GENDER DISPARITIES IN WORK-RELATED TRAFFIC ACCIDENTS: ADVANCING SAFE SYSTEM STRATEGIES IN BATAM CITY

Vito Raegentsario[1], *Yusra Aulia Sari[2], Andri Irfan Rifai[3]
[1,2,3]Faculty of Civil Engineering and Planning, Universitas Internasional Batam, Batam
*)Email : yusra@uib.ac.id

ABSTRACT

Work-related traffic accidents represent a significant public health and economic issue in rapidly urbanising areas like Batam City, Indonesia. As a major industrial and trade hub, Batam experiences high volumes of commuter traffic, exacerbating road safety challenges. Despite this, a critical gap exists in current research and policy where gender-specific vulnerabilities— including differences in risk perception, vehicle choice, and travel patterns—are often overlooked. This study aims to fill this gap by investigating these nuanced gender disparities in work-related traffic accidents in Batam. Furthermore, it seeks to propose actionable strategies for systematically integrating gender considerations into the established Safe System framework, thereby providing evidence-based recommendations for stakeholders. A quantitative research design was employed, utilising a structured questionnaire distributed via Google Forms to a cohort of 498 randomly sampled workers in Batam City. The collected data were analysed using descriptive statistics and simple linear regression in SPSS. The analysis specifically examined the relationship between positive safety perceptions and experiences (BTHD) and workers perceived vulnerability and wariness (BTHC) during their commute. The results revealed a statistically significant positive relationship (B = 0.626, p < .001). Counter-intuitively, this indicates that as respondents' positive safety perceptions increased, their self-reported level of wariness and alertness also rose. This key finding suggests that a sense of safety among Batam's workforce is not a passive state leading to complacency but is actively constructed upon a state of heightened awareness. The study concludes that achieving the goal of zero fatalities requires the Safe System approach to evolve beyond physical infrastructure to incorporate these complex psychological drivers and gender-specific factors. These findings offer policymakers critical insights for developing more inclusive, equitable, and effective road safety interventions.

Keyword: *Gender Disparities, Work Traffic Accidents, Safety System Approach, Risk Perception.*

1. INTRODUCTION

Traffic accidents constitute a significant public health crisis worldwide, resulting in millions of injuries and fatalities each year. According to the World Health Organization (WHO), road traffic injuries are the eighth leading cause of death globally, with an estimated 1.35 million lives lost annually as of 2016 [1]. The burden of these injuries is disproportionately borne by low- and middle-income countries, where 93% of road traffic fatalities occur [1]. The increasing prevalence of motor vehicles, coupled with inadequate road infrastructure and enforcement of traffic regulations, exacerbates the risk of accidents. As urbanization accelerates, particularly in rapidly developing regions, the need for effective road safety interventions becomes increasingly urgent. The mitigation of traffic accidents is contingent upon a clear analysis of their root causes and the development of targeted safety measures.

In Batam City, Indonesia, the rapid pace of industrialization and urbanization has resulted in a significant increase in traffic volumes, thereby heightening the risk of accidents [2]. The city's burgeoning economy has attracted a diverse workforce, resulting in a complex interplay of transportation needs and challenges. As Batam continues to develop, the existing infrastructure may struggle to accommodate the growing demands of both commercial and personal transportation. This scenario is further complicated by the limited availability of safe and efficient public transport options, which can lead to increased reliance on private vehicles and, consequently, a higher likelihood of traffic incidents. Addressing these challenges requires a multifaceted approach that considers the unique characteristics of Batam's urban landscape and the specific needs of its residents.

Gender disparities in traffic accidents represent a critical area of study that warrants further exploration. Research indicates that men are more frequently involved in severe traffic accidents, primarily due to their higher engagement in high-risk occupations such as driving and construction [3]. Conversely, women may face unique vulnerabilities, including limited access to safe transportation options and the dual burden of work and caregiving responsibilities [3]. These gendered perspectives are essential for developing effective road safety strategies, particularly in work-related contexts where the risks may differ significantly between genders [3]. A gender-sensitive approach to road safety can enhance the effectiveness of interventions and ensure that the specific needs of all demographic groups are met [4].

However, while these general gender differences are established, there is a significant gap in understanding how they manifest in the specific context of a rapidly industrializing Southeast Asian city like Batam. Furthermore, it

remains unclear how these nuanced, local dynamics can be practically integrated into the Safe System framework, which is often criticized for overlooking such gender-specific factors [5]. This study, therefore, aims to address this gap by examining these factors within Batam's unique workforce to propose more inclusive safety strategies.

The Safe System approach has emerged as a leading framework for addressing road safety challenges by aiming to minimize the risk of severe injuries or fatalities [6]. However, its implementation often neglects the specific needs of diverse demographic groups, including gender differences [6]. Integrating gender considerations into road safety strategies can lead to more equitable outcomes, particularly in diverse workforces such as that found in Batam City, where many women are employed in sectors like manufacturing and services, which may expose them to unique traffic-related risks [6]. The effectiveness of the Safe System framework can be significantly enhanced by recognizing and addressing these gender-specific vulnerabilities.

This study aims to fill this gap by investigating gender disparities in work-related traffic accidents in Batam City. By analyzing the complex relationship between workers' risk perceptions, past experiences, and their demographic profiles, this research seeks to propose concrete strategies for incorporating gender considerations into the Safe System framework. The findings will provide valuable insights for policymakers and urban planners, ultimately advancing the goal of reducing traffic fatalities in Batam and similar urban contexts. The findings will provide valuable insights for policymakers, urban planners, and safety advocates, ultimately advancing the goal of reducing traffic fatalities and serious injuries in Batam and similar urban contexts [7].

Work-Related Accidents

The examination of gender disparities in work-related traffic accidents is a critical area of study that sheds light on both the demographic trends and the underlying contributing factors to such incidents. Research indicates that male individuals are disproportionately represented in traffic fatalities, with studies showing that up to 75% of traffic-related deaths involve males, while only 25% are females [8]. This discrepancy is not isolated to one region; similar trends have been observed internationally, indicating a global pattern in which gender plays a significant role in traffic accident dynamics [8][9]. Furthermore, risk factors such as age have also been found to correlate with these disparities, as younger males are statistically more likely to be involved in serious traffic accidents [10] [11].

