

## Empirical Analysis of Risk Behavior in Truck Drivers Across Industrial Zones and Policy Recommendations

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### Abstract

Truck drivers play a crucial role in industrial development but face disproportionately high risks of traffic-related injuries and fatalities. These risks arise from complex traffic conditions, especially in truck-congested industrial zones, and economic pressures that encourage risky driving behaviors. This study investigates key factors influencing these behaviors among truck drivers in industrial zones using an integrated framework combining the Health Belief Model and Protection Motivation Theory, a novel approach in this context. A random parameter model was employed to account for unobserved heterogeneity in drivers' responses. The results highlight several significant psychological factors: perceived susceptibility (when drivers perceive the risk of crashes while driving), perceived severity (when drivers feel that crashes will impact their work), perceived barriers (when truck drivers perceive that fastening seat belts causes discomfort and when they perceive safety equipment for vehicles as expensive and unaffordable), cues to action (when truck drivers encounter safe driving campaigns), and health motivation (when truck drivers prioritize adequate rest and relaxation). Additionally, the study identifies route familiarity as a random effect, revealing variations in how this factor influences behavior across individuals. The study provides practical, evidence-based policy recommendations aimed at reducing road injuries and fatalities among truck drivers, offering valuable insights for policymakers, transport authorities, and logistics stakeholders.

**Keywords:** Truck Drivers; Industrial Zones; Health Belief Model; Protection Motivation Theory; Thailand.

## 1. Introduction

Road traffic crashes remain a significant global traffic disaster that persists today. The loss from crashes claims approximately 1.19 million lives worldwide, with a fatality rate of 15 per 100,000 population [1]. This poses a challenge for countries worldwide striving to manage the traffic disaster, especially developing nations [2]. According to estimates by the World Health Organization, the economic cost of road traffic injuries globally is high, reaching up to 1.8 to 2 trillion US dollars, equivalent to about 10-12% of the Gross Domestic Product (GDP) worldwide. It's deeply concerning that 92% of fatalities occur in low- and middle-income developing countries [1]. Researchers have diligently attempted to study influential factors and behaviors of drivers to find ways to mitigate traffic disasters. However, it seems traffic

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crashes remain a continuous challenge, as the number of fatalities and injuries in developing countries remains higher than those in developed countries [3].

In the current context, Thailand's narrative has shifted to that of a country in social, economic, and industrial development, yet it is plagued by the curse of road traffic disasters. According to statistics recorded by the World Health Organization, road crashes claim a high number of lives in Thailand, ranking 9th globally and making it a leading country in Asia and the ASEAN region [4]. In 2022, there were 17,000 fatalities and 15,000 disabilities due to road injuries, resulting in significant human and economic losses estimated at around 500,000 million baht (approximately 12.5 billion USD) [1]. When considering statistics from recent years, Thailand's crash figures concentrate heavily in provinces situated within industrial zones [5]. Due to the environment in areas designated specifically for industrial activities, particularly manufacturing, these areas are densely packed with buildings, factories, and residential housing. This results in heavy traffic congestion filled with trucks and numerous other vehicles, making it highly prone to crashes. There was a concerning upward trend in the proportion of injuries and fatalities involving trucks between 2020 and 2022, with figures reported at 43.75% in 2020, increasing to 50.50% in 2021, before slightly declining to 45.20% in 2022, in comparison with other types of vehicles [6]. Particularly alarming is the fact that collisions involving trucks result in far greater losses than those not involving trucks [7]. Figure 1 presents the trend in the number of injuries and fatalities resulting from truck-related accidents, which has shown a continuous upward trajectory. This trend highlights the challenges in managing road safety and underscores the need for proactive measures to mitigate accident risks associated with this category of vehicles. Furthermore, significant disclosures from the statistics reveal that the mortality rate from truck crashes in industrial zones is the highest compared to other vehicles [7], as shown in Figure 2.

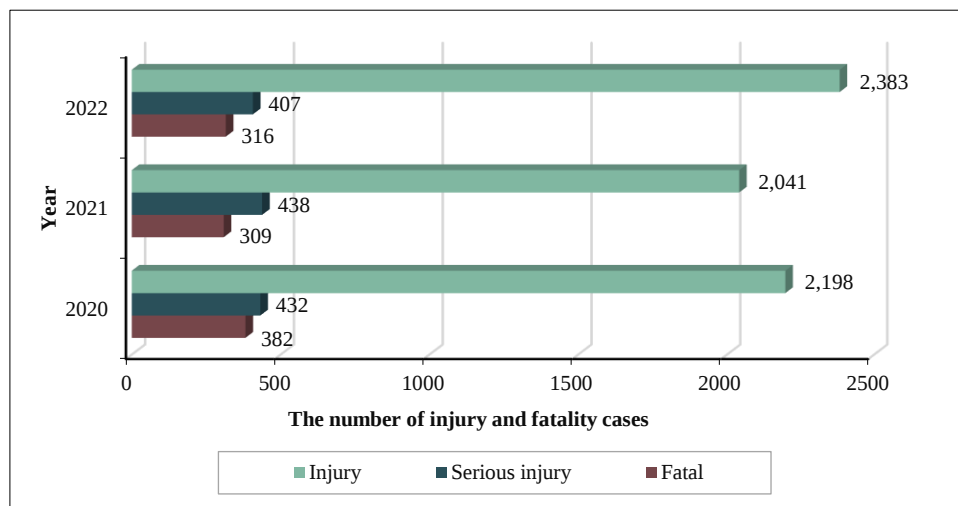


Figure 1. The number of injuries and fatalities caused by truck-related incidents in industrial zones

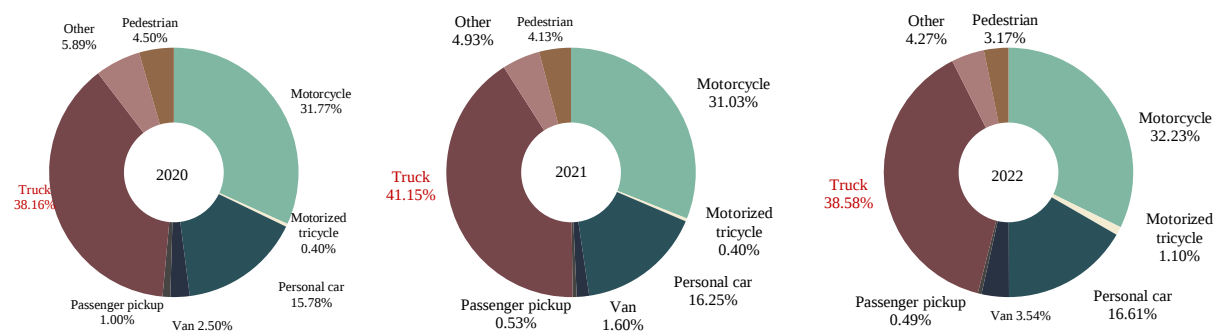


Figure 2. The mortality rates in industrial zones categorized by vehicle type from 2020 to 2022

