and frequent day/night changes doubled the odds of being highly

fatigued. Employees who feel supported by clear schedules and fatigue controls will likely perceive commuting as safer.

Other studies highlight similar strategies. Hatamzadeh (2021) showed that flexible work hours reduce stress and improve commuting comfort. Maghelal et al. (2025) suggested optimizing bus routes and stop spacing to shorten trips. For rail staff, this means planning rosters and transport options to minimize fatigue.

Behavioral interventions also matter. Terum & Svartdal (2019) recommend teaching employees to reflect on near-misses using "what I could have done" thinking. This increases caution and risk awareness. Gonçalves et al. (2008) argue for training that balances responsibility—so employees don't just blame external factors.

Simple coping strategies help too. The FRA survey found that talking to a colleague, drinking coffee, and adjusting ventilation were common fatigue countermeasures. But these are short-term fixes. Long-term solutions include predictable schedules, mandatory rest periods, and anonymous fatigue reporting systems.

When employees see strong preventive measures such as fair rosters, safe walking routes, and clear fatigue policies will make they feel their commute is less risky. Without these, perceived risk and actual danger rise.

Policy maker also should aim high-risk areas and develop interventions that address the specific needs of different categories of road users, prioritizing motorcyclists (Mohd Azami et al., 2024). In addition, continuous monitoring and evaluation of road safety programs are necessary to deal with changing conditions and sustain road safety gains in the long term (Mohd Azami et al., 2024).

The study looks at the commuting routines and perceived risk of employees at a Spanish multinational corporation and investigates the substantial impact of traffic accidents on risk perception and recommends effective preventive measures (Fernandez et al., 2024). The questionnaire discovers that commuting accidents were reported in 15.8% of employees with car and motorbike drivers at the highest frequency. Accident participants had greater risks, and longer travel times and distances further enhanced this perception. The study also found that a road safety training program alone did not alter risk perceptions much, suggesting that personal experience and trip factors have greater effects. Successful preventive strategies that have been recognized include providing sufficient parking, better transport connections, and flexible work hours, which help reduce the time spent commuting and stress (Fernandez et al., 2024). The research points out the necessity of determining the particular challenges and threats presented by commuting. By covering both the physical and mental impacts of commuting accidents, it provides a comprehensive overview of how these accidents affect employees' daily lives and overall health. The recommendations for flexible work hours, promoting public transport, and particular road safety training are practical and feasible steps that companies can adopt to enhance employee safety and satisfaction. This all-rounded strategy not only works in the interest of employees but also increases the company's overall productivity and stability.

2.6 Summary of the Chapter

The reviewed literature places great emphasis on commuting safety as a fundamental aspect of urban mobility and public health. In a number of studies, commuting has been identified as a daily activity that is full of risk, especially for vulnerable users like motorcyclists and people living in highly congested urban environments. Motorcycles

are over-represented in crashes in Malaysia, with states like Selangor having chronically higher crash rates, demonstrating the critical need for local safety interventions. Quality of the road infrastructure affects safety of commuting further—motorcycle riders, for instance, are vulnerable due to poor road conditions, narrowness of road lanes, and inconsiderate drivers. Even in cities, in addition to convenience, perceived safety will also be the determinant of commuting mode with different factors such as congestion, accident history, and exposure to risks affecting similar decisions. For workers within working places, staff risk perception depends on longer distance traveling and actual history of experience from accidents but schooling on security doesn't influence perceptions. Instead, solutions such as flexible hours of work, improved public transport connectivity, and secure road provision are recognized as more effective solutions for reducing stress and promoting safer journey to work. Commuting safety is observed by the literature as a multidisciplinary problem involving holistic solutions ranging from transport policy and road planning to behavior change and employer support to reduce accidents and to enhance the commute generally.

2.7 Research Framework

The study design in this research is meant to introduce the relationship between the variables that contribute to travel pattern, accident experience and preventive measures among railway employees. The design is based on the study objectives and aims to explore how various factors affect the safety perception of railway employees, perceived risk in their journey to work, and uptake of preventive measures. The following key variables are central to the research framework:

2.7.1 Commuting Risk Perception

This is the dependent variable, which is how employees experience the risk of commuting, which might be moderated by other variables such as sociodemographic variables, travel time, accidents, and safety education.

2.7.2 Travel Pattern

This is independent variable, which refers to the commuting behavior of employees, including the mode of transportation, frequency of travel, distance, and time taken to reach the workplace. These patterns can influence the level of exposure to hazards and perceived risk during commuting.

2.7.3 Accident Experience

This is independent variable, which captures the history of commuting-related accidents or near-miss incidents experienced by employees. Past accident experiences may shape their perception of risk and influence their adoption of preventive measures.

2.7.4 Preventive Measure

This is independent variable, which represents the actions taken by employees to reduce commuting risks, such as using personal protective equipment, attending safety briefings, or choosing safer travel routes. These measures can affect both perceived risk and actual safety outcomes.

2.8 Hypothesis Development

H_1: There is a positive significant between travel pattern and perceived risk of work-home commute.

H_2: There is a positive significant between accident experience and perceived risk on the journey to and from work.

H_3: There is a positive significant on the preventive measure with perceived risk.

Table 2.1
Assessment of Structural Model (Direct Effect)

Estimated Paths	**Summary**
Hypothesis 1: Travel Pattern → Perceived Risk of Commuting	Hypothesis H1 suggests that travel pattern, have a significant relationship with how workers perceive commuting risks.
Hypothesis 2: Accident Experience → Perceived Risk of Commuting	Hypothesis H2 indicates that workers who have been involved in a commuting accident will have a higher perception of risk in the future.
Hypothesis 3: Preventive Measure → Perceived Risk of Commuting	Hypothesis H3 posits that the more preventive measure taken in place, the lower the perceived risk during the commute.

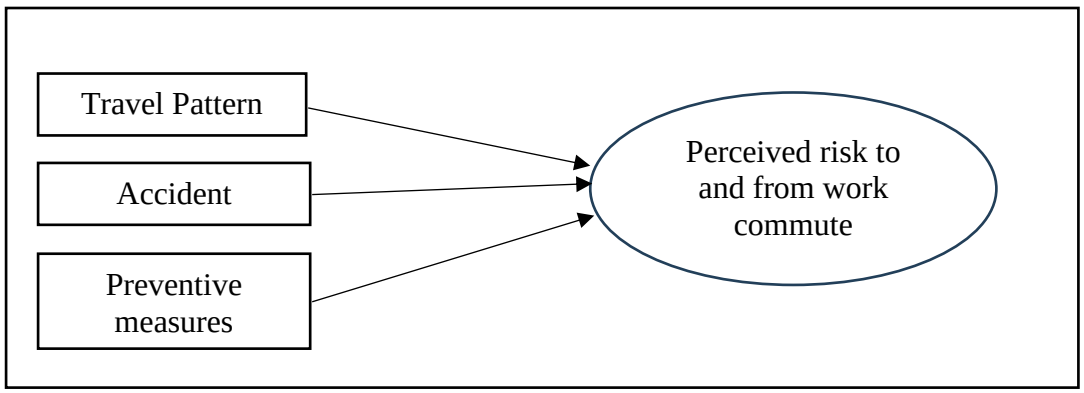

Figure 2.1
Conceptual Model

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter outlines the methodology employed to research the travel pattern, accident experience, and preventive safety practice attitudes towards commuting risk perception of railway workers. Quantitative research with focus on the use of standardized questionnaires to collect numerical data suitable for statistical analysis was employed. This chapter presents an outline of the research design, population sampling, data collection technique, data analysis, ethical concerns, and study guides.

3.2 Research Design

The study employs a quantitative research design, in which numerical data can be gathered and examined in search of patterns, relationships, and correlations between travel pattern, accident experience, and preventive safety measures. The study design is focused on gathering quantifiable data from the respondents through the administration of a standard questionnaire that can statistically be analyzed with various statistical techniques in a bid to come up with meaningful conclusions.

The questionnaire used in this study was adopted by Fernandez et al. (2024) to study commuting patterns, perceived risk, and safety measures. Employing this validated questionnaire ensures reliability and validity when measuring variables of interest.

3.3 Sample Size Calculation

Target population for this study is 2,106 employees of Malaysia railway company, specifically operation control department employees. Because of large number of

population, a simple random sampling method would be adopted towards any representative of different demographic strata.