In assessing the socio-economic implications of traffic accidents, it becomes evident that such incidents impose significant societal costs beyond immediate medical expenses. For instance, the repercussions of traffic accidents extend to productivity losses within families, as individuals may need time off work to care for injured family members or due to their own incapacitation [12]. This economic burden is compounded by the existing gender disparities, as research has shown that male drivers often engage more frequently in risky driving behaviors, which increases their likelihood of suffering severe injuries or fatalities [9]. Moreover, studies have linked occupational characteristics, such as the demanding nature of job demands for public school teachers, to increased susceptibility to accidents while commuting to or from work, further entrenching gender disparities in this area [13].

The role of psychosocial factors in traffic accidents cannot be understated, especially when examining gender differences. Research highlights how driving is not only a physical task but also a complex psychomotor function that requires coordination of cognitive and sensory systems [14]. Differences in emotional and psychological responses to driving conditions between genders can significantly affect driving safety; for instance, males may exhibit a higher propensity for aggression on the road compared to females [15] [16]These findings advocate for targeted interventions that consider gender-specific vulnerabilities to enhance traffic safety in urban contexts.

Moreover, the intersection of socioeconomic factors, such as the dynamics of employment and access to transportation, further compounds the gender disparities evident in work-related traffic accidents. Research evaluations have found that young drivers, who often face significant pressure in the workplace combined with less experience behind the wheel are more likely to prioritize speed over safety, thereby increasing their risk of accidents [10]. Additionally, the implications of occupational stress on driving performance underscore the vital need for comprehensive workplace safety programs that address both mental health and safe commuting practices, particularly in male-dominated industries [17].

In addressing these gender disparities, it is crucial to develop multifaceted strategies that reflect both empirical evidence and the specific context of the locality. Implementing sustainable transport policies, educational campaigns on safe driving, and support systems for occupational health can help mitigate the disparities observed in work-related traffic accidents [18]. The integration of predictive analytics and community-focused interventions will be vital in tailoring effective responses that accommodate the unique demographic and socioeconomic landscape, thus advancing safer systems for all road users, regardless of gender.

Gender Disparities in Traffic Accidents

The investigation into gender disparities in traffic accidents reveals significant insights into the behavioral tendencies and outcomes associated with male and female drivers. Studies consistently illustrate that men are more likely to engage in high-risk driving behaviors, which correlates with a higher incidence of accidents. Research indicates that male drivers frequently prioritize speed over safety, while female drivers typically demonstrate a more cautious approach to driving [19]. Furthermore, the analysis of risk perception reveals that males perceive themselves as less vulnerable to crash-related injuries, contributing to a range of reckless driving behaviors [20]. This gender-specific attitude towards risk impacts driving safety and has broader implications for public health and road safety strategies.

The consequences of these behaviors are reflected in patterns of injury severity across genders. Females tend to be less frequently involved in serious traffic violations and may experience lighter injuries in the event of accidents [21]. A study exploring the relationship between gender and accident outcomes found that while males account for a higher percentage of traffic fatalities, women often sustain injuries that are more frequently associated with non-fatal outcomes [22]. This dichotomy in accident outcomes consider these gender differences, potentially leading to a more effective allocation of resources aimed at reducing traffic injuries and fatalities.

The role of education and awareness in addressing these gender disparities cannot be overstated. Enhanced road safety education initiatives can significantly influence driving behaviors, particularly among young male drivers who exhibit a propensity for risk-taking [19]. By fostering an appreciation for road safety through tailored educational programs, there is potential to mitigate dangerous behaviors and improve traffic outcomes for both genders. Furthermore, studies indicate that increasing traffic safety knowledge among males can lead to a reduction in risky behaviors, such as road driving behaviors [23]. Continued research into effective educational strategies is essential to fostering safer driving cultures that accommodate gender differences.

Lastly, the significance of psychosocial factors in understanding gender disparities in traffic incidents is an emerging area of interest. Research has identified that women often display more prosocial behaviors in traffic situations, such as providing emotional support at accident scenes, reflecting broader social norms and expectations regarding gender roles [24]. Conversely, men may exhibit behaviors that prioritize physical interventions in crisis situations. Recognizing these distinctions in social behavior could inform the development of gender-sensitive road safety campaigns accounting for varying approaches to driving and crisis interactions, ultimately enhancing community responses to road safety challenges [25].

In conclusion, the interplay of gender, risk perception, and behavioral tendencies affects traffic accident dynamics. A nuanced understanding of these factors that address disparities in traffic safety and contribute to building safer driving environments. Future research should continue to explore these dimensions, particularly how educational initiatives and psychosocial considerations can be integrated into comprehensive road safety strategies aimed at reducing the incidence and severity of traffic accidents across genders.

Safe System Approach

Gender disparities in work-related traffic accidents in Batam City require an understanding of the Safe System approach, a framework that emphasizes shared responsibility among all road system users and stakeholders. The Safe System philosophy aims to prevent fatalities and serious injuries by addressing the underlying design and management of traffic systems [26]. Gender considerations are often overlooked in traffic safety policies, resulting in disparate impacts of traffic crashes on male and female workers in occupational settings [25]. In Batam City, a systematic integration of gender perspectives within the Safe System approach could enhance the effectiveness of traffic safety interventions.

The Safe System approach. It advocates for a proactive strategy that aims to effectively manage risks associated with road traffic by implementing comprehensive safety measures across all aspects of road transport [27]. Recent evaluations emphasize the need to incorporate gender analysis into traffic safety strategies to ensure equitable protection for all users [28]. This is particularly relevant in work-related scenarios, where specific occupational groups may face unique risks based on gender-related factors [25]. Advocacy for gender-sensitive data collection and analysis is critical in informing policies that can mitigate the disproportionate impact of traffic accidents on women and men, thereby fostering inclusive safety measures [27].