Even though there are numerous factors contributing to road crashes, the major factors often stem from abnormal driving behaviors [8-10]. This is because driver behavior plays a significant role in controlling vehicle movements in road situations [10]. This aligns with crucial evidence indicating that 95% of crashes result from human factors, with over 90% attributed to unsafe driving behaviors [8, 11]. Despite truck drivers playing a vital role in promoting industrial development, they also face a higher risk of unforeseen road events resulting in fatalities and injuries compared to drivers in other groups [12]. This is attributable to truck drivers facing chaotic traffic conditions, spending extended periods on the road, and adhering to demanding schedules, all of which contribute to prolonged illegal working hours as a means of economic survival [13]. Additionally, truck drivers are generally older than other drivers due to the nature of their

work [14, 15], which relies on long-term driving expertise and experience, leading to certain personal traits and risky behaviors that contribute to road crashes. Therefore, systematically reviewing abnormal driving behaviors of truck drivers is crucial for implementing preventive measures to promote safe and effective driving among this group.

In the past decade, truck-related accidents have emerged as a critical road safety issue. A growing body of research has focused on truck drivers' behavior, which is recognized as one of the key factors contributing to accident risk [16]. A review of the literature reveals that numerous studies have applied various behavioral science and psychological theories to investigate risky driving behavior among truck drivers. Notably, the Health Belief Model (HBM) [17, 18] has been employed to examine individuals' perceptions of risks and the consequences of their behaviors. In contrast, the Theory of Planned Behavior (TPB) [18-21] emphasizes the role of behavioral intentions shaped by attitudes, subjective norms, and perceived behavioral control. Additionally, the Driver Behavior Questionnaire (DBQ) has been widely used as a behavioral instrument to classify accident-prone behaviors [22-25]. These findings suggest that selecting a theoretical framework appropriate to the context is crucial for comprehensively understanding risky driving behavior and for informing effective prevention strategies.

Recent studies have increasingly applied the Protection Motivation Theory (PMT) to traffic safety research in order to reflect the cognitive and emotional dimensions influencing behavior, such as driving practices and customer interactions among public transport operators [26]. Examples include analyses of PMT and cognitive failures related to texting while driving among young drivers [27], protective behavior in ride-sharing through the lenses of PMT and usage situation theory [28], studies on helmet use among commercial motorcyclists [29], parental risk perceptions in family travel to rural destinations [30] and the examination of protective driving behavior among bus drivers using a combination of PMT and TPB [31]. However, to date, no studies have been found that combine HBM and PMT to examine risky driving behavior among truck drivers. Integrating these two psychological perspectives offers a more holistic approach to understanding the internal mechanisms that underlie such behaviors. This study applies HBM to focus on individuals perceived susceptibility and severity of risk, while PMT extends the conceptual framework to include self-appraisal in the face of danger. The integration of both theories enables a systematic analysis of "risk perception" and "behavioral motivation," thus allowing for a deeper understanding of the decision-making process involved in choosing between safe and risky driving behaviors. Moreover, this theoretical combination enhances the development of targeted interventions and policies by addressing information dissemination, self-efficacy, and the reduction of behavioral barriers more effectively.

Previously, studies have examined factors influencing driver behavior to find ways to mitigate road crashes, often utilizing results from conventional statistical models [9, 32, 33]. However, it appears that these studies still lack robustness in explaining the parameters using random effects models, which are widely employed nowadays due to their ability to capture variability and complexity accurately [34-37]. Furthermore, the current trend includes utilizing the concept of unobserved heterogeneity (in means) to study traffic safety [2]. Unobserved heterogeneity refers to characteristics that may not directly influence the outcome but may have indirect effects. Moreover, it can be applied to random parameter models, where the hidden influence in the unobserved heterogeneity method may affect the direction of model parameters and increase the model's complexity [34]. This is an interesting aspect to consider in studying factors influencing driver behavior because most studies have not explored these potential relationships, which could lead to missing significant results. Additionally, significant evidence suggests that models with unobserved diversity have greater explanatory and predictive power than conventional models [2, 38, 39].

To further address gaps in previous research, this study aims to investigate the factors influencing risky behavior among truck drivers in Thailand's industrial zones. Given the unique traffic conditions in these areas, which may contribute to specific risk-taking tendencies among drivers, this study pioneers the integration of the Health Belief Model (HBM) and Protection Motivation Theory (PMT) within the context of truck driver behavior. This approach fills a critical gap in literature, where no prior studies have combined these two psychological frameworks in this domain. Furthermore, the study adopts a structured analytical framework to explain key behavioral parameters by employing random effects models, which are recognized for their ability to accurately capture variability and model complexity. This includes accounting for unobserved heterogeneity in means, an important aspect often overlooked in earlier research, potentially leading to the omission of significant insights. The findings of this study are expected to offer valuable guidance for policymakers and relevant stakeholders in developing targeted interventions to reduce road crashes and promote safer, more effective driving practices among truck drivers.

## 2. Methodological Approach

### 2.1. Model Development

To consider the unnoticed differences and the nature of ranking risky driving behaviors among truck drivers, this study employs an ordered probit model that allows for parameter variability. In theoretical terms, it is necessary to define the latent utility function  $Y_{in}^*$  that specifies the likelihood of the outcome of driving behavior  $i$  for driver (i.e., respondent)  $n$ . This is outlined as follows [40-43]:

$$Y_{in}^* = \beta_n X_{in} + \varepsilon_n \quad (1)$$

where  $\beta_n$  represents the vector of estimated parameters,  $X_{in}$  denotes the vector of explanatory variables, and  $\varepsilon_n$  signifies the error term, assumed to follow a normal distribution with a mean of 0 and a variance of 1 for driving scenario  $n$ . Here,  $n$  denotes driver (i.e., respondent). This can be specified as follows [40, 41, 44]:

$$Y_{in}^* = i, \text{ if } \mu_{i-1,n} < Y_n^* \leq \mu_{i,n} \quad (2)$$

where  $i$  (with  $i = 1, 2, 3$ ) represents "Sometimes," "often," and "Regularly," respectively, and  $\mu_i$  is the estimated parameter (or threshold) for defining  $Y_n^*$  in accordance with the ordered levels of driving behavior such that  $\mu_{i-1} < \mu_i$ . The probability of each level  $P(y=i)$  of risky driving behavior of truck drivers for each observed crashes can be specified as follows [40, 41]:

$$P(y=i) = \Phi(\mu_i - \beta_n X_n) - \Phi(\mu_{i+1} - \beta_n X_n) \quad (3)$$

where  $\Phi$  represents the cumulative standard normal distribution, influencing the mean and variance of the explanatory variables, and  $\beta_{in}$  is the vector of estimated parameters, which vary according to the specified constraints [38, 39, 44, 45].