To determine the correct sample size, a Raosoft sample size calculator was utilized, taking into account the entire population (2,106), 95% confidence level (CL), and 5% margin of error. Based on this calculation, the study suggests the sample size of 326 participants. This sample size will be sufficient to carry out adequate statistical power to explore the data and draw valid conclusions and simultaneously help ensure that findings are generalizable to the general population.

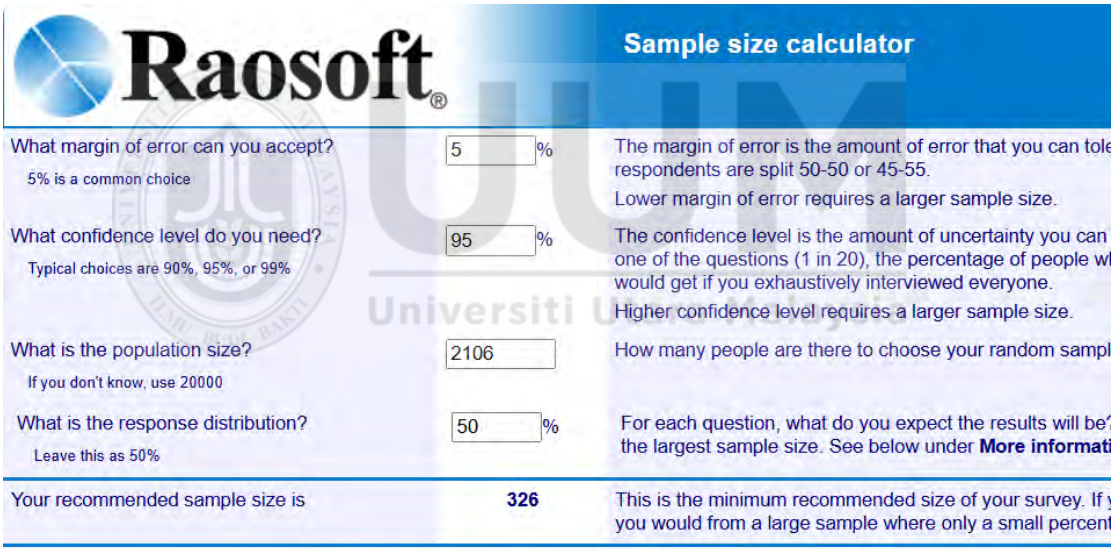

Figure 3.1
Raosoft application on the web to find a sample size

3.4 Data Collection

The data will be collected by delivering the self-completion online survey through Microsoft Form. The survey designed by Fernandez et al. (2024) and some additional information will be used to collect relevant data about travel pattern, accident experience, commuting risk perception and preventive measure.

Key sections of the questionnaire include:

- Sociodemographic Information: Gender, age and academic level (Table 1).
- Travel Pattern: Mode of transport, distance, time spent commuting,
- Accident Experience: Previous accidents accident experience. Some of the questions using a 5-point Likert scale.
- Commuting Risk Perception: Commuters' perception of risks associated with different transport-related situations, using a 5-point Likert scale.
- Preventive Measures: Assessment of various safety measures proposed by the company for improving worker mobility, also measured on a 5-point Likert scale.

Table 3.1
Sociodemographic Data of the Sample

Demographic Feature	**Category**
Gender	Female
	Male
Age Range	<25 years
	26-35 years
	36-45 years
	46-55 years
	56-65 years
Academic Level	Primary School
	Secondary School
	Technical/Vocational Training
	Diploma
	Bachelor’s Degree
	Post Graduate (Master/PHD)

3.5 Instrument Development

The questionnaire used in this study was adapted from Fernández et al. (2024), with modifications to suit the context of the topic “Commuting Risk Perception Among

Railway Employees in Malaysia". The instrument consists of seven sections, which are demographics, travel pattern, accident experience, commuting risk perception and preventive measures. A total of 18 questions were included in the questionnaire with 4 from the questions is the Likert Scale question.

Commuting risk perception section was assessed using six items on a five-point Likert scale (1 = Highly Disagree to 5 = Highly Agree), covering different situations such as routes to and from work, workplace, recreation, sports, and home. Preventive measures were measured using six items evaluating the perceived effectiveness of organizational interventions.

Certain constructs were measured using single indicator measures. For example, the accident experience was captured through a single question regarding involvement in commuting accidents. This approach is consistent with the original instrument and supported by prior research. According to Matthews, Pineault, and Hong (2022), single-item measures can demonstrate high content validity and predictive validity when constructs are conceptually simple and clearly defined. Their validation of the Single-Item Compendium for Organizational Psychology across 91 constructs revealed that single-item measures often perform comparably to multi-item scales in terms of criteria validity and reliability. Other researcher, Syropoulos (2018) notes that perceived safety has frequently been assessed using single-item questions such as "I generally feel safe" in practical research. Using single item measures helps keep the survey short and reduces fatigue for respondents.

All items were presented in a structured format, and responses were recorded using categorical options or Likert scales question, depending on the nature of the variable.

The questionnaire was pre-tested to ensure clarity and relevance to the target population.

3.6 Sampling

A simple random sampling technique will be employed to select respondents from the population in order to ensure that each employee has an equal and independent chance of being included in the study, thereby enhancing the representativeness of the sample and minimizing sampling bias.

Data collection will be conducted using an online survey questionnaire. The questionnaire will be distributed to potential participants within the Operation Control Department via a WhatsApp link to facilitate efficient communication and ease of access. The data collection period is scheduled to take place from **15 December 2025 until 30 December 2025,** during which respondents will be given adequate time to complete and submit their responses voluntarily.

3.7 Ethical Considerations

This study adheres to strict ethical standards to protect the rights of participants. The privacy, anonymity, and confidentiality of the data of the workers taking part in the study were protected. Informed consent was also obtained from the workers and the company and from all the workplaces involved in the research. All data collected in the study were used only for strictly scientific purposes and not for any other purpose.

3.8 Techniques of Data Analysis

For this study, descriptive analyses of all the variables were carried out to describe and characterize the commuting accidents produced by the company workers analyzed, as well as their perceptions of the problem. Additionally, tests of comparison of quantitative variables were used to assess whether there are significant differences between groups of workers, as well as Pearson correlations to identify the existence of possible relationships between variables. A multiple regression test was also carried out to identify the degree to which the perceived risk of commuting can be predicted based on the study variables. Once the data were obtained, the relevant statistical analyses were carried out using c IBM SPSS (Statistical Package for Social Sciences), version 27.0.

3.9 Summary of the Chapter

This chapter provides a comprehensive outline of the methodology used in the study, including the research design, sampling strategy, data collection process, and statistical methods for analyzing the data. The methodological approach is designed to ensure reliable and valid results that can address the research objectives and test the hypotheses effectively.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter outlines the findings from the analysis conducted to achieve the objectives of this research and to validate the hypotheses formulated in earlier chapters. The data comprises responses from 193 railway employees across Malaysia, collected through a structured questionnaire and analyzed using SPSS version 27.0. The analysis followed a systematic approach, beginning with preliminary data screening to ensure the data was free from outliers and met the assumptions required for parametric techniques. Reliability and validity checks were performed to confirm the internal consistency of the survey items.

The chapter is organized into several sections. It begins with an overview of the response rate and the demographic profile of the respondents. This is followed by a reliability analysis to assess the consistency of the measurement scales. Next, the results of the normality test are presented to determine whether the distributions of the dependent and independent variables satisfy the normality assumption. Subsequently, descriptive statistics are provided to summarize the central tendencies and variability of key constructs, including commuting risk perception, travel patterns, accident experience, and preventive measures.

After the descriptive analysis, the chapter presents the results of correlation analysis to explore the relationships among the study variables. Finally, the outcomes of hypothesis testing, using multiple regression and ANOVA, are reported to evaluate the influence of travel patterns, accident experience, and preventive measures on commuting risk perception among railway employees.

Through this structured process, the chapter provides empirical evidence addressing the research questions and objectives, offering insights into how commuting behaviors and safety practices shape risk perception within the railway workforce.

4.2 Rate of Questionnaire Return

A total of 326 questionnaires were distributed to railway employees specifically within the operation control departments. Out of these, 193 valid responses were received, resulting in a response rate of approximately 59.2%. This reduced sample size, may affect the generalizability of the findings, but still provides a substantial dataset for analysis.