The introduction of innovative methodologies and technologies, such as real-time traffic management systems, can also play a crucial role in enhancing road safety for all, particularly in urban environments like Batam [29]. Implementing practices such as variable speed limits and route optimization can contribute to safer travel experiences for workers, aligning with the objectives of the Safe System paradigm [29]. Attention should be given to how these smart systems can incorporate gender-specific patterns of travel and risk exposure that characterize work-related journeys [28]. Through the adoption of evidence-based interventions guided by a gender-responsive

Safe System approach, the potential for reducing traffic-related injuries and deaths in Batam City can be significantly improved.

In conclusion, advancing Safe System strategies within the context of gender disparities in work-related traffic accidents necessitates a holistic and inclusive approach. Leveraging data-driven insights and stakeholder collaboration can facilitate the identification of key safety interventions tailored to the specific needs of diverse gender groups [27]. Stakeholders in Batam City can enhance the resilience of transport systems by emphasizing safety as a shared responsibility among all users, ultimately working toward the overarching goal of zero fatalities in work-related traffic incidents [26].

Research Questions
1. What are the key demographic characteristics and work-related travel patterns of male and female workers in Batam City?
2. How do positive safety perceptions predict perceived vulnerability and wariness among this workforce?
3. Based on these findings, what concrete strategies can be proposed for incorporating psychological factors and gender-specific considerations into the Safe System framework?

2. METHOD

Case Study Context and Selection
In examining gender disparities in work-related traffic accidents in Batam City, this study will utilize a case study approach to offer an in-depth understanding of the specific context underlying these incidents. Batam City, a vibrant industrial hub with a high density of work-force related transportation needs, serves as an ideal setting for this topic. The city's unique characteristics, including varying socio-economic backgrounds and diverse occupational demands, make it a pertinent case for exploring how gender dynamics influence traffic safety outcomes [30]. Selecting this location is critical for isolating the contributing factors to gender-specific differences in accident involvement among workers, particularly in an urban environment where traffic conditions can be complex and variable.

To facilitate a comprehensive analysis, a purposive sampling method will be employed to select respondents who fit specific criteria reflective of the target population. The aim is to gather insights from a diverse array of occupational categories, including both male and female workers, whose roles demand regular commuting or driving as part of their job functions. By focusing on this demographic, the study aims to and whether such gaps can be attributed to distinct behavioral or environmental factors [31]. This selected approach will enable the study to pivot between qualitative insights drawn from respondents' personal narratives and quantitative patterns observable from the statistical data collected.

Furthermore, data collection will be conducted through structured questionnaires disseminated via Google Forms, resulting in a total of 399 respondents. This online dissemination strategy was selected for its efficiency in reaching a geographically dispersed sample and for streamlining the data collection process. By employing simple random sampling techniques, the study will ensure that every segment of the working population has an equal opportunity to participate. The target population comprised workers from diverse occupational sectors in Batam City who commute regularly as part of their employment. This choice of sampling enhanced generalizability of the findings, which is crucial for deriving meaningful conclusions that can inform policy interventions in traffic safety. The outcomes of this case study will provide empirical evidence necessary to advocate for targeted safety measures that address gender disparities, ultimately contributing to the overarching goal of improved roadway safety for all workers in Batam City.

Research Design
This research will employ a quantitative research design to investigate gender disparities in work-related traffic accidents in Batam City. The target population was specifically defined to include workers from diverse occupational sectors within Batam City who regularly commute as a necessary part of their employment. To ensure a representative sample from Batam's total population (est. 1-2 million), a minimum sample size of 399 respondents was calculated using Slovin's formula (e=0.05). Respondents were selected through simple random sampling, and a total of 498 valid responses were ultimately collected. Data were gathered using a structured questionnaire disseminated via Google Forms, which focused on essential variables including demographic information, driving behaviors, personal experiences with traffic incidents, and road safety perceptions. By capturing these dimensions, the study aims to elucidate the nuanced interplay between gender and traffic safety outcomes.

Once the data is collected, it will be analyzed using the Statistical Package for the Social Sciences (SPSS). The primary analytic approach will be regression analysis, which will allow for a systematic examination of the

relationships between the identified variables, including gender, age, occupation, and driving frequency. This analytical strategy is particularly suited for exploring how these factors influence the likelihood of involvement in traffic accidents. Furthermore, regression analysis facilitates the control of potential confounding variables, thereby enhancing the robustness of the study's conclusions regarding gender-specific risk factors in traffic incidents.

In addition to regression analysis, descriptive statistics will be utilized to summarize and interpret the data collected from the respondents. This will provide insights into the demographic distribution of the sample and the prevalence of reported traffic accidents among different gender groups. Such statistical representations are essential for establishing a clear context of work-related traffic accidents in Batam City, supporting effective communication of the study's findings to various stakeholders, including policymakers and urban planners. The design and analysis framework emphasizes the importance of rigorous data collection and analytical techniques to yield reliable and insightful outcomes pertinent to traffic safety.

By employing both descriptive and inferential statistical methods within a well-structured research design, this study aims to uncover meaningful insights into the gender disparities observed in work-related traffic accidents. Ultimately, the findings will contribute to the development of targeted interventions aimed at improving road safety for all workers in Ba-tam City, informed by empirical evidence and sound statistical analysis.

Analysis

In this study, a quantitative research methodology will be employed to analyze gender disparities in work-related traffic accidents in Batam City, utilizing regression analysis through SPSS software. A structured questionnaire, created using Google Forms, will be administered to collect data from a sample of 399 respondents selected through random sampling methods. This approach ensures that the sample accurately represents the broader population, minimizing biases and enhancing the validity of the findings. The questionnaire will focus on demographic information, driving behavior, perceived safety, and experience with work-related traffic incidents, which are critical factors in understanding gender differences in accident involvement.

The data collected will then be processed using SPSS, which enables robust statistical analyses to identify relationships between the variables under study. Specifically, regression analysis will be utilized to explore how various predictors, such as gender, age, occupation, and driving frequency, influence the likelihood of involvement in traffic accidents. This analytical method is particularly effective in assessing the strength and direction of these relationships, while also allowing for the control of potential confounding variables. By examining these interactions quantitatively, this study aims to traffic safety outcomes in an occupational context.