$$\beta_{in} = \beta + \eta Z_n + \omega_n \quad (4)$$

where  $\beta$  denotes the constant term for random parameters [38, 46].  $Z_n$  represents the vector of explanatory variables capturing differences in the mean of random parameters.  $\eta$  is the vector of estimated parameters aligned with  $Z_n$ ,  $\eta Z_n$  denotes terms to describe undetected differences resulting from interactions (intercepting explanatory variables) causing variations in the parametric function of random parameters [38, 45, 46].  $\omega_n$  is a  $K \times 1$  vector that cannot be observed, where  $K$  is the number of random parameters. Embedded random terms with zero mean affect the mean and covariance-variance matrix of random parameters, which become  $E((\beta_n | \omega_n) = \beta + \eta Z_n)$  and  $\text{Var}(\beta_n | \omega_n) = \Gamma \Gamma^T$ , respectively [45-47].  $\Gamma$  is a symmetric Cholesky matrix used to compute the standard deviations of random parameters. This study estimates the model using maximum likelihood estimation with 200 Halton draws to simplify the interpretation of the results and calculates marginal effects to analyze the impact of explanatory variables on the probability of each risky driving behavior level. The direction of the impact cannot be indicated by parameter values [48]. Additional marginal effects were calculated by changes in the probability of each outcome for each level. These additional marginal effects were computed by averaging the observed values as follows [41, 48]:

$$\frac{P(y=i)}{\partial X} = [\Phi(\mu_{i-1} - \beta X) - \Phi(\mu_i - \beta X)] \beta \quad (5)$$

where  $P(y=i)$  is the probability that the outcome equals category  $i$ ,  $X$  is a vector of explanatory variables,  $\beta$  is a vector of estimated coefficients associated with  $X$ ,  $\mu_{i-1}$ ,  $\mu_i$  are the threshold parameters (cut points) defining the boundaries between outcome categories  $i-1$  and  $i$ ,  $\Phi(\cdot)$  denotes the cumulative distribution function (CDF) of the standard normal distribution.

## 2.2. Model Evaluation and Comparison

In analyzing the factors influencing risky driving behavior among truck drivers in Thailand's industrial zones, a comprehensive assessment of the model's goodness-of-fit, confirming that the model is effective in predicting outcomes as specified [38, 40].

$$X^2 = -2[LL(\beta_A) - LL(\beta_B)] \quad (6)$$

where  $LL(\beta)$  is the log-likelihood at convergence, and  $LL(\beta_A)$  and  $LL(\beta_B)$  represent the likelihoods of the converged records for Models A and B, respectively. The  $X^2$  statistic is a chi-square distributed statistic with degrees of freedom equal to the difference in the number of parameters between Model A and Model B. The overall goodness-of-fit assessment of the estimated model is shown in subsequent sections (Table 4).

## 2.3. Research Process

The research process for this study was conducted systematically, as illustrated in Figure 3. It began with an extensive review of literature related to risky driving behaviors among truck drivers in industrial zones, aiming to develop a theoretical framework grounded in the Health Belief Model (HBM) and the Protection Motivation Theory (PMT). The study also explored analytical techniques, specifically the Probit Model and Random Parameters Model, to prepare for subsequent data analysis. Following the theoretical development, a questionnaire was designed as the primary data

collection instrument. The content validity of the questionnaire was assessed by subject matter experts using the Index of Item-Objective Congruence (IOC) to ensure alignment between the survey items and the research objectives. Upon validating the questionnaire, data were collected from a sample of 600 truck drivers operating within industrial zones. The collected data underwent a cleaning process and were then analyzed using statistical methods, particularly the Probit Model and Random Parameters Model, to identify factors influencing risky driving behaviors. Model performance was subsequently evaluated and compared using the Chi-square distributed statistic to determine the most appropriate analytical approach. Finally, the study synthesized the research findings and proposed practical and policy-oriented recommendations aimed at mitigating risky driving behaviors within industrial zones.