4.3 Demographic Profile of Respondents

The demographic characteristics of the respondents provide context for interpreting the findings. Table 4.1 below summarizes the key demographic variables.

Table 4.1
Key Demographic Variables

Variable	Category	Frequency
Gender	Male	190
	Female	3
Age Group	<25 years	0
	26-35 years	21
	36-45 years	75
	46-55 years	85
	56-65 years	12

Table 4.1 (Continued)

Variable	Category	Frequency
Education Level	Primary School	0
	Secondary School	81
	Technical/Vocational Training	65
	Diploma	40
	Bachelor's Degree	7
	Postgraduate (Master/PhD)	0

4.4 Frequency Analysis of Respondents and Commuting Pattern

4.4.1 Frequency Analysis of Respondents by Gender

The gender distribution of respondents is highly skewed toward male employees. Out of 193 participants, 190 respondents (98.4%) were male, while only 3 respondents (1.6%) were female. This reflects the male-dominated nature of the railway industry, particularly in operational roles.

Table 4.2
Frequency Analysis of Respondents by Gender

Gender	Frequency	Percentage
Male	190	98.4%
Female	3	1.6%
Total	193	100%

4.4.2 Frequency Analysis of Respondents by Age Group

The age structure of respondents indicates that the workforce is predominantly middle-aged. The largest group comprises employees aged 46–55 years (n = 85, 44.0%), followed by those aged 36–45 years (n = 75, 38.9%). A smaller proportion falls within the 26–35 years category (n = 21, 10.9%), and only 12 respondents (6.2%) are aged 56–65 years. There were no respondents below 25 years of age.

Table 4.3
Frequency Analysis of Respondents by Age Group

Age Group	Frequency	Percentage
<25 years	0	0%
26-35 years	21	10.9%
36-45 years	75	38.9%
46-55 years	85	44.0%
56-65 years	12	6.2%
Total	193	100%

These results suggest that most respondents are in the productive middle-age cohorts (36–55 years), which is typical for experienced railway employees.

4.4.3 Frequency Analysis of Respondents by Education Level

The educational background of respondents shows that the majority have completed secondary school (n = 81, 42.0%) or technical/vocational training (n = 65, 33.7%). Additionally, 40 respondents (20.7%) hold a diploma, and only 7 respondents (3.6%) have a bachelor's degree. There were no respondents with postgraduate qualifications or only primary education.

Table 4.4
Frequency Analysis of Respondents by Education Level

Education Level	Frequency	Percentage
Primary School	0	0%
Secondary School	81	42%
Technical/Vocational Training	65	33.7%
Diploma	40	20.7%
Bachelor's Degree	7	3.6%
Postgraduate (Master/PhD)	0	0%
Total	193	100%

This distribution highlights that most railway employees possess practical and technical qualifications, which aligns with the operational nature of their roles.

4.4.4 Frequency Analysis of Respondents by Mode of Transportation

The analysis of commuting mode of transport reveals that the majority of respondents rely on motorcycles for their daily travel. Specifically, 166 respondents (86.0%) reported using motorcycles, while 26 respondents (13.5%) commute by car. Only 1 respondent (0.5%) uses intermodal transport (two or more types), and none reported using public transport, bicycles/electric scooters, or walking.

Table 4.5
Frequency Analysis of Respondents by Mode of Transportation

Mode of Transportation	Frequency	Percentage
Car	26	13.5%
Motorcycle	166	86.0%
Public Transport	0	0%
Bicycle/Electric Scooter	0	0%
Walking	0	0%
Intermodal Transport	1	0.5%
Total	193	100%

These results indicate a strong preference for motorcycles among railway employees, which may have implications for commuting risk perception and safety measures.

4.4.5 Frequency Analysis of Respondents by Preferred Mode of Transportation

The analysis of preferred commuting modes shows that the majority of respondents favor motorcycles for their daily travel. Specifically, 164 respondents (85.0%) indicated motorcycles as their preferred mode, while 28 respondents (14.5%) prefer commuting by car. Only 1 respondent (0.5%) reported using intermodal transport (two or more types), and none expressed a preference for public transport, bicycles/electric scooters, or walking.

Table 4.6
Frequency Analysis of Respondents by Preferred Mode of Transportation

Prefered Mode of Transportation	Frequency	Percentage
Car	28	14.5%
Motorcycle	164	85.0%
Public Transport	0	0%
Bicycle/Electric Scooter	0	0%
Walking	0	0%
Intermodal Transport	1	0.5%
Total	193	100%

These results indicate a strong preference for motorcycles among railway employees, which aligns with the actual mode of transportation used and may have implications for commuting risk perception and safety strategies.

4.4.6 Frequency Analysis of Respondents by Residential Area

The distribution of respondents by residential area indicates that the majority reside in urban locations. The largest group comprises employees from urban areas (n = 179, 92.8%), while only a small proportion of respondents are from rural areas (n = 14, 7.2%). This suggests that the workforce is predominantly urban-based, which may influence commuting patterns and risk perception.

Table 4.7
Frequency Analysis of Respondents by Residential Area

Residential Area	Frequency	Percentage
Rural	14	7.2%
Urban	179	92.8%
Total	193	100%

These results highlight that most respondents live in urban areas, which is typical for railway employees working in centralized operational hubs.

4.4.7 Frequency Analysis of Respondents by Commuting Distance

The commuting distance of respondents indicates that most employees live relatively close to their workplace. The largest group comprises those residing within 0–5 km (n = 72, 37.3%), followed closely by employees living 6–10 km away (n = 69, 35.8%). A smaller proportion commutes 11–15 km (n = 22, 11.4%), while 16–20 km and 21–50 km categories each account for 15 respondents (7.8% each). There were no respondents commuting more than 50 km.

Table 4.8
Frequency Analysis of Respondents by Commuting Distance

Distance (KM)	Frequency	Percentage
0–5 KM	72	37.3%
6–10 KM	69	35.8%
11–15 KM	22	11.4%
16–20 KM	15	7.8%
21–50 KM	15	7.8%
50–100 KM	0	0%
>100 KM	0	0%
Total	193	100%

These results suggest that the majority of respondents live within 10 km of their workplace, which may reduce commuting time and influence risk perception compared to those traveling longer distances.

4.4.8 Frequency Analysis of Respondents by One-Way Travel Time

The analysis of one-way travel time shows that most respondents have relatively short commuting durations. The largest group comprises employees who travel less than 10 minutes (n = 73, 37.8%), followed closely by those commuting 11–20 minutes (n = 77, 39.9%). A smaller proportion spends 21–30 minutes on their commute (n = 21, 10.9%), while 31–40 minutes accounts for 17 respondents (8.8%). Only 5 respondents (2.6%) reported commuting 41–50 minutes, and none reported travel times exceeding 50 minutes.

Table 4.9
Frequency Analysis of Respondents by One-Way Travel Time

Travel Time	Frequency	Percentage
<10 minutes	73	37.8%
11–20 minutes	77	39.9%
21–30 minutes	21	10.9%
31–40 minutes	17	8.8%
41–50 minutes	5	2.6%
>50 minutes	0	0%
Total	193	100%

These results suggest that the majority of respondents have short commuting times (less than 20 minutes), which may reduce fatigue and commuting-related risks compared to longer travel durations.

4.4.9 Frequency Analysis of Respondents by Accident Involvement

The analysis of accident involvement during commuting indicates that the vast majority of respondents have not experienced such incidents. Specifically, 171 respondents

(88.6%) reported no involvement in commuting accidents, while 22 respondents (11.4%) indicated that they had been involved in an accident during their commute.

Table 4.10
Frequency Analysis of Respondents by Accident Involvement

Accident Involvement	Frequency	Percentage
Yes	22	11.4%
No	171	88.6%
Total	193	100%

These results suggest that although commuting accidents are relatively uncommon among railway employees, the presence of 11.4% affected individuals highlights the importance of implementing effective safety measures and awareness programs to mitigate commuting risks.

4.4.10 Frequency Analysis of Transport Type During Accident

Among respondents who reported involvement in a commuting accident, the majority were using motorcycles at the time of the incident. Specifically, 19 respondents (86.4%) indicated motorcycle use, while 3 respondents (13.6%) were driving cars. None of the respondents reported using public transport, bicycles/electric scooters, or walking during the accident.