Table 1. Examples of survey transcription with keywords and categories

Respondent ID	Survey transcription (keywords highlighted)	Code Categories
BTHC1	(I feel) unsafe if women/teenager/children drive a motorcycle	**Bold** : perceived safety
BTHC2	(I feel) wary, especially at night when (the alleyway) get crowded with motorcycles, (I) have to be accompanied and become dependent to be mobile	*Italic* : past experience
		Underline: reasons for perceived safety
BTHC3	(I feel) wary but *so far* there is no problem, (I) just warned those that are driving too fast	
BTHC4	(I) feel wary but *so far* is safe	
BTHD1	*Never experienced* any problems	
BTHD2	Although there were *bad cases*, but *so far* the area is quite peaceful	
BTHD3	Feeling safe because lots of people around	
BTHD4	Because there is a dedicated sidewalk, lots of people in the surrounding area	

(Source: Researcher, 2025)

Moreover, the findings from the regression analysis will provide evidence to support policy recommendations and interventions aimed at reducing traffic accidents among different gender groups in Batam City. The use of quantitative data enables a more precise understanding of the risk factors associated with work-related traffic incidents, thereby fostering targeted strategies for improving road safety. This methodological framework aligns with contemporary trends in transportation safety research, which increasingly emphasizes the importance of quantitative analyses in developing effective safety interventions tailored to specific context-related characteristics.

In summary, the deployment of a quantitative research methodology featuring regression analysis facilitated by SPSS will provide a robust framework for examining gender disparities in work-related traffic accidents. The resulting insights will not only enrich the academic discourse surrounding traffic safety but also contribute to the design of inclusive policies aimed at enhancing the safety and well-being of all workers in Batam City.

3. RESULTS

The subsequent chapter presenting the findings derived from the data collected for this study. The research employed a quantitative approach, gathering data from 498 respondents in Batam City through a structured questionnaire. The analysis delineate the demographic and travel characteristics of the sample. This is followed by the inferential statistical analysis, which aims to address the research questions.

Respondent Demographics and Work-Related Transportation Characteristics

The demographic profile of the respondents and their work-related travel patterns were analyzed to provide a foundational context for the study. The key characteristics of the sample are detailed below.
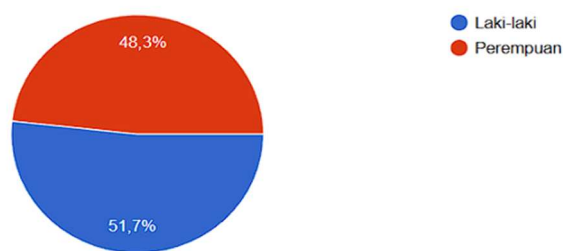
(Source: Researcher, 2025)

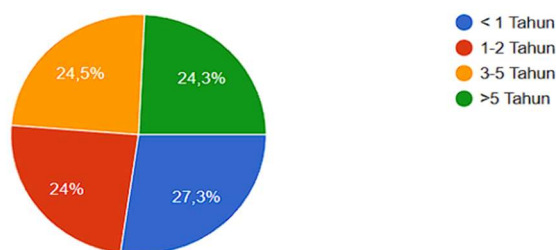**Figure 1.** Gender Distribution

The distribution of the 498 respondents is presented by gender, age, and work experience. A primary characteristic of the sample is its balanced gender distribution, a critical feature for the validity of this study. As illustrated in Figure 1, the sample was composed of 51.7% male participants (n = 257) and 48.3% female participants (n = 241) (see Figure 1). This near-equal representation is a significant methodological strength, particularly for a study with a primary objective of investigating gender disparities in work-related traffic accidents. By ensuring a comparable number of respondents from both genders, this composition provides a robust and unbiased foundation for the subsequent comparative analysis of key variables such as risk perception and driving behaviors. This balance allows for a more reliable statistical examination of the differences in experiences between men and women, thereby strengthening the validity of any conclusions drawn regarding gender-specific factors within the Safe System framework.
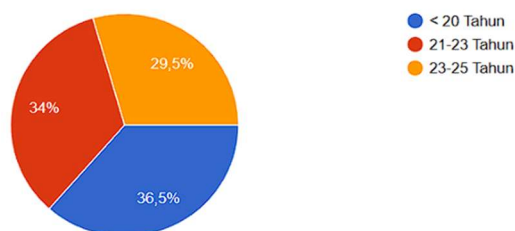
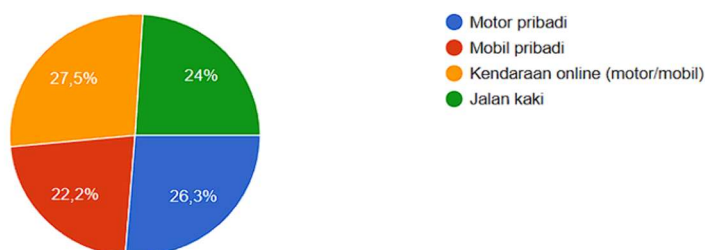(Source: Researcher, 2025)

Figure 2. Age Distribution

The age distribution of the sample reveals a significant concentration of young adults, a key demographic for traffic safety research. As demonstrated in Figure 2, the demographic with the highest percentage was individuals below the age of 20, constituting 36.5% (n ≈ 182), followed closely by those aged 21-23 years at 34.0% (n ≈ 169), and respondents aged 23-25 years at 29.5% (n ≈ 147). This demographic concentration is highly relevant, as young adults are widely recognized in traffic safety literature as a high-risk group for road accidents. This heightened vulnerability is often attributed to a combination of factors including limited driving experience, still-developing cognitive functions related to risk assessment, and a greater propensity for risk-taking behaviors. Given that this young demographic likely represents a substantial portion of the workforce in a rapidly industrializing city like Batam, this sample composition provides a critical opportunity for a focused analysis of the perceptions and behaviors of the population most vulnerable to work-related traffic incidents.