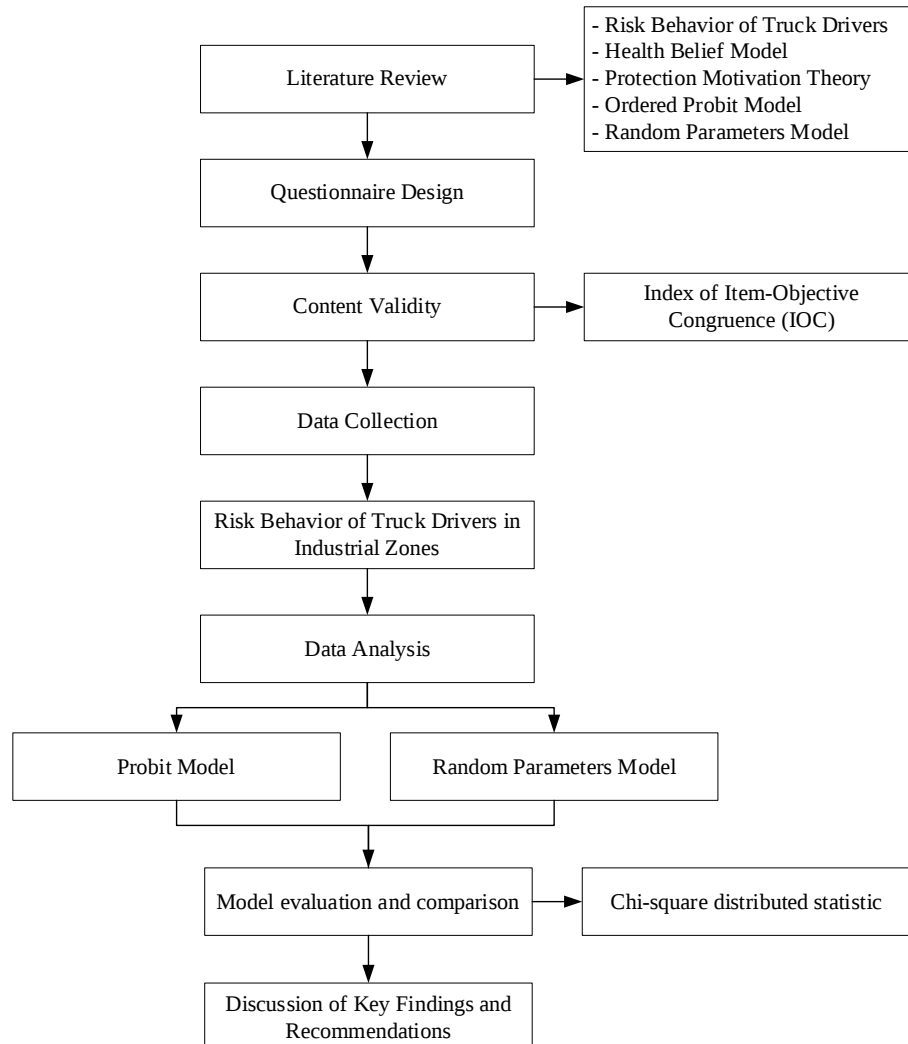


Figure 3. Research process flowchart

### 3. Data Collection

#### 3.1. Questionnaire Structure

For The questionnaire structure is divided into three sections. The first section gathers general information about the socio-economic characteristics of truck drivers, such as gender, age, marital status, education level, income, and occupation. These data are categorical and can describe the baseline and differences among drivers. The second section collects data on truck drivers' attitudes towards crashes based on the Health Belief Model and Protection Motivation Theory. These theories are widely used to explore drivers' attitudes [9, 31, 33, 49, 50]. Nine factors are considered: 1) Perceived Susceptibility, 2) Perceived Severity, 3) Perceived Benefits, 4) Perceived Barriers, 5) Cues to Action, 6) Health Motivation, 7) Response Efficacy, 8) Self-efficacy, and 9) Behavioral Intention. Likert scales with 5 levels were used for measurement (1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree). These data reflect the diverse attitudes, perceptions, awareness, and expectations of truck drivers regarding the risks of road crashes involving trucks. The final section collects data on the behaviors of truck drivers, which can explain the different driving experiences of drivers. Seven main factors are considered: 1) Violations, 2) Errors in driving, 3) Lapses, 4) Use of safety equipment, 5) Control errors, 6) Use of distracting devices such as social media, and 7) Alcohol consumption and drug use. Likert scales with 3 levels were used for measurement (1=Sometimes, 2=Often, 3=Regularly).

### 3.2. Data Collection and Sample Statistics

In this study, data was collected from truck drivers covering the main industrial zones in Thailand. These drivers were aged 18 and above and operated trucks within the main industrial zones in 11 provinces of Thailand. To ensure that the survey respondents represent the largest possible population of truck drivers in the industrial zone, the goal was to gather responses from 600 respondents. The survey was conducted from June 13th, 2023, to July 13th, 2023. Participants were briefed on the purpose of the survey, the concepts of the Health Belief Model and the Protection Motivation Theory (PMT), and some key information before answering the questions. This was done to ensure that they fully understood the objectives of the survey and the underlying concepts to provide accurate data. The study adhered to important ethical considerations, including obtaining approval from the Ethics Committee of Suranaree University of Technology. The survey questionnaire received approval and was deemed to have low risk (COE No.94/2565, November 8, 2022). The demographic characteristics of the survey respondents are presented in Table 1.

**Table 1. Participants' demographic characteristics**

| Category                                       | Frequency | Percentage |
|------------------------------------------------|-----------|------------|
| <b>Age</b>                                     |           |            |
| 18 – 25 years old                              | 26        | 4.33       |
| 26 – 35 years old                              | 159       | 26.50      |
| 36 – 45 years old                              | 260       | 43.33      |
| 46 – 55 years old                              | 127       | 21.17      |
| 56 – 65years old                               | 28        | 4.67       |
| <b>Gender</b>                                  |           |            |
| Male                                           | 562       | 93.67      |
| Female                                         | 38        | 6.33       |
| <b>Marital status</b>                          |           |            |
| Single                                         | 144       | 24.00      |
| Married                                        | 401       | 66.83      |
| Divorced                                       | 55        | 9.17       |
| <b>Education</b>                               |           |            |
| Primary school                                 | 159       | 26.50      |
| Lower secondary school                         | 222       | 37.00      |
| Higher secondary school/Vocational certificate | 186       | 31.00      |
| Diploma/high vocational certificate            | 20        | 3.33       |
| Bachelor's degree                              | 5         | 0.83       |
| Master's degree                                | -         | -          |
| Doctor of philosophy                           | -         | -          |
| Others                                         | 8         | 1.33       |
| <b>Personal income (Baht per month)</b>        |           |            |
| Less than 10,000                               | 27        | 4.50       |
| 10,000-20,000                                  | 436       | 72.67      |
| 20,001-30,000                                  | 113       | 18.83      |
| 30,001-40,000                                  | 22        | 3.67       |
| 40,000 or higher                               | 2         | 0.33       |
| <b>Driver's license ownership</b>              |           |            |
| No                                             | 27        | 4.50       |
| Yes                                            | 573       | 95.50      |
| <b>Crash experience</b>                        |           |            |
| Never                                          | 536       | 89.33      |
| Ever                                           | 64        | 10.67      |
| <b>Driving time</b>                            |           |            |
| 0:00-6:00 AM (Late night)                      | 83        | 13.83      |
| 6:00-12:00 PM (Morning)                        | 316       | 52.67      |
| 12:00-6:00 PM (Afternoon)                      | 129       | 21.50      |
| 6:00-12:00 AM (Night)                          | 72        | 12.00      |

### 3.3. Model Specification and Descriptive Statistics

This study utilized questionnaire data obtained from a survey of truck drivers, focusing on truck drivers in the main industrial zones in Thailand, with a sample size of 600 respondents. The data collected from the survey was used to construct a model aimed at analyzing factors influencing the risky behaviors of truck drivers. The model considered a total of 33 influencing factors and indicators. In addition, prior to conducting the model analysis, the issue of multicollinearity among the independent variables was assessed to prevent distortion of the regression coefficients, which could lead to misinterpretation of the results or instability of the model. The Variance Inflation Factor (VIF) was employed as a preliminary diagnostic tool. The results indicated that most variables had VIF values below the acceptable threshold of 10, consistent with the recommendations of Kutner et al. and Hair et al., who suggest that VIF values should not exceed 10 to avoid severe multicollinearity problems [51, 52]. Tables 2 and 3 present details of the variables and descriptive statistics.