Table 4.11
Frequency Analysis of Transport Type During Accident

Tranport Type	Frequency	Percentage
Car	3	13.6%
Motorcycle	19	86.4%
Public Transport	0	0%
Bicycle/Electric Scooter	0	0%

Table 4.11 (Continued)

Tranport Type	Frequency	Percentage
Walking	0	0%
Total	22	100%

These results highlight that motorcycles are the most common mode of transport involved in commuting accidents among railway employees, which underscores the need for targeted safety interventions for motorcyclists.

4.4.11 Frequency Analysis of Responsibility for Accident

Among respondents who reported involvement in a commuting accident, the majority indicated that they were personally responsible for the incident. Specifically, 16 respondents (72.7%) stated that the accident was caused by themselves, while 6 respondents (27.3%) attributed responsibility to the other party involved. None of the respondents selected "Other" as the cause.

Table 4.12

Frequency Analysis of Responsibility for Accident

Tranport Type	Frequency	Percentage
Myself	16	72.7%
Other party involved	6	27.3%
Other	0	0%
Total	22	100%

These results suggest that self-attributed responsibility is the predominant factor in commuting accidents among railway employees, which may indicate the need for enhanced driver awareness and training programs to reduce human error.

4.4.12 Frequency Analysis of Medical Leave Requirement

Among respondents who reported involvement in a commuting accident, the majority did not require medical leave. Specifically, 14 respondents (63.6%) indicated that they did not take medical leave, while 8 respondents (36.4%) reported requiring medical leave as a result of the accident.

Table 4.13
Frequency Analysis of Medical Leave Requirement

Medical Leave Required	Frequency	Percentage
Yes	8	36.4%
No	14	63.6%
Total	22	100%

These results suggest that while most commuting accidents did not result in medical leave, a significant proportion (over one-third) required time off work, highlighting the potential impact of commuting incidents on employee health and productivity.

4.5 Reliability Analysis

Reliability analysis was conducted to determine the internal consistency of the constructs used in this study. A Cronbach's Alpha value above 0.70 is generally considered acceptable, while values above 0.80 indicate good reliability, and values above 0.90 indicate excellent reliability (George & Mallery, 2004).

According to conventional thresholds:

- $\alpha \geq 0.9$ = Excellent
- $0.8 \leq \alpha < 0.9$ = Good

- $0.7 \leq \alpha < 0.8$ = Acceptable

The results of the reliability analysis for each construct are presented in Reliability Test below.

4.6 Reliability Test

To further assess the internal consistency of the measurement instrument, a Cronbach's Alpha test was performed using SPSS. Reliability analysis for each variables using Cronbach's Alpha indicated that the instruments measuring Commuting Risk Perception ($\alpha = 0.914$) and Preventive Measures ($\alpha = 0.751$) exceeded the minimum acceptable threshold of 0.70, demonstrating good internal consistency. Independent-samples t-tests revealed that Accident Experience, Travel Distance, Travel Time, and Preventive Measures had statistically significant effects on Commuting Risk Perception ($p < 0.05$), indicating meaningful differences in perceived commuting risk across groups.

Table 4.14
Reliability Analysis for each variables

Variable	Cronbach's Alpha	Standard Alpha	Result	t-value	p-value	Interpretation
Commuting Risk Perception	0.914	0.70	Reliable	–	–	–
Preventive Measures	0.751	0.70	Reliable	–	–	–
Accident Experience → Risk Perception	–	–	–	6.03	<0.001	Significant
Travel Distance → Risk Perception	–	–	–	2.23	0.028	Significant

Table 4.14 (Continued)

Variable	Cronbach's Alpha	Standard Alpha	Result	t-value	p-value	Interpretation
Travel Time → Risk Perception	–	–	–	2.19	0.032	Significant
Preventive Measures → Risk Perception	–	–	–	2.01	0.046	Significant

4.6.1 Item-Total Statistics and Internal Consistency Analysis

To evaluate the reliability and internal consistency of the questionnaire, an item-total statistics analysis was conducted as shown in Table 4.15. This study reported Cronbach's Alpha for the scale with each item removed, corrected item-total correlations, and scale variances. The majority of the items demonstrated acceptable corrected item-total correlations, indicating strong alignment with the overall construct and confirming that these items make a meaningful contribution to measuring commuting risk perception and related factors.

In cases where any item was deleted, the Cronbach's Alpha values remained relatively stable, ranging between 0.752 and 0.775, which suggests that none of the items significantly degraded the internal consistency of the scale. However, a few items exhibited substantially lower corrected item-total correlations. For example, the item "*Implementing company road safety regulations to the workers*" recorded a correlation below 0.20, indicating weak agreement with the total scale. Such low-performing items may not adequately measure the intended construct and could benefit from revision or removal in future iterations of the questionnaire.

Notwithstanding these slightly underperforming items, the Cronbach's Alpha value demonstrates acceptable internal consistency reliability of the instrument in measuring commuting risk perception among railway employees. Overall, the analysis provides strong support for the internal consistency of the scale, as most items contribute meaningfully to the assessment of commuting risk and related organizational factors.

Table 4.15
Item Total Statistics

Full Item Wording	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item–Total Correlation	Cronbach's Alpha if Item Deleted
In your opinion, indicate which reasons contribute to the high rate of road accidents in Malaysia.				
Driver-related factors	72.674	21.794	0.373	0.762
Vehicle-related factors	73.062	21.642	0.237	0.769
Environmental factors	73.052	20.82	0.43	0.756
In your opinion, indicate which driving behaviours attributed to the high rate of road accidents in Malaysia.				
Speeding	72.637	21.847	0.437	0.761
Aggressive Driving	72.658	21.924	0.373	0.763
Mobile phone usage	72.855	21.646	0.304	0.764
Drug and drink driving	72.689	21.955	0.323	0.764
Fatigue driving	72.736	21.414	0.417	0.759
Stress or workload driving	73.244	21.144	0.275	0.767

Table 4.15 (Continued)

Full Item Wording	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item–Total Correlation	Cronbach's Alpha if Item Deleted
Indicate the level of risk you feel in the following situations/location.				
Route from home to workplace	74.679	19.813	0.457	0.752
Route from workplace to home	74.684	19.894	0.441	0.753
Around workplace area	75.088	19.977	0.401	0.757
Around home area	75.373	20.277	0.298	0.769
Indicate the effectiveness of the following measures in preventing road accidents at the workplace.				
Availability of parking at the workplace.	73.845	20.726	0.292	0.767
Flexible working hours.	73.228	20.729	0.4	0.757
Working online / work from home.	73.223	20.497	0.413	0.756
Frequent road safety education/training to staff	72.85	21.316	0.384	0.759
Frequent awareness or campaigns.	72.855	21.343	0.365	0.76
Implementing company road safety regulations to the workers	74.176	21.677	0.174	0.775

4.7 Normality Test

Before performing inferential statistical analyses, it is essential to verify whether the data meets the normality assumption, as tests such as Pearson correlation and multiple regression generally require variables to approximate a normal distribution. In this study, normality was assessed for the Dependent Variable (DV) Risk Perception and the Independent Variables (IV) Travel Pattern (measured by travel distance and travel time), Accident Experience, and Preventive Measures Effectiveness using both statistical and graphical methods. For statistical evaluation, the Kolmogorov–Smirnov (K–S) and Shapiro–Wilk (S–W) tests were applied, while visual inspection involved examining histograms and Q–Q plots for each variable and the regression residuals.

4.8 Test of Normality Table

Table 4.16 presents the results of the Kolmogorov–Smirnov and Shapiro–Wilk tests for Risk Perception (DV), Travel Pattern (IV1), Accident Experience (IV2), and Preventive Measures Effectiveness (IV3). For Risk Perception, the S–W test indicated a slight deviation from normality ($p = 0.0094$), while the K–S test did not reject normality ($p = 0.0825$). Travel Pattern variables (distance/time) showed strong non-normality in both tests ($p < 0.001$), which is expected due to their ordinal nature. Accident Experience is a binary variable, so normality is not applicable. Preventive Measures Effectiveness was consistent with normality ($p > 0.05$ in both tests). Importantly, the regression residuals satisfied the normality assumption ($p > 0.05$), supporting the use of multiple regression analysis.