(Source: Researcher, 2025)

Figure 3. Working Experience

In addition to gender and age, the sample demonstrated a remarkably balanced distribution across various levels of work experience, as illustrated in Figure 3. The respondents were almost equally divided among four tenure levels: those with less than one year of experience constituted 27.3% (n ≈ 136) of the sample, while those with 1-2 years of experience (24.0%) (n ≈ 120), those with 3-5 years of experience (24.5%) (n ≈ 122), and seasoned employ-ees with more than five years of experience accounted for 24.3% (n ≈ 121). This equitable representation across career stages is a significant methodological strength. It enables the analysis to move beyond static demographic traits and explore the dynamic nature of risk perception and commuting behaviors as a worker gains more experience in the workforce. For instance, it allows for a nuanced comparison between the potential overconfidence or heightened caution of novices and the potentially habituated risk perceptions of veteran employees. This diversity enriches the dataset, providing a valuable opportunity to investigate how the interplay of experience, age, and gender may shape a worker's overall vulnerability to traffic incidents in Batam

(Source: Researcher, 2025)

Figure 4. Primary Mode of Transportation for Work-Related Travel

Respondents reported using a variety of transportation modes for their work-related journeys, revealing a complex urban mobility landscape as detailed in Figure 4. Significantly, the most prevalent modes were online transportation, such as app-based services (27.5%), and private motorcycles (26.3%). When combined, these two categories account for more than half (53.8%) of all commutes, indicating a heavy reliance on two-wheeled transportation. This dependence on motorcycles a vehicle type consistently associated with higher vulnerability and accident severity is a key finding that underscores the direct relevance of this sample to the study of traffic safety. This transportation pattern likely reflects the urban characteristics of Batam City, where rapid industrialization and population growth may outpace the development of comprehensive public transport options. This risk profile is further emphasized by the comparatively lower usage of private cars (22.2%) and a significant portion of respondents commuting by walking (24.0%), reinforcing that the predominant risk exposure for this demographic is linked to more vulnerable road user modes. Ultimately, this finding is critical as it establishes the specific daily risk exposures faced by the majority of Batam's workforce, providing an essential context for analyzing their subsequent safety perceptions and gender-specific travel experiences.

Respondents reported using a variety of transportation modes for work-related journeys. As demonstrated in Figure 4, the most prevalent mode was online transportation (e.g., app-based motorcycle or car services), reported by 27.5% of participants. The utilisation of private motorcycles emerged as the second most prevalent mode, accounting for 26.3% of all journeys. A significant proportion of respondents commuted by walking (24.0%), while 22.2% used a private car. This diverse modal split highlights the intricate transportation landscape experienced by workers in Batam City.

Inferential Analysis

A questionnaire item is considered valid if its calculated r-value (r-calculated) is greater than the critical r-value (r-table) [32]. The validity test for this study was conducted using SPSS, and items are declared valid if their r-calculated value exceeds 0.088. This r-table value was obtained from the r-distribution table based on the degrees

of freedom (df), which is calculated as df = n - 2. The complete results of the validity test are presented in the following table.

Table 2. Validity Test Results

Variable	r-calculated	r-table	Status
BTHC1	0.439	0.088	Valid
BTHC2	0.403	0.088	Valid
BTHC3	0.376	0.088	Valid
BTHC4	0.442	0.088	Valid
BTHD1	0.636	0.088	Valid
BTHD2	0.628	0.088	Valid
BTHD3	0.632	0.088	Valid
BTHD4	0.611	0.088	Valid

(Source: Researcher, 2025)

According to Table 2, the validity test results show that all items for each variable are declared valid because their respective r-calculated values are greater than the r-table value of 0.088.

Following the validity analysis, each variable that was declared valid then underwent reliability testing to assess internal consistency. The results are presented in the following table.

Table 3. Reliability Test Results

Variable	N of Items	Cronbach's Alpha	Status
BTHC	4	0.705	Reliable
BTHD	4	0.718	Reliable

(Source: Researcher, 2025)

The reliability test results, as presented in Table 3, indicate that all variables are reliable, as each possesses a Cronbach's alpha value exceeding 0.7

Table 4. Summary of Simple Linear Regression Analysis for BTHD Predicting BTHC (N=498)

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std.Error	Beta	t	Sig.	Tolerance	VIF
1	Constanct	1.596	.149		10.707	<.001		
	BTHD	.626	.035	.626	17.896	<.001	1.000	1.000

Note. R^2 = .392, Adjusted R^2 = .391. $F(1, 496)$ = 320.264, $p < .001$.

(Source: Researcher, 2025)

A simple linear regression analysis was conducted to assess the extent to which BTHD (the predictor variable) could predict BTHC (the dependent variable). Prior to the analysis, an evaluation of the assumptions for linear regression was performed. The Durbin-Watson statistic was found to be 1.792, which is within the acceptable range, thus suggesting the absence of significant first-order autocorrelation in the residuals. The normal P-P plot of regression standardized residuals indicated that the data was approximately normally distributed, and the scatterplot of residuals showed that the assumptions of linearity and homoscedasticity were met. Additionally, multicollinearity was not a concern, as the Variance Inflation Factor (VIF) was 1.000.

The results of the regression analysis are presented in Table 1. The overall model was found to be statistically significant, $F(1, 496)$ = 320.264, $p < .001$, and accounted for 39.2% of the variance in BTHC (R^2 = .392).

The analysis revealed that BTHD was a statistically significant positive predictor of BTHC (B = 0.626, $p < .001$). This indicates that for each one-unit increase in the BTHD score, the BTHC score is predicted to increase by 0.626 units. The model's intercept was also statistically significant (B = 1.596, $p < .001$).

4. DISCUSSION & CONCLUSION

Presented in the preceding chapter. The study provides an interpretation of the results, discusses their connection to existing literature and the Safe System framework, and outlines the implications of the study. Finally, the text acknowledges the limitations of the research and offers recommendations for future investigation before drawing an overall conclusion.

Summary of Key Findings

The objective of this study was to investigate gender disparities in work-related traffic accidents within Batam City and to propose strategies for integrating gender considerations into the Safe System framework. The

descriptive analysis revealed that the research sample primarily consists of young adult workers who utilise a diverse range of transportation modes for their work-related journeys. Specifically, these results refer to the demographic data presented in the preceding chapter, which showed that the entire respondent pool was under the age of 25, with the largest single group being those under 20 years old (36.5%). The finding on transportation modes refers to the data in Figure 4, which highlighted the workforce's significant reliance on high-vulnerability, two-wheeled transport over half of the respondents (53.8%) reported using either online transportation (27.5%) or private motorcycles (26.3%) for their commute. Collectively, these descriptive findings establish that the study's sample is a young, mobile, and highly exposed workforce, providing the critical context for the main inferential findings on risk perception.