**Table 2. Definition and Descriptive Statistics of Dependent Variables**

| Variables                                                                                                        | Code | Sometimes |         | Often     |         | Regularly |         |
|------------------------------------------------------------------------------------------------------------------|------|-----------|---------|-----------|---------|-----------|---------|
|                                                                                                                  |      | Frequency | Percent | Frequency | Percent | Frequency | Percent |
| 1) You drive above the legally prescribed speed limit.                                                           | BH1  | 51        | 8.50    | 166       | 27.70   | 383       | 63.80   |
| 2) You take curves at high speeds to the extent that you feel you may lose control of the vehicle.               | BH2  | 23        | 3.80    | 60        | 10.00   | 517       | 86.20   |
| 3) You disregard speed limits, especially during late-night and early-morning hours.                             | BH3  | 28        | 4.70    | 82        | 13.70   | 490       | 81.70   |
| 4) You exceed speed limits in community or village zones.                                                        | BH4  | 26        | 4.30    | 83        | 13.80   | 491       | 81.80   |
| 5) You overtake in no-passing zones (solid line indicating restricted passing area).                             | BH5  | 43        | 7.20    | 75        | 12.50   | 482       | 80.30   |
| 6) You exceed the legally permitted load weight.                                                                 | BH6  | 45        | 7.50    | 61        | 10.20   | 494       | 82.30   |
| 7) You frequently drive beyond the 4-hour limit.                                                                 | BH7  | 155       | 25.80   | 134       | 22.30   | 311       | 51.80   |
| 8) You tend to drive while fatigued.                                                                             | BH8  | 102       | 17.00   | 134       | 22.30   | 364       | 60.70   |
| 9) You do not wear a seatbelt while driving.                                                                     | BH9  | 129       | 21.50   | 1         | 0.20    | 470       | 78.30   |
| 10) You do not use traffic cones or a red flag as a precaution to prevent accidents caused by other vehicles.    | BH10 | 88        | 14.70   | 90        | 15.00   | 422       | 70.30   |
| 11) You drive without turning on headlights during the daytime.                                                  | BH11 | 319       | 53.20   | 116       | 19.30   | 165       | 27.50   |
| 12) You lose control of the vehicle when driving at high speeds.                                                 | BH12 | 41        | 6.80    | 57        | 9.50    | 502       | 83.70   |
| 13) You use a phone or headset while driving.                                                                    | BH13 | 99        | 16.50   | 160       | 26.70   | 341       | 56.80   |
| 14) You engage in social media (Facebook, Twitter, Instagram, Line) while driving.                               | BH14 | 38        | 6.30    | 56        | 9.30    | 506       | 84.30   |
| 15) You drive after consuming alcohol or while actively drinking alcohol.                                        | BH15 | 16        | 2.70    | 31        | 5.20    | 553       | 92.20   |
| 16) During major festive periods such as New Year, Songkran, or social gatherings, you commonly drink and drive. | BH16 | 17        | 2.80    | 41        | 6.80    | 542       | 90.30   |

**Table 3. Definition and Descriptive Statistics of Independent Variables**

| Variables                                                                                   | Code | Min | Max | Mean  | SD    | VIF   |
|---------------------------------------------------------------------------------------------|------|-----|-----|-------|-------|-------|
| <b>Perceived Susceptibility</b> ( <i>Cronbach's Alpha</i> = 0.835)                          |      |     |     |       |       |       |
| 1) I am aware that when driving, I may be at risk of having a crash.                        | PS1  | 1   | 5   | 4.120 | 1.036 | 2.074 |
| 2) I know that familiarity with the route due to regular driving can help me avoid crashes. | PS2  | 1   | 5   | 4.082 | 0.959 | 2.137 |
| 3) I am aware that lack of experience in driving increases the risk of crashes.             | PS3  | 1   | 5   | 4.192 | 0.929 | 2.517 |
| 4) I know that drinking alcoholic beverages and then driving can lead to crashes.           | PS4  | 1   | 5   | 4.597 | 0.780 | 2.810 |
| 5) I know that using a mobile phone/social media while driving may cause crashes.           | PS5  | 1   | 5   | 4.473 | 0.809 | 3.545 |
| 6) I am aware that carrying a heavy load can increase the risk of crashes.                  | PS6  | 1   | 5   | 4.093 | 1.089 | 1.765 |
| <b>Perceived Severity</b> ( <i>Cronbach's Alpha</i> = 0.892)                                |      |     |     |       |       |       |
| 7) If not wearing a seatbelt, I may face a higher risk of injury or death in a crash.       | PV1  | 1   | 5   | 4.440 | 0.872 | 2.631 |
| 8) Crashes from driving may result in long-term injuries or disabilities.                   | PV2  | 1   | 5   | 4.510 | 0.758 | 3.770 |
| 9) Crashes can significantly impact my work.                                                | PV3  | 1   | 5   | 4.510 | 0.839 | 3.049 |
| 10) Crashes can affect the lives of people I know, such as family and friends.              | PV4  | 1   | 5   | 4.485 | 0.827 | 2.678 |
| 11) Each accident may cause damage to my property and consume time.                         | PV5  | 1   | 5   | 4.515 | 0.766 | 3.674 |