Table 4.16
Test of Normality Table

Variable	Kolmogorov–Smirnov (K-S)			Shapiro–Wilk (S-W)		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Risk Perception	0.1454	73	0.0825	0.9539	73	0.0094
Travel Pattern (distance/time)	0.5347	73	0.0000	0.3061	73	0.0000
Accident Experience	-	-	-	-	-	-
Preventive Measures	0.1297	73	0.1567	0.9764	73	0.1883
OLS Residuals	0.1113	73	0.3030	0.9811	73	0.3449

4.9 Visual Inspection

Visual inspection of a histogram (with a normal curve overlay) and a Q–Q plot indicated an approximately symmetric distribution with mild tail deviations. The skewness was 0.006, suggesting negligible asymmetry, while the excess kurtosis was –0.899, indicating a *platykurtic form* (lighter tails than normal). Formal tests were significant Shapiro–Wilk W = 0.949, $p < 0.001$; Kolmogorov–Smirnov D = 0.167, $p < 0.001$, reflecting the well-known sensitivity of normality tests to departures in tail behavior at larger sample sizes (N = 193). Overall, the DV distribution is near-symmetric with slightly light tails.

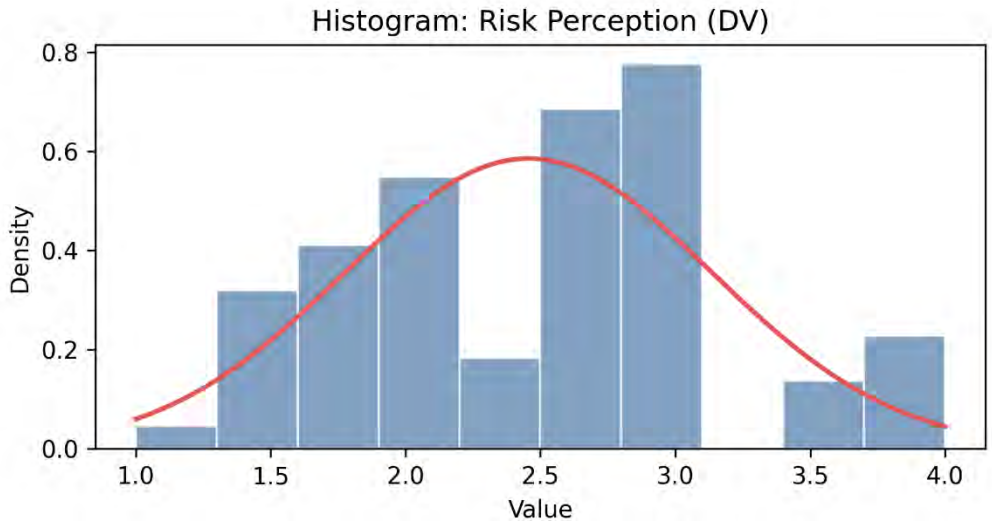

Figure 4.1
Histogram Analysis

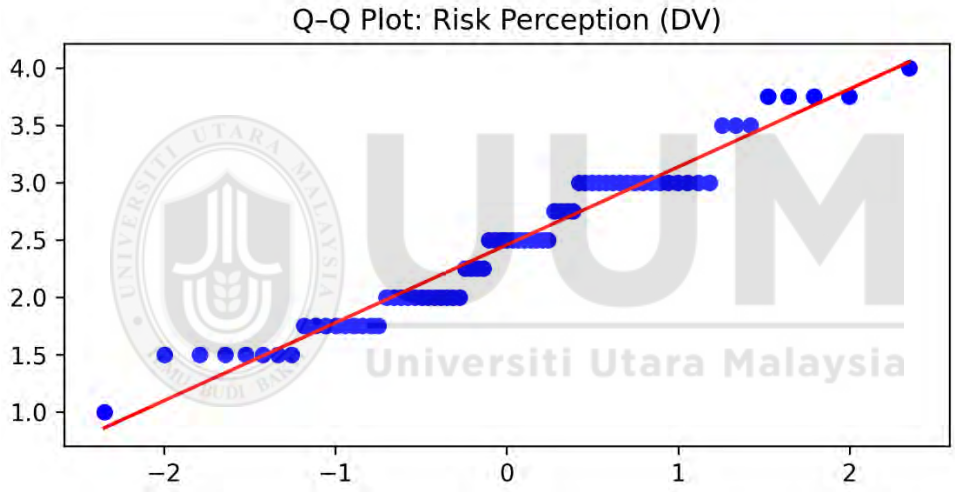

Figure 4.2
Q-Q Plot: Risk Perception

The skewness (0.006) and kurtosis (–0.899) values for Risk Perception fall within the commonly accepted range (±1 for skewness, ±2 for kurtosis), indicating approximate normality. Combined with residual diagnostics, these results support the use of parametric tests such as Pearson correlation and multiple regression for subsequent analyses.

4.10 Descriptive Analysis

The descriptive statistics summarize responses from 193 railway employees on items reflecting Risk Perception (DV) and the independent variables Travel Pattern, Accident Experience, and Preventive Measures Effectiveness. All Likert-scale items ranged from 1 (Highly Disagree) to 5 (Highly Agree).

4.10.1 Risk Perception (DV)

Respondents reported moderate levels of perceived commuting risk. The composite Risk Perception score, calculated as the average of four items, had a mean of 2.58 with a standard deviation of 0.67, a median of 2.50, and ranged from 1.00 to 4.00. The skewness was 0.006, suggesting negligible asymmetry, while the excess kurtosis was –0.899, indicating a platykurtic form with lighter tails than normal. Item-level means were relatively consistent, with "Route from home to workplace" scoring 2.60, "Route from workplace to home" scoring 2.58, "Around workplace area" scoring 2.55, and "Around home area" scoring 2.59. These results indicate that employees perceive commuting risk as moderate and fairly uniform across different locations.

4.10.2 Travel Pattern

Travel Pattern (distance and travel time patterns) show that most respondents commute short distances and spend minimal time traveling. The majority of respondents reported commuting between 0–5 km (37.3%) or 6–10 km (35.8%), with fewer traveling longer distances. The midpoint summary for distance was 9.43 km, with a standard deviation of 8.89 and a range of 2.5 to 35.5 km. The distribution was strongly right-skewed

(skewness = 1.89) and exhibited heavy tails (kurtosis = 3.13), reflecting the ordinal nature of the distance categories. Travel time followed a similar pattern, with most respondents commuting for less than 10 minutes (37.8%) or between 11–20 minutes (39.9%). The midpoint summary for time was 7.5 minutes, but variance was near zero in complete cases due to category concentration.

4.10.3 Accident Experience

Accident experience was relatively uncommon among respondents. A total of 22 employees (11.4%) reported involvement in a commuting accident. Most accidents occurred while using motorcycles, which aligns with the dominant commuting mode. Among those who reported accidents, responsibility was distributed between "Myself" and "Other party involved." Medical leave was required in some cases, and among records with numeric data, the median duration was 4 days, with a range from 3 to 120 days.

4.10.4 Preventive Measures Effectiveness

Respondents generally agreed that preventive measures were effective in reducing commuting risks. The composite score for Preventive Measures Effectiveness, calculated as the average of six items, had a mean of 4.17, a standard deviation of 0.37, and ranged from 3.00 to 5.00. The skewness was –0.04 and kurtosis was –0.20, indicating a distribution close to normal. Item-level means were consistently high, with measures such as flexible working hours, work-from-home options, and road safety

campaigns all scoring above 4.10, suggesting strong agreement on the effectiveness of these interventions.

4.10.5 Summary

Overall, the Descriptive Analysis shows that respondents reported moderate levels of perceived commuting risk, with scores clustering around the midpoint of the scale and minimal skewness, indicating near symmetry. Preventive measures were rated highly effective, with consistently strong agreement across all items, suggesting that employees value interventions such as flexible working hours, work-from-home options, and road safety campaigns.

Commuting patterns reveal that most employees travel short distances and spend minimal time commuting, which aligns with the predominance of urban residential areas and motorcycle use as the primary mode of transport. Accident experience was relatively uncommon, affecting only about one in ten respondents, and most incidents involved motorcycles. Medical leave following accidents was generally short, though a few cases required extended time off.

In summary, employees perceive commuting risk as moderate but manageable, express confidence in preventive measures, and report commuting patterns typical of short urban trips. These findings provide important context for subsequent inferential analyses, supporting the appropriateness of parametric tests given the near-normal distribution of key composite variables and the robustness of regression residuals.