The principal inferential finding is that there is a statistically significant positive relationship between all BTHD variables (BTHD1, BTHD2, BTHD3, and BTHD4) (representing positive safety perceptions and past experiences) and all BTHC variables (BTHC1, BTHC2, BTHC3, and BTHC4) (representing perceived vulnerability and wariness). This result, counterintuitively, indicates that as respondents' perception of a safe environment or their positive past experiences increase, their self-reported level of wariness and vulnerability also tends to increase. This finding, which is complex in nature, challenges simplistic assumptions about risk perception and forms the central point of this discussion.

Interpretation of Findings

The most significant and thought-provoking outcome of this study is the positive correlation between BTHD (positive safety perceptions) and BTHC (perceived wariness), as statistically established in the regression analysis detailed in Table 2. This finding prompts a critical inquiry: what factors might contribute to an elevated sense of wariness despite heightened perceptions of safety or favourable past experiences? Several interpretations can be advanced. Several interpretations can be proposed.

The present relationship may be explained by the "Heightened Awareness Hypothesis." This hypothesis posits that for the demographic studied primarily young workers who are highly reliant on vulnerable transportation modes like motorcycles (as shown in Figure 4). It has been demonstrated that individuals who possess strong positive safety perceptions (e.g., recognising safe infrastructure such as dedicated sidewalks, as noted in BTHD4) may not be complacent. Conversely, individuals who can identify elements of a safe system may possess a more developed awareness of residual and unpredictable risks in Batam's complex traffic environment. This heightened awareness could lead to increased vigilance and caution (as indicated by a higher BTHC score), explaining the positive predictive relationship identified in our regression model (B = 0.626, p < .001). Consequently, their sense of security cannot be attributed to a state of passive ignorance; rather, it is an active condition characterised by heightened cognitive alertness.

Secondly, the finding can be interpreted through a gendered lens, which is a central theme of this research. The balanced gender composition of our sample (Figure 1) provides a solid basis for this consideration. Existing literature suggests that women often face unique transport-related vulnerabilities. It is therefore conceivable that even when female respondents in our study perceive their environment as objectively safe (a high BTHD score), a persistent and necessary level of wariness (a high BTHC score) remains as a protective strategy shaped by societal experience. This interpretation aligns with the research by [33], which highlights how gender and safety perceptions shape mobility in Southeast Asia. This underlying vigilance may persist as a constant, regardless of external safety factors, thus contributing to the positive correlation observed in Table 2.

Secondly, the finding may be interpreted through a gendered lens, which is a central theme of this research. existing literature, women frequently encounter specific vulnerabilities regarding transportation. It is conceivable that even when female respondents perceive their environment as objectively safe (high BTHD), a persistent and necessary level of wariness (high BTHC) remains as a protective strategy shaped by societal experience. This finding is consistent with the research conducted by [33], which highlights the role of gender and safety perceptions in shaping mobility patterns in Southeast Asia. This underlying vigilance may persist even in the presence of ameliorating external safety factors.

Comparative Discussion

This positive correlation between positive safety perceptions (BTHD) and perceived wariness (BTHC) provides a critical nuance when compared to studies from similar urban contexts in Southeast Asia. For instance, in Surabaya, Indonesia, and Kuala Lumpur, Malaysia, highlighted that female commuters adopt numerous protective strategies (a form of wariness) in direct response to perceived safety risks, such as avoiding travel after dark or preferring app-based ride-hailing services [33]. While our findings align with the high prevalence of such strategies (given that online transportation was the most-used mode in our sample), they also present a significant divergence. This aligns with existing research [33], along with much of the literature, links perceived danger (low safety) to heightened wariness. Our Batam data, conversely, reveals that positive safety perceptions (high BTHD) also

significantly predict heightened wariness (high BTHC). This comparison suggests that for the young workforce in Batam, 'wariness' is not merely a reactive strategy employed in the face of perceived danger, but is rather a baseline, active cognitive state consistent with our "Heightened Awareness Hypothesis". This active vigilance, remaining alert despite a safe environment challenges traditional risk-compensation models and highlights a complex psychological dynamic likely shaped by Batam's specific demographic and high-vulnerability modal mix.

Connection to Existing Literature and the Safe System Approach

The findings of this study contribute to the extant literature in several ways. Whilst a substantial body of research suggests that males are more predisposed to high-risk behaviours and perceive themselves as less vulnerable, the present study provides a more nuanced perspective from a mixed gender working population in Batam. The findings of this study suggest that, within this demographic, a perception of safety does not necessarily negate a sense of wariness, thus complicating the direct link between risk perception and behaviour.

This research directly addresses the gap identified by [5] and [25], who argue that the Safe System approach often overlooks the specific needs and differences of diverse demographic groups, including those related to gender. The findings of this study provide substantial support for this critique. To achieve the overarching objective of zero fatalities, the Safe System framework must evolve beyond physical infrastructure and traffic management systems to encompass the complex psychological and perceptual landscape of its users. The study validates the call for gender-sensitive data collection and analysis to inform more equitable and effective safety measures.

Implications of The Research

Practical Implications: This research carries significant practical implications for policymakers and urban planners in Batam City. It is suggested that enhancing physical infrastructure alone, while undoubtedly essential, may be inadequate to modify user perceptions of vulnerability. It is imperative that road safety campaigns are developed with a focus on cultivating positive behaviours, such as situational awareness, rather than merely issuing warnings against specific unsafe acts. Furthermore, interventions must acknowledge that even when citizens feel their environment is safe, a protective level of wariness exists and should be understood, rather than dismissed.

Theoretical Implications: The present study contributes to the existing body of literature on traffic safety by challenging the simplistic inverse relationship between feelings of safety and feelings of wariness. The present study provides empirical evidence from a rapidly urbanising Indonesian city that gendered perceptions of safety are a critical and complex component of traffic safety dynamics. This reinforces the need for more nuanced theoretical models.