| Variables                                                                                                  | Code | Min | Max | Mean  | SD    | VIF   |
|------------------------------------------------------------------------------------------------------------|------|-----|-----|-------|-------|-------|
| <b>Perceived Benefits</b> ( <i>Cronbach's Alpha = 0.881</i> )                                              |      |     |     |       |       |       |
| 12) I believe that wearing a seatbelt reduces the severity of injuries in case of a crash.                 | PB1  | 1   | 5   | 4.417 | 0.805 | 3.131 |
| 13) I feel unsafe when driving without wearing a seatbelt.                                                 | PB2  | 1   | 5   | 4.428 | 0.879 | 3.187 |
| 14) I feel safe when driving cautiously and within the speed limits.                                       | PB3  | 1   | 5   | 4.502 | 0.767 | 3.458 |
| 15) I think following traffic rules enhances safety.                                                       | PB4  | 1   | 5   | 4.443 | 0.803 | 3.124 |
| <b>Perceived Barriers</b> ( <i>Cronbach's Alpha = 0.783</i> )                                              |      |     |     |       |       |       |
| 16) Wearing a seatbelt makes me feel secure.                                                               | PR1  | 1   | 5   | 2.473 | 1.444 | 1.464 |
| 17) I think safety equipment for cars is expensive and impractical to purchase.                            | PR2  | 1   | 5   | 2.515 | 1.426 | 1.446 |
| <b>Cues to Action</b> ( <i>Cronbach's Alpha = 0.916</i> )                                                  |      |     |     |       |       |       |
| 18) I often receive compliments on my safe driving from people close to me.                                | CA1  | 1   | 5   | 3.812 | 1.141 | 3.601 |
| 19) Public awareness campaigns on safe driving make me constantly aware of the importance of safe driving. | CA2  | 1   | 5   | 4.075 | 1.068 | 4.527 |
| 20) Strict traffic enforcement by police motivates me to drive safely.                                     | CA3  | 1   | 5   | 4.040 | 1.137 | 3.013 |
| <b>Health Motivation</b> ( <i>Cronbach's Alpha = 0.941</i> )                                               |      |     |     |       |       |       |
| 21) I believe that crashes involving vehicles are the most dangerous.                                      | HM1  | 1   | 5   | 4.293 | 1.023 | 4.204 |
| 22) I think health and physical condition are crucial for safe driving.                                    | HM2  | 1   | 5   | 4.410 | 0.998 | 6.574 |
| 23) Adequate rest is important for safe driving.                                                           | HM3  | 1   | 5   | 4.495 | 0.949 | 7.781 |
| 24) I prioritize safety when driving.                                                                      | HM4  | 1   | 5   | 4.367 | 1.020 | 6.874 |
| <b>Response Efficacy</b> ( <i>Cronbach's Alpha = 0.882</i> )                                               |      |     |     |       |       |       |
| 25) Driving within speed limits reduces the risk of crashes.                                               | RE1  | 1   | 5   | 4.303 | 0.974 | 4.738 |
| 26) Using safety equipment can lessen the severity of crashes.                                             | RE2  | 1   | 5   | 4.203 | 0.993 | 3.901 |
| 27) Strict penalties for traffic violations can decrease the likelihood of crashes.                        | RE3  | 1   | 5   | 3.940 | 1.120 | 3.337 |
| <b>Self-efficacy</b> ( <i>Cronbach's Alpha = 0.936</i> )                                                   |      |     |     |       |       |       |
| 28) I can drive within speed limits.                                                                       | SE1  | 1   | 5   | 4.168 | 1.092 | 5.558 |
| 29) I can drive in strict adherence to traffic rules.                                                      | SE2  | 1   | 5   | 4.237 | 1.056 | 4.960 |
| 30) I can use safety equipment every time I drive.                                                         | SE3  | 1   | 5   | 4.213 | 1.057 | 6.350 |
| <b>Behavioural intention</b> ( <i>Cronbach's Alpha = 0.929</i> )                                           |      |     |     |       |       |       |
| 31) I will use safety equipment to make driving safer.                                                     | BI1  | 1   | 5   | 4.233 | 1.033 | 5.876 |
| 32) I will strictly follow traffic rules to reduce the risk of crashes.                                    | BI2  | 1   | 5   | 4.292 | 1.046 | 5.927 |
| 33) I will recommend friends to use safety equipment to reduce the risk of crashes.                        | BI3  | 1   | 5   | 4.130 | 1.104 | 4.289 |

SD = Standard Deviation; VIF = Variance Inflation Factor

## 4. Results and Discussion

### 4.1. Model Evaluation Results

Table 4 presents the results of estimating the Random Parameters Model for truck driving behavior. The estimated values from the model reveal a noticeable improvement in model fit, as evidenced by the evaluation metrics. The 95% confidence interval of the model indicates a confident statistic of 97.2%, and the  $R^2$  value is 0.222, which is considered acceptable compared to existing studies [38, 53-55]. Additionally, an analysis was conducted with a Random Parameters Model with heterogeneity in means and found no significant implications. The following section provides a detailed discussion of the results obtained from the Random Parameters Model. A positive coefficient indicates that the likelihood of risky behavior increases with an increase in the associated variable, while a negative coefficient suggests a decrease in the likelihood of risky behavior as the variable increases.