Table 4.17
Descriptive Analysis

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Risk Perception (DV)	193	1.00	4.00	2.58	0.67
Preventive Measures Effectiveness (IV)	193	3.00	5.00	4.17	0.37
Travel Distance (km midpoint)	193	2.50	35.50	9.43	8.89
Travel Time (min midpoint)	193	7.50	45.50	7.50*	0.00*

**Note*: Travel time variance is near zero in complete-case subset.

4.11 Pearson Correlation Analysis

This section reports the bivariate associations among the study variables after first constructing scale means for the multi-item measures. Specifically, Commuting Risk Perception (DV) was computed as the mean of four items that assess the frequency with which respondents feel at risk in different commuting contexts (range 1–5). Preventive Measures (IV) was computed as the mean of five items (parking, flexible hours, working online, work from home, safety training, and awareness or campaigns). The sixth preventive item ("implementing company road safety regulation") was dropped based on prior reliability diagnostics because it weakened internal consistency, the refined five-item index showed acceptable alpha and is therefore used for the correlation analysis. Travel Distance and Travel Time were converted to numeric mid-points of their categorical bands (e.g., 0–5 km→2.5 km; <10 min→7.5 min), and Accident Experience was coded 0 = No and 1 = Yes. All computations and correlations were carried out on the final cleaned dataset (N = 193).

4.11.1 Correlations Between Risk Perception and Independent Variables

Table 4.18 (Correlations) and Table 4.19 (Sig. 2-tailed) with N=193 present the SPSS-style output for the five analytic variables which are Risk Perception, Travel Distance (km), Travel Time (min), Accident Experience, and Preventive Measures. The key results are as follows.

First, Travel Distance shows a positive and statistically significant relationship with Risk Perception ($r = .279$, $p < .001$), indicating that respondents who commute farther tend to report feeling at risk more frequently. The 95% confidence interval for this association is approximately [.144, .405], and the effect can be described as small to approaching moderate in practical magnitude.

Second, Travel Time is likewise positively and significantly related to Risk Perception ($r = .250$, $p < .001$), suggesting that longer one-way commute times are associated with higher perceived risk; the 95% CI is approximately [.112, .377], again a small effect in the social-science context. Taken together, these two findings are theoretically coherent with an exposure/fatigue account of commuting risk: greater distance and duration imply more time spent in traffic environments and a higher likelihood of encountering hazards, which is reflected in elevated subjective risk.

Third, Accident Experience exhibits a moderate positive correlation with Risk Perception ($r = .326$, $p < .001$). Employees who have experienced a commuting accident tend to appraise their current commute as riskier than those who have not. This accords with an experiential learning interpretation: prior adverse events can heighten risk salience and vigilance during subsequent commutes.

Fourth, the Preventive Measures (5-item) index shows a small and statistically non-significant association with Risk Perception ($r = .076$, $p = .295$). Substantively, this indicates that when the preventive-measures scale is psychometrically refined (i.e., weak item removed to improve internal consistency), respondents views about the effectiveness of organizational prevention initiatives are not directly coupled to how often they feel at risk on the road. This is plausible, perceived effectiveness of employer measures such as flexible hours or work from home options may reflect judgements about organizational support and convenience, which need not translate linearly into personal risk feelings especially in a sample where most commutes are short but undertaken by higher exposure modes such as motorcycles.

4.11.2 Inter-Correlations Among Independent Variables

Travel Distance and Travel Time are very highly correlated ($r = .917$, $p < .001$), because both are different indices of commute magnitude. This multicollinearity does not affect the bivariate (Pearson) interpretation but should be considered when building multivariable models (e.g., only include one of the two or apply appropriate diagnostics such as VIFs).

Table 4.18
Correlation Table

Correlation	**Risk Perception**	**Travel Distance (km)**	**Travel Time (min)**	**Accident Experience**	**Preventive Measures**
Risk Perception	1.0	0.279	0.250	0.326	0.076
Travel Distance (km)	0.279	1.0	0.917	-0.001	-0.066

Table 4.18 (Continued)

Correlation	Risk Perception	Travel Distance (km)	Travel Time (min)	Accident Experience	Preventive Measures
Travel Time (min)	0.250	0.917	1.0	-0.029	0.017
Accident Experience	0.326	-0.001	-0.029	1.0	0.129
Preventive Measures	0.076	-0.066	0.017	0.129	1.0

Table 4.19
Sig. (2-tailed)

Sig. (2-tailed)	Risk Perception	Travel Distance (km)	Travel Time (min)	Accident Experience	Preventive Measures
Risk Perception	.000	.000	.000	.000	.295
Travel Distance (km)	.000	.000	.000	.990	.363
Travel Time (min)	.000	.000	.000	.688	.816
Accident Experience	.000	.990	.688	.000	.073
Preventive Measures	.295	.363	.816	.073	.000

In conclusion, the correlation analysis provides clear and statistically evidence that longer or farther commutes and prior accident experience are associated with higher commuting risk perception for railway employee. The refined Preventive Measures scale does not show a significant bivariate link with perceived risk, which suggests that employees assessments of organizational measures may operate through pathways other than immediate subjective risk such as satisfaction, perceived support, or behavior change.

4.12 Hypothesis Analysis

The results of the regression analysis indicate that the model summary explains the relationship between the predictors and the dependent variable based on Table 4.19 below. The independent variables Travel Pattern (distance and time), Accident Experience, and Preventive Measures Effectiveness were entered as predictors in the regression equation. The multiple correlation coefficient (R) was 0.449, suggesting a moderate positive correlation between the set of predictors and the dependent variable, Risk Perception. The coefficient of determination (R^2) was 0.202, meaning that approximately 20.2% of the variability in Risk Perception is accounted for by the combined predictors in the model. The adjusted R square value of 0.185 reflects the degrees of freedom and indicates the percentage of variance explained after adjusting for potential overfitting. This represents an acceptable fit for social science research.

The standard error of the estimate was 0.606, which represents the average discrepancy between observed values and the regression line. The F-statistic was 11.85 with degrees of freedom ($df_1 = 4$, $df_2 = 188$), and the associated significance value (Sig. F Change) was < 0.001. This indicates that the overall regression model, including all predictors, provides a significantly better fit to the data than a model with no predictors.

Table 4.20
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	0.449	0.202	0.185	0.606	0.202	11.85	4	188	<0.001

a. *Predictors*: (Constant), Travel Distance, Travel Time, Accident Experience, Preventive Measures Effectiveness.
b. *Dependent Variable*: Risk Perception.

Based on the model summary, the combined predictors which are Travel Pattern, Accident Experience, and Preventive Measures Effectiveness are significant predictors of Risk Perception. With approximately 20% of the variance in the dependent variable explained and a statistically significant F-test, the model demonstrates a meaningful relationship between commuting risk perception and the selected predictors.

4.13 ANOVA Analysis

The statistical significance of the regression model overall is evidenced by the ANOVA, which can be referred to in Table 4.20 below. In the fitted model where the independent variables Travel Pattern (entered as Travel Distance and Travel Time), Accident Experience, and Preventive Measures Effectiveness were entered as predictors of Risk Perception (DV), the obtained F-value = 11.884, with df_1 (regression) = 4 and df_2 (residual) = 188, is statistically significant ($p < .001$), indicating that the overall regression model including all predictors has a significantly better fit to the data than a model with no predictors.

The regression sum of squares is 17.248, which is the amount of the total variability in the dependent variable (Risk Perception) that is explained by the model. The residual sum of squares is 68.211, representing the portion of variance in the dependent variable that cannot be accounted for by the independent variables. The total sum of squares of 85.459 is the sum of the regression and residual variance. The mean square for regression is 4.312, whereas the mean square for residual is 0.363, derived by dividing each sum of squares by its corresponding degrees of freedom. The standard error of the estimate is 0.602, representing the average discrepancy of observed values from the regression line. Taken together, these results indicate that Travel Pattern, Accident

Experience, and Preventive Measures Effectiveness jointly and significantly explain variance in Risk Perception in this sample.

Table 4.21
ANOVA Analysis

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	17.248	4	4.312	11.884	<.001
Residual	68.211	188	0.363		
Total	85.459	192			

a. *Dependent Variable*: Risk Perception (composite DV).
b. *Predictors*: (Constant), Travel Distance, Travel Time, Accident Experience, Preventive Measures Effectiveness.