Limitations and Future Research

The findings of this study should be considered in light of its limitations. Firstly, the cross-sectional research design identifies a predictive relationship; however, it is unable to prove causality. Secondly, the reliance on self-reported data from a questionnaire is subject to potential recall and social desirability biases. Finally, the study is context-specific to the young, working population of Batam City, and its findings may not be generalisable to other demographic groups or different urban settings.

In light of the study's limitations, several avenues for future research are recommended to build upon these findings. It is recommended that future research employ a qualitative methodology, such as in-depth interviews, to explore the nuanced reasoning behind the positive correlation between safety perceptions and wariness. Moreover, a longitudinal study would be of immense value in tracking the evolution of workers' perceptions and experiences over time, thereby providing insights into the stability of these safety attitudes. Finally, to enhance the generalizability of the findings, comparative studies between Batam and other cities with differing socio-economic and traffic characteristics would offer a broader understanding of how these complex perceptual dynamics manifest in various urban contexts.

5. CONCLUSION

The present study investigated gender disparities in work-related traffic accidents in Batam City, unveiling a complex and significant positive relationship between positive safety perceptions (BTHD) and perceived vulnerability (BTHC). This key finding emphasises the importance of incorporating psychological and gender-specific factors into the Safe System approach. To build upon these results, future research is recommended to delve deeper into the underlying reasons for this correlation, potentially through qualitative methodologies such as in-depth interviews. Furthermore, longitudinal studies are suggested to track the evolution of these perceptions over time, while comparative studies with other cities would enhance the generalizability of the findings. Ultimately, by expanding the focus beyond a single emphasis on physical infrastructure to a more comprehensive understanding of the intricate reality experienced by all road users, policymakers in Batam can formulate more

effective, inclusive, and ultimately safer transportation systems for the city's entire workforce, thereby advancing the objective of eliminating traffic-related fatalities and serious injuries.

REFERENCES

[1]   B. Corben, S. Peiris, and S. Mishra, "The Importance of Adopting a Safe System Approach—Translation of Principles into Practical Solutions," *Sustainability (Switzerland)*, vol. 14, no. 5, Mar. 2022, doi: 10.3390/su14052559.

[2]   D. Prastio, Y. A. Sari, and M. Pamadi, "Evaluasi Kinerja Simpang Panbil Terhadap Tingkat Pelayanan Lalu Lintas (Studi Kasus Simpang Panbil - Batam)," *Journal of Civil Engineering and Planning*, vol. 3, no. 1, pp. 60–69, Jun. 2022, doi: 10.37253/jcep.v3i1.1317.

[3]   T. Fosdick, D. Campsall, M. Kamran, and S. Scott, "Creating a Cultural Maturity Model to Assess Safe System Readiness Within Road Safety Organisations," *Journal of Road Safety*, vol. 35, no. 1, pp. 52–64, 2024, doi: 10.33492/JRS-D-24-1-2125507.

[4]   M. Kraut and I. V. Koglbauer, "STPA-based analysis of the process involved in enforcing road safety in Austria," Jun. 01, 2021, *MDPI AG*. doi: 10.3390/safety7020034.

[5]   M. H. Shakil, "Environmental, social and governance performance and financial risk: Moderating role of ESG controversies and board gender diversity," *Resources Policy*, vol. 72, Aug. 2021, doi: 10.1016/j.resourpol.2021.102144.

[6]   M. Isradi, E. Hasdian, R. H. Ariyapijati, A. Nurmahdi, S. Syafwandi, and A. I. Rifai, "Keselamatan Lalu Lintas dan Pentingnya Kepatuhan Terhadap Kecepatan di Jalan Raya Bagi Masyarakat Indonesia di Pulau Pinang, Malaysia," *I-Com: Indonesian Community Journal*, vol. 5, no. 2, pp. 1006–1017, Jun. 2025, doi: 10.70609/i-com.v5i2.7434.

[7]   N. Deretić, D. Stanimirović, M. Al Awadh, N. Vujanović, and A. Djukić, "SARIMA Modelling Approach for Forecasting of Traffic Accidents," *Sustainability (Switzerland)*, vol. 14, no. 8, Apr. 2022, doi: 10.3390/su14084403.

[8]   M. T. Ghaneian *et al.*, "An Epidemiological Survey on Factors Related to Traffic Accidents in Yazd City, Center of Iran (2016-2018)," *Journal of Occupational Health and Epidemiology*, vol. 10, no. 4, pp. 231–238, Sep. 2021, doi: 10.52547/johe.10.4.231.

[9]   T. ŘEZNÍČEK and V. KOVAČ, "THE IMPACT OF DEMOGRAPHIC FACTORS ON THE TRAFFIC ACCIDENT RATE IN CZECH REPUBLIC," *Transport Problems*, vol. 20, no. 2, pp. 5–17, Jun. 2025, doi: 10.20858/tp.2025.20.2.01.

[10]   T. Agrawal, S. K. Sinha, and N. Agrawal, "Retrospective Evaluation of Determinants of Road Traffic Injuries at a Naval Station," *Indian J Community Health*, vol. 33, no. 1, pp. 205–211, Mar. 2021, doi: 10.47203/IJCH.2021.v33i01.030.

[11]   H. Abuzaid, R. Almashhour, and G. Abu-Lebdeh, "Driving towards Sustainability: A Neural Network-Based Prediction of the Traffic-Related Effects on Road Users in the UAE," *Sustainability*, vol. 16, no. 3, p. 1092, Jan. 2024, doi: 10.3390/su16031092.

[12]   C. Papic *et al.*, "Factors associated with long term work incapacity following a non-catastrophic road traffic injury: analysis of a two-year prospective cohort study," *BMC Public Health*, vol. 22, no. 1, p. 1498, Aug. 2022, doi: 10.1186/s12889-022-13884-5.

[13]   V. J. Delgado-Fernández, M. del C. Rey-Merchán, A. López-Arquillos, and S. D. Choi, "Occupational Traffic Accidents among Teachers in Spain," *Int J Environ Res Public Health*, vol. 19, no. 9, p. 5175, Apr. 2022, doi: 10.3390/ijerph19095175.