Table 4. Results of the random parameters model for truck driving behavior

| Variables                                                                                              |        | Fixed-Probit Model             |        |     | Random Parameters Model |        |     |
|--------------------------------------------------------------------------------------------------------|--------|--------------------------------|--------|-----|-------------------------|--------|-----|
|                                                                                                        |        | Coefficient                    | t-Stat |     | Coefficient             | t-Stat |     |
| Threshold $\mu$                                                                                        |        | 1.336                          | 11.903 | *** | 2.044                   | 3.651  | *** |
| constant                                                                                               |        | -1.185                         | -2.382 | *   | -1.517                  | -2.070 | *   |
| <i>Random parameters</i>                                                                               |        |                                |        |     |                         |        |     |
| I know that familiarity with the route due to regular driving can help me avoid crashes.               | PS2    | -0.207                         | -2.433 | *   | -0.496                  | -2.159 | *   |
|                                                                                                        | sd.PS2 | -                              | -      |     | 0.295                   | 2.104  | *   |
| <i>Fixed Parameters</i>                                                                                |        |                                |        |     |                         |        |     |
| <b>Perceived Susceptibility</b>                                                                        |        |                                |        |     |                         |        |     |
| I am aware that when driving, I may be at risk of having a crash.                                      | PS1    | 0.167                          | 1.947  | *   | 0.271                   | 1.785  | *   |
| I am aware that lack of experience in driving increases the risk of crashes.                           | PS3    | -0.132                         | -1.379 |     | -0.195                  | -1.343 |     |
| I know that drinking alcoholic beverages and then driving can lead to crashes.                         | PS4    | -0.142                         | -1.159 |     | -0.153                  | -0.887 |     |
| I know that using a mobile phone/social media while driving may cause crashes.                         | PS5    | 0.117                          | 0.860  |     | 0.122                   | 0.613  |     |
| I am aware that carrying a heavy load can increase the risk of crashes.                                | PS6    | -0.064                         | -0.860 |     | -0.121                  | -1.008 |     |
| <b>Perceived Severity</b>                                                                              |        |                                |        |     |                         |        |     |
| If not wearing a seatbelt, I may face a higher risk of injury or death in a crash.                     | PV1    | 0.140                          | 1.317  |     | 0.274                   | 1.531  |     |
| Crashes from driving may result in long-term injuries or disabilities.                                 | PV2    | 0.112                          | 0.774  |     | 0.103                   | 0.510  |     |
| Crashes can significantly impact my work.                                                              | PV3    | 0.280                          | 2.118  | *   | 0.496                   | 1.943  | *   |
| Crashes can affect the lives of people I know, such as family and friends.                             | PV4    | -0.133                         | -1.209 |     | -0.179                  | -1.066 |     |
| Each crash may cause damage to my property and consume time.                                           | PV5    | -0.330                         | -2.281 | *   | -0.570                  | -2.058 | *   |
| <b>Perceived Benefits</b>                                                                              |        |                                |        |     |                         |        |     |
| I believe that wearing a seatbelt reduces the severity of injuries in case of a crash.                 | PB1    | -0.141                         | -1.094 |     | -0.292                  | -1.295 |     |
| I feel unsafe when driving without wearing a seatbelt.                                                 | PB2    | 0.152                          | 1.226  |     | 0.290                   | 1.363  |     |
| I feel safe when driving cautiously and within the speed limits.                                       | PB3    | -0.002                         | -0.015 |     | 0.054                   | 0.253  |     |
| I think following traffic rules enhances safety.                                                       | PB4    | -0.336                         | -2.867 | **  | -0.585                  | -2.298 | *   |
| <b>Perceived Barriers</b>                                                                              |        |                                |        |     |                         |        |     |
| Wearing a seatbelt makes me feel secure.                                                               | PR1    | 0.331                          | 6.651  | *** | 0.538                   | 3.218  | **  |
| I think safety equipment for trucks is expensive and impractical to purchase.                          | PR2    | 0.223                          | 4.265  | *** | 0.361                   | 2.898  | **  |
| <b>Cues to Action</b>                                                                                  |        |                                |        |     |                         |        |     |
| I often receive compliments on my safe driving from people close to me.                                | CA1    | -0.126                         | -1.302 |     | -0.166                  | -1.151 |     |
| Public awareness campaigns on safe driving make me constantly aware of the importance of safe driving. | CA2    | 0.238                          | 1.866  | *   | 0.407                   | 1.818  | *   |
| Strict traffic enforcement by police motivates me to drive safely.                                     | CA3    | 0.112                          | 1.112  |     | 0.133                   | 0.915  |     |
| <b>Health Motivation</b>                                                                               |        |                                |        |     |                         |        |     |
| I believe that crashes involving vehicles are the most dangerous.                                      | HM1    | 0.145                          | 1.233  |     | 0.243                   | 1.266  |     |
| I think health and physical condition are crucial for safe driving.                                    | HM2    | -0.085                         | -0.638 |     | -0.204                  | -0.928 |     |
| Adequate rest is important for safe driving.                                                           | HM3    | 0.550                          | 3.459  | *** | 0.877                   | 2.604  | **  |
| I prioritize safety when driving.                                                                      | HM4    | 0.038                          | 0.271  |     | 0.058                   | 0.275  |     |
| <b>Response Efficacy</b>                                                                               |        |                                |        |     |                         |        |     |
| Driving within speed limits reduces the risk of crashes.                                               | RE1    | -0.232                         | -1.947 | *   | -0.398                  | -1.862 | *   |
| Using safety equipment can lessen the severity of crashes.                                             | RE2    | -0.042                         | -0.373 |     | -0.034                  | -0.203 |     |
| Strict penalties for traffic violations can decrease the likelihood of crashes.                        | RE3    | 0.010                          | 0.107  |     | 0.057                   | 0.385  |     |
| <b>Self-efficacy</b>                                                                                   |        |                                |        |     |                         |        |     |
| I can drive within speed limits.                                                                       | SE1    | 0.087                          | 0.717  |     | 0.143                   | 0.769  |     |
| I can drive in strict adherence to traffic rules.                                                      | SE2    | -0.160                         | -1.294 |     | -0.200                  | -1.103 |     |
| I can use safety equipment every time I drive.                                                         | SE3    | -0.003                         | -0.020 |     | 0.025                   | 0.121  |     |
| <b>Behavioral Intention</b>                                                                            |        |                                |        |     |                         |        |     |
| I will use safety equipment to make driving safer.                                                     | BI1    | 0.030                          | 0.240  |     | 0.006                   | 0.030  |     |
| I will strictly follow traffic rules to reduce the risk of crashes.                                    | BI2    | -0.287                         | -2.244 | *   | -0.459                  | -2.011 | *   |
| I will recommend friends to use safety equipment to reduce the risk of crashes.                        | BI3    | -0.026                         | -0.248 |     | -0.038                  | -0.235 |     |
|                                                                                                        |        | <b>Model statistic</b>         |        |     | <b>Random vs. Fixed</b> |        |     |
|                                                                                                        |        | Parameters (K)                 | 35     |     | 36                      |        |     |
|                                                                                                        |        | LL(B)                          | -314.7 |     | -312.3                  |        |     |
|                                                                                                        |        | McFadden pseudo-R <sup>2</sup> | 0.216  |     | 0.222                   |        |     |
|                                                                                                        |        | X <sup>2</sup>                 |        |     | 4.8                     |        |     |
|                                                                                                        |        | Degree of freedom              |        |     | 1                       |        |     |
|                                                                                                        |        | Confident                      |        |     | 97.2%                   |        |     |

## 4.2. Health Belief Model and Protection Motivation Theory Factor

### • *Perceived Susceptibility*

Table 4 The research findings indicate that perceived susceptibility has certain factors that influence the increase and decrease of risky behaviors among truck drivers. According to the study results, (PS1) when drivers perceive the risk of crashes while driving, it leads to an increase in risky behavior. Previous research has found that perceived susceptibility is not a variable in improving safe driving behavior among drivers [9, 33]. Because risk perception does not always lead to a reduction in risky behavior, particularly among individuals with high levels of experience and confidence, risky behaviors may persist despite awareness of potential dangers [56, 57]. It is possible to infer that within the group of truck drivers, there is confidence in their well-received training and extensive driving expertise. Therefore, they may not perceive driving trucks as personally threatening in terms of road crashes, which consequently leads to an increase in risky behavior. On the contrary, (PS2) when drivers are familiar with the route, it leads to a decrease in risky driving behavior. This contradicts previous studies which found that drivers on familiar routes tend to exhibit more dangerous driving behavior due to their feeling of understanding the road conditions well and having less chance of encountering unexpected obstacles. These feelings lead to negligence and lack of attention while driving, resulting in increased risky behavior [58-65]. However, in the context of truck drivers, familiarity with the route may lead to the assumption that the benefits of their familiarity, understanding road conditions, and traffic situations well, can help reduce stress and anxiety, leading to increased attentiveness to the road ahead. This familiarity also enhances accuracy in remembering situations and quick responses in unexpected circumstances [66]. These findings are intriguing and suggest that effective road crash prevention measures must promote a good awareness of perceived susceptibility among drivers to ultimately lead to safer driving behavior among truck drivers.