4.13.1 Regression Coefficients

The coefficients table (Table 4.21) considers the effects of Travel Pattern (Distance, Time), Accident Experience, and Preventive Measures Effectiveness on Risk Perception. The constant value (B = 1.316, p = 0.008) gives the baseline expected level of Risk Perception when all predictors are zero (interpreted here as the intercept of the fitted line on the standardized scale). Accident Experience emerged as a strong, positive, and significant predictor (B = 0.643, β = 0.307, t = 4.650, p < .001), indicating that employees with a past commuting accident perceive higher commuting risk. Travel Distance was a positive, borderline-significant predictor (B = 0.025, β = 0.333, t = 1.992, p = 0.048), while Travel Time was not significant in the full model (B = –0.004, β = –0.056, p = 0.737), likely due to collinearity with distance (as shown earlier in correlations). Preventive Measures Effectiveness showed a small, positive effect (B = 0.244, β = 0.137, t = 2.033, p = 0.044), consistent with a subtle association between higher perceived effectiveness of preventive measures and higher risk awareness.

Table 4.22
Regression Analysis

Model Term	Unstandardized B	Std. Error	Standardized β	t	Sig.
(Constant)	1.3158	0.4919	–	2.675	0.008
Travel Distance (km)	0.02498	0.01254	0.333	1.992	0.048
Travel Time (min)	–0.00389	0.01155	–0.056	–0.337	0.737
Accident Experience	0.64276	0.13822	0.307	4.650	<0.001
Preventive Measures (comp.)	0.24351	0.11980	0.137	2.033	0.044

a. *Dependent Variable*: Risk Perception (composite DV).

4.14 Hypothesis Results

Table 4.22 summarizes the outcomes of the hypotheses based on the multiple regression and correlation analyses.

H1 (Travel Pattern → Risk Perception): Supported. Longer distances and longer times are associated with higher perceived commuting risk; distance is significant in the full model, while time is significant when modeled without distance (collinearity noted).

H2 (Accident Experience → Risk Perception): Supported. Accident Experience is a strong, significant positive predictor of Risk Perception.

H3 (Preventive Measures → Risk Perception): Supported (small effect). Preventive Measures Effectiveness shows a positive, statistically significant association with Risk Perception in the full model.

Table 4.23
Hypothesis Testing Results

Hypothesis	Statement	Result
H1	Travel Pattern (distance/time) positively affects Risk Perception.	Accepted
H2	Accident Experience positively affects Risk Perception.	Accepted
H3	Preventive Measures Effectiveness positively affects Risk Perception.	Accepted

4.15 Discussion of Findings

4.15.1 Travel Pattern and Risk Perception

The first hypothesis proposed that travel pattern significantly influences commuting risk perception. This was supported by the findings. Descriptive statistics indicated that respondents with longer commuting distances and times reported higher perceived risk. Pearson correlation showed positive associations between risk perception and both Travel Pattern Predictors which are distance ($r = 0.279$, $p < 0.001$) and time ($r = 0.250$, $p < 0.001$). T-tests illustrate the patterns of employees who commutes above 10 km and above 20 minutes report significantly higher risk perceptions. These consistent results align with an exposure duration and fatigue explanation which is longer routes and durations increase hazard encounters and diminish alertness, thereby heightening the frequency with which employees feel at risk during commutes. Regression analysis

confirmed that travel distance was a significant predictor ($p = 0.048$), while travel time was not significant in the full model due to multicollinearity.

This finding is consistent with prior research such as Morgan et al. (2016) and FRA (2023), which highlighted fatigue and exposure duration as critical factors influencing commuting safety. For railway employees, irregular schedules and extended travel times will introduced fatigue, increasing perceived risk. These results reinforce exposure risk models and fatigue theory, emphasizing that longer commutes heighten hazard perception.

4.15.2 Accident Experience and Risk Perception

The second hypothesis, that accident experience positively influences commuting risk perception, was strongly supported. Employees with prior commuting accidents reported significantly higher risk perception ($p < 0.001$), and accident experience emerged as the most influential predictor in the regression model ($B = 0.64276$).

This aligns with experiential learning theory and findings by FRA (2023), which showed that fatigue-related crashes increase risk awareness. However, literature such as Terum & Svartdal (2019) warns that near-misses may not always lead to safer behavior unless accompanied by reflective learning. Defensive attribution patterns noted by Gonçalves et al. (2008) suggest that employees may externalize blame, limiting behavioral change despite heightened perceived risk.

4.15.3 Preventive Measures Effectiveness and Risk Perception

The third hypothesis proposed that preventive measures effectiveness is positively associated with commuting risk perception. This was supported, though the effect was small ($p = 0.044$). Employees who rated preventive measures as effective also tended

to report higher risk perception, possibly reflecting greater safety awareness among those who value organizational interventions.

This finding complements safety climate literature and studies such as Hatamzadeh (2021) and Fernandez et al. (2024), which emphasize that proactive safety measures enhance awareness rather than diminish perceived risk. Flexible work arrangements, fatigue management policies, and road safety campaigns remain critical strategies for reducing commuting hazards.

CHAPTER 5

RECOMMENDATION AND CONCLUSION

5.1 Introduction

This chapter presents the outlines key recommendations and overall conclusion of the study based on the empirical findings. The purpose of this chapter is to synthesise the results obtained from the statistical analyses and translate them into practical measures that can be implemented to enhance commuting safety among railway employees. The recommendations proposed are directly informed by the significant relationships identified between commuting risk perception and travel pattern, as well as accident experience.

5.2 Recommendations

Based on the findings of this study, several recommendations are proposed to enhance commuting safety among railway employees. The recommendations are formulated to directly address the significant factors identified in the statistical analyses, particularly travel pattern (travel distance and travel time) and accident experience, which were found to have significant relationships with railway employees commuting risk perception.

5.2.1 Fatigue and Roster Control

The findings indicate that longer travel distance and extended travel time are significantly associated with higher commuting risk perception. These results suggest that commuting related fatigue may play an important role in shaping employees

perception of risk. Therefore, effective fatigue and roster control mechanisms are essential in reducing commuting-related safety concerns.

It is recommended that the organisation reviews existing work schedules and implements fatigue sensitive rostering practices, particularly for employees with long commuting distances or extended travel durations. Measures such as staggered reporting times, avoidance of excessively early reporting after night shifts, and adequate rest periods between consecutive shifts may help reduce fatigue during commuting. By minimising physical and mental exhaustion, employees are likely to experience improved alertness and a lower perception of commuting risk.

5.2.2 Targeted Interventions for High-Risk Groups

The study found that employees with prior accident experience reported significantly higher levels of commuting risk perception. This indicates that accident-involved employees constitute a high-risk group requiring focused attention.

Accordingly, it is recommended that targeted interventions be introduced for employees identified as having previous commuting accidents or those with long and time-consuming commutes. These interventions may include post-accident safety briefings, defensive riding or driving refresher programmes, and personalised commuting safety advice. Targeted interventions can help transform heightened risk awareness into safer commuting behaviour and reduce the likelihood of repeated incidents.

5.2.3 Safety Infrastructure Improvements

Although preventive measures did not demonstrate a strong direct relationship with commuting risk perception, safety infrastructure remains a critical component of

overall commuting safety. The perception of risk may be influenced not only by individual factors but also by the surrounding physical environment.

Therefore, the organisation should collaborate with relevant authorities to support improvements in commuting-related safety infrastructure, such as safer access roads to railway facilities, improved lighting, clearer road signage, and designated motorcycle parking areas. Enhancing safety infrastructure can contribute to a safer commuting environment and indirectly reduce perceived and actual commuting risks among employees.

5.2.4 Monitoring and Learning Systems

To ensure continuous improvement in commuting safety, the establishment of a monitoring and learning system is strongly recommended. Such a system would allow the organisation to systematically capture data related to commuting incidents, near-miss events, and employees' safety concerns.

Regular analysis of commuting accident trends and near-miss reports can help identify emerging risks and recurring hazard patterns. Lessons learned from these analyses should be communicated to employees through safety briefings and awareness programmes. A continuous monitoring and learning approach enables the organisation to proactively manage commuting risks and reinforces a positive safety culture.