[14]   M. Amoadu, E. W. Ansah, and J. O. Sarfo, "Psychosocial work factors, road traffic accidents and risky driving behaviours in low-and middle-income countries: A scoping review," *IATSS Research*, vol. 47, no. 2, pp. 240–250, Jul. 2023, doi: 10.1016/j.iatssr.2023.03.005.

[15]   F. Balada, A. Aluja, Ó. García, N. Aymamí, and L. F. García, "Gender Differences in Prefrontal Cortex Response to Negative Emotional Stimuli in Drivers," *Brain Sci*, vol. 14, no. 9, p. 884, Aug. 2024, doi: 10.3390/brainsci14090884.

[16]   P. Cordellieri, L. Piccardi, M. Giancola, A. M. Giannini, and R. Nori, "On the Road Safety: Gender Differences in Risk-Taking Driving Behaviors Among Seniors Aged 65 and Older," *Geriatrics*, vol. 9, no. 5, p. 136, Oct. 2024, doi: 10.3390/geriatrics9050136.

[17]   D. A. J. Salvagioni *et al.*, "Prospective association between burnout and road traffic accidents in teachers," *Stress and Health*, vol. 36, no. 5, pp. 629–638, Dec. 2020, doi: 10.1002/smi.2958.

[18]   R. Činčikaitė and I. Meidutė-Kavaliauskienė, "STUDY OF THE INFLUENCE OF SUSTAINABLE TRANSPORT ON TRAFFIC INCIDENTS," *Business, Management and Economics Engineering*, vol. 21, no. 02, pp. 237–247, Oct. 2023, doi: 10.3846/bmee.2023.19678.

[19] N. A. A. binti Mohmood Nor, N. N. binti Mohd Suhaimi, N. K. binti Ismail, and N. F. S. binti Isarudin Shah, "Protecting the Future: How Road Safety Knowledge Can Prevent Risky Behaviours among Adolescents in Malaysia," *International Journal of Academic Research in Progressive Education and Development*, vol. 13, no. 1, Feb. 2024, doi: 10.6007/ijarped/v13-i1/20168.

[20] P. Penmetsa and S. S. Pulugurtha, "Peer-reviewed papers Original Road Safety Research Risk Perceptions of Crash Related Traffic Rule Violations."

[21] A. Hailemariam, E. Adanu, S. A. Churchill, and R. Smyth, "Gender Gaps in the Severity of Road Traffic Accidents," 2020. [Online]. Available: https://www.researchgate.net/publication/340271201

[22] S. S. Granieri *et al.*, "Motorcycle-related trauma:effects of age and site of injuries on mortality. A single-center, retrospective study.," *World Journal of Emergency Surgery*, vol. 15, no. 1, Mar. 2020, doi: 10.1186/s13017-020-00297-1.

[23] S. Useche, F. Alonso, L. Montoro, and L. Garrigós, "More aware, more protected: A cross-sectional study on road safety skills predicting the use of passive safety elements among Spanish teenagers," *BMJ Open*, vol. 9, no. 11, Nov. 2019, doi: 10.1136/bmjopen-2019-035007.

[24] C. Okafor, G. Obeta, and O. Nnamchi, "Prosocial Behaviour Towards Victims of Road Accidents: Examining Personality, Gender and Traumatic Experience," *Asian Journal of Humanities and Social Studies*, vol. 12, no. 1, Feb. 2024, doi: 10.24203/ajhss.v12i1.7213.

[25] J. A. Cox, G. J. M. Read, G. L. Butler, and P. M. Salmon, "Examining gender differences in gig worker safety," *Hum Factors Ergon Manuf*, vol. 34, no. 1, pp. 3–15, Jan. 2024, doi: 10.1002/hfm.21007.

[26] M. Khayesi, "Vision Zero in the United Nations," in *The Vision Zero Handbook*, Cham: Springer International Publishing, 2023, pp. 637–646. doi: 10.1007/978-3-030-76505-7_23.

[27] M. N. Khan and S. Das, "Advancing traffic safety through the safe system approach: A systematic review," *Accid Anal Prev*, vol. 199, p. 107518, May 2024, doi: 10.1016/j.aap.2024.107518.

[28] M. A. Javid, N. Ali, M. Abdullah, and R. C. P. Wong, "Enhancing social acceptance of women's mobility for equitable transport: Behavioural theories driven approach," *J Public Trans*, vol. 26, p. 100109, 2024, doi: 10.1016/j.jpubtr.2024.100109.

[29] M. Eskandari Torbaghan, M. Sasidharan, L. Reardon, and L. C. W. Muchanga-Hvelplund, "Understanding the potential of emerging digital technologies for improving road safety," *Accid Anal Prev*, vol. 166, p. 106543, Mar. 2022, doi: 10.1016/j.aap.2021.106543.

[30] A. L. P. Freitas, M. T. S. Silva Filho, and D. A. de Assis, "An analysis of gender differences and perception of influential criteria for the quality of urban bus transportation: Evidence from Brazil," *J Public Trans*, vol. 25, p. 100050, 2023, doi: 10.1016/j.jpubtr.2023.100050.

[31] M. (Melrose) Pan and A. Ryan, "Segmenting the target audience for transportation demand management programs: An investigation between mode shift and individual characteristics," *Int J Sustain Transp*, vol. 18, no. 1, pp. 62–83, Jan. 2024, doi: 10.1080/15568318.2023.2201941.

[32] R. S. Putri, S. Astiti, and R. N. S. Amriza, "Analisis Kepuasan Konsumen Terhadap Kualitas Pelayanan E-Commerce Jd.Id Menggunakan Metode E-Servqual," *JURNAL MEDIA INFORMATIKA BUDIDARMA*, vol. 6, no. 2, p. 1207, Apr. 2022, doi: 10.30865/mib.v6i2.3893.

[33] I. Hidayati, W. Tan, and C. Yamu, "How gender differences and perceptions of safety shape urban mobility in Southeast Asia," *Transp Res Part F Traffic Psychol Behav*, vol. 73, pp. 155–173, Aug. 2020, doi: 10.1016/j.trf.2020.06.014.