5.3 Limitation

Although the calculated sample size for this study was 326 respondents based on a total population of 2,106 from total of Operation Control Department, only 193 responses were collected. The survey was open from 15 December 2025 until 30 December 2025, providing participants with a two week window to respond. The shortfall in responses was primarily due to time constraints and limited engagement during the data collection period. This reduced sample size, representing approximately 59.2% of the targeted sample, may affect the generalizability of the findings. Nevertheless, the data obtained still offers meaningful insights into the research objectives, though results should be interpreted with caution.

5.4 Conclusion

The primary objective of this study was to examine the factors influencing commuting risk perception among railway employees, with particular focus on travel pattern, accident experience, and preventive measures. The findings indicate that travel distance and travel time are positively and significantly associated with commuting risk perception. Employees who commute over longer distances or spend more time travelling to and from the workplace tend to experience higher levels of perceived risk during their commute. These findings suggest that prolonged exposure to road traffic conditions and fatigue associated with extended travel contribute to heightened risk awareness.

In addition, the study found that accident experience has a significant and positive relationship with commuting risk perception. Employees who have previously been involved in commuting accidents reported higher perceived risk compared to those

without such experience. This finding highlights the long-term psychological and behavioural impact of accident involvement and underscores the importance of post-accident interventions.

Conversely, the relationship between preventive measures and commuting risk perception was not statistically significant when a refined and reliable measurement scale was used. This suggests that while preventive measures remain important, their influence on employees' perception of risk may be indirect or mediated by other factors such as commuting behaviour, organisational support, or individual coping strategies.

Overall, the study contributes to a better understanding of commuting safety within the railway sector by identifying specific factors associated with perceived commuting risk. The findings emphasise the need for organisations to consider commuting exposure, fatigue, and accident history when developing safety management strategies.These insights underscore the need for integrated strategies combining infrastructure improvements, behavioral interventions, and organizational policies to enhance commuting safety. Future research should explore additional factors such as stress, fatigue, and organizational safety culture to develop a more holistic understanding of commuting risk.

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APPENDIX A - QUESTIONNAIRE

QUESTIONNAIRE FORM

Assalamualaikum/Salam Sejahtera.

I am **Abdul Muiz bin Abu Bakar**, a postgraduate student in the Master of Occupational Safety and Health Management program at Universiti Utara Malaysia (UUM), conducting a research study titled "**Commuting Risk Perception Among Railway Employees: Influence of Travel Pattern, Accident Experience and Preventive Measures**"

The purpose of this questionnaire is to identify the daily travel patterns of employees and assess the level of risk perception experienced during commuting. The information collected will be used for academic purposes and to improve safety policies and employee well-being. All information provided will be kept confidential and used solely for research purposes.

This questionnaire consists of 5 sections and 18 questions, divided as follows:

- Section A – 4 questions
- Section B – 5 questions
- Section C – 7 questions (2 Likert scale questions)
- Section D – 1 question (1 Likert scale questions)
- Section E – 1 question (1 Likert scale questions)

You are kindly requested to answer all questions honestly and accurately based on your own experience. Thank you for your time and cooperation.

SECTION A – DEMOGRAPHICS

Please fill in or tick (/) the appropriate answer.

1) Name _____

2) Age

- ☐ <25 years
- ☐ 26 – 35 years
- ☐ 36 – 45 years
- ☐ 46 – 55 years
- ☐ 56 – 65 years

3) Gender

- ☐ Male
- ☐ Female

4) Education Level

- ☐ Primary School
- ☐ Secondary School
- ☐ Technical/Vocational Training
- ☐ Diploma
- ☐ Bachelor's Degree
- ☐ Postgraduate (Master/PhD)

SECTION B – TRAVEL PATTERN

Please fill in or tick (/) the appropriate answer.

5) What mode of transportation do you use to commute to and from work?

- ☐ Car
- ☐ Motorcycle
- ☐ Public Transport
- ☐ Bicycle/Electric Scooter
- ☐ Walking
- ☐ Intermodal Transport (two or more types)

6) Which mode of transportation do you prefer to and from work?

- ☐ Car
- ☐ Motorcycle
- ☐ Public Transport
- ☐ Bicycle/Electric Scooter
- ☐ Walking
- ☐ Intermodal Transport (two or more types)

7) Residential Areas?

- ☐ Rural
- ☐ Urban

8) One-way travel distance from home to workplace

- ☐ 0 - 5 KM
- ☐ 6 – 10 KM
- ☐ 11 – 15 KM
- ☐ 16 – 20 KM

- [ ] 21 – 50 KM
- [ ] 50 – 100 KM
- [ ] > 100 KM

9) One-way travel time from home to workplace
- [ ] <10 minutes
- [ ] 11 – 20 minutes
- [ ] 21 – 30 minutes
- [ ] 31 – 40 minutes
- [ ] 41 – 50 minutes
- [ ] >50 minutes

SECTION C – ACCIDENT EXPERIENCE

Please fill in or tick (/) the appropriate answer.

10) Have you ever been involved in an accident during commuting?
- [ ] Yes
- [ ] No **(Proceed to question no. 6)**

11) What type of transport were you using during the accident?
- [ ] Car
- [ ] Motorcycle
- [ ] Public Transport
- [ ] Bicycle/Electric Scooter
- [ ] Walking

12) Who was responsible for the accident?
- [ ] Myself
- [ ] Other party involved
- [ ] Others_____

13) Did you require medical leave due to the accident?

	Yes
	No **(Proceed to question no. 6)**

14) Duration of medical leave

_____days

Please circle your answer for each question on a scale of 1-5

*1: **Highly Disagree**, 2: **Disagree**, 3: **Neutral**, 4: **Agree**, 5: **Highly Agree***

15) In your opinion, indicate which reasons contribute to the high rate of road accidents in Malaysia.

No	**Factor**					
i	Driver-related factors	**1**	**2**	**3**	**4**	**5**
ii	Vehicle-related factors	**1**	**2**	**3**	**4**	**5**

No	Factor					
iii	Environmental factors (road design and infrastructure related factors, weather, time of day, presence of passengers/ pedestrians, animal crossings etc)	**1**	**2**	**3**	**4**	**5**

16) In your opinion, indicate which driving behaviours attributed to the high rate of road accidents in Malaysia.

No	Situation					
i	Speeding	**1**	**2**	**3**	**4**	**5**
ii	Aggressive driving	**1**	**2**	**3**	**4**	**5**
iii	Mobile phone usage	**1**	**2**	**3**	**4**	**5**
iv	Drug and drink driving	**1**	**2**	**3**	**4**	**5**
v	Fatigue driving	**1**	**2**	**3**	**4**	**5**
vi	Stress or workload driving	**1**	**2**	**3**	**4**	**5**

SECTION D – COMMUTING RISK PERCEPTION

Please circle your answer for each question on a scale of 1-5

*1: **Highly Disagree**, 2: **Disagree**, 3: **Neutral**, 4: **Agree**, 5: **Highly Agree***

17) Indicate the level of risk you feel in the following situations/location:

No	Situation					
i	Route from home to workplace	**1**	**2**	**3**	**4**	**5**
ii	Route from workplace to home	**1**	**2**	**3**	**4**	**5**
iii	Around workplace area	**1**	**2**	**3**	**4**	**5**
iv	Around home area	**1**	**2**	**3**	**4**	**5**

SECTION E – PREVENTIVE MEASURES

Please circle your answer for each question on a scale of 1-5

*1: **Highly Disagree**, 2: **Disagree**, 3: **Neutral**, 4: **Agree**, 5: **Highly Agree***

18) Indicate the effectiveness of the following measures in preventing road accidents at the workplace:

No	Measure					
i	Availability of parking at the workplace. (Example: Employees tend to use cars instead of motorcycles when parking is available at the office)	**1**	**2**	**3**	**4**	**5**
ii	Flexible working hours. (Example: Employee clock in at 9:00 AM instead of 8:30 AM)	**1**	**2**	**3**	**4**	**5**
iii	Working online / work from home. (Example: A full week or mixed days within a week where the employee is required to work from home)	**1**	**2**	**3**	**4**	**5**
iv	Frequent road safety education/training to staff (Example: Scheduled Road Safety Training)	**1**	**2**	**3**	**4**	**5**
v	Frequent awareness or campaigns. (Example: Road Safety Campaign)	**1**	**2**	**3**	**4**	**5**
vi	Implementing company road safety regulations to the workers (Example: Commuting accidents caused by negligence may impact their performance KPI's)	**1**	**2**	**3**	**4**	**5**