### • *Perceived Severity*

Table 4 Shows that perceived severity influences both increases and decreases in risky behaviors among truck drivers. According to the study, (PV3) suggests that when truck drivers perceive that crashes impact their work, it significantly increases risky behavior. In general, the awareness that accidents can negatively impact work performance should reduce risky behaviors. However, previous research has indicated that perceived severity does not necessarily predict safe driving behavior [33, 67]. This may be explained by the context of truck drivers who face work-related time pressure and perceived stress. Under such circumstances, drivers may engage in other forms of risky behavior, such as speeding and avoiding rest breaks, in order to meet their work targets. Even though they are aware of the potential work-related consequences of accidents, they may still exhibit increased risky behaviors. These findings are consistent with prior studies, which have demonstrated that occupational stress and fatigue from insufficient rest contribute to risky driving behavior, despite an awareness of accident risks [68-70]. In contrast, (PV5) indicates that when truck drivers perceive that crashes result in both time and property damage, it leads to a decrease in risky behavior. This aligns with previous research findings suggesting that perceived severity, which directly impacts drivers, results in safer behavior. When drivers perceive negative severity that they feel puts them in dangerous situations regarding time and property, it leads to more cautious and safer driving behavior [33, 71].

### • *Perceived Benefits*

Table 4 The research findings indicate that perceived benefits influence reduced risk behavior. According to the study results, (PB4) when truck drivers perceive that following traffic rules leads to safety, it results in reduced risk behavior. This is supported by evidence from previous research that disobedient behavior may lead to severe traffic crashes caused by traffic rule violations [72]. Conversely, consistently following traffic rules is significant in helping road users drive safely and effectively reducing the number of traffic crashes [73-75].

### • *Perceived Barriers*

Table 4 the research findings indicate that perceived barriers influence increased risky behaviors. Previous studies have confirmed that perceived barriers are the best predictors of behavior among all variables in the HBM (Health Belief Model) [76]. According to the findings of this study (PR1), when truck drivers perceive that fastening seat belts causes discomfort, it affects increased risky behaviors. This finding is in line with prior studies indicating that discomfort associated with seat belt design is a significant factor contributing to drivers' reluctance to use them [77, 78]. Such avoidance behavior can be analogized to the reluctance to wear clothing that is dirty, itchy, or excessively tight, which causes physical discomfort and distress [77, 79]. Similarly, truck drivers may perceive barriers to seat belt use, experiencing discomfort or distress while driving. These perceived barriers may, in turn, contribute to an increase in risky driving behaviors. Similarly to the findings of (PR2), when truck drivers perceive

that safety equipment in vehicles is expensive and unaffordable, it influences increased risky behaviors. It is possible that drivers prioritize cost over the safety benefits of the equipment, as the barrier of affordability may make it difficult for drivers to access and afford these safety features. This finding is consistent with previous studies, which found that insufficient income and wages that do not adequately cover access to safety equipment lead drivers to neglect the installation of safety devices and regular equipment inspections. Such neglect is clearly associated with risky driving behaviors [23, 24]. Consequently, the level of safety while driving may be compromised if such equipment is lacking [9]. However, these findings suggest that supporting awareness of barriers emphasizing the severe consequences may be sufficient to stimulate acceptance of safe behaviors, along with governmental support for access to basic safety equipment for truck drivers, which is crucial. Additionally, effective promotion of safety behaviors should aim to eliminate and minimize barriers as much as possible.

#### • *Cues to Action*

Table 4 the research findings indicate that cues to action significantly influence increased risky behaviors. According to the findings of this study (CA)<sup>2</sup>, when truck drivers encounter safe driving campaigns, it leads to increased risky behaviors. This contradicts previous studies that found continuous safe driving campaigns lead to increased safe driving behaviors by addressing aggressive driving issues, raising awareness of fatigue-related driving risks, and implementing effective coping strategies [80-82]. However, evidence from previous studies suggests that although safety campaigns alone have a positive impact, their effectiveness is significantly increased when combined with legal measures or road safety education [83, 84]. It is possible that, for truck drivers, safety campaigns alone without emphasizing the severe negative consequences of failing to comply with traffic regulations or without integration with other measures such as law enforcement and education may be insufficient to effectively encourage safe driving behavior in this group. Given the importance, promoting safe driving behavior among truck drivers may require communication efforts that emphasize the negative consequences of non-compliance with traffic laws, along with integration of legal and educational measures to enhance the effectiveness of safety campaigns. In addition, using communication methods such as distributing leaflets to promote safe driving specifically highlighting the severe negative consequences of violating traffic rules—may be an effective approach to encouraging safe driving behavior among truck drivers. This is supported by evidence showing that leaflet distribution is a direct communication channel and is considered one of the most effective methods, with a communication effectiveness rate of over 70% [81]

#### • *Health Motivation*

Table 4 the research findings reveal that health motivation significantly influences increased risky behaviors. According to the findings of this study (HM)<sup>3</sup>, when truck drivers feel that sufficient rest is important, it affects increased risky behaviors. This contradicts previous studies that clearly indicate that health motivation influences safe driving behaviors among drivers [85]. Because drivers are concerned about the problem of driving while fatigued due to insufficient rest, which is a significant factor in serious crashes [69, 70]. However, it is possible that truck drivers are well aware that sufficient rest and coping with fatigue are crucial for driving. Yet, due to heavy work schedules and increased workload, they tend to resist and lack awareness of the serious consequences of driving while fatigued to achieve work goals [10, 86, 87]. Moreover, economic incentives constitute a critical mechanism contributing to risky behaviors among truck drivers. Prior studies have indicated that drivers who are paid on a piece-rate basis such as by load weight, distance traveled, or a percentage of revenue are more likely to violate traffic regulations and engage in risky behaviors, including working extended hours beyond legal limits [10, 13]. Given the importance, health motivation for truck drivers should be a primary focus in raising awareness to promote safe driving behavior on the roads. Sufficient rest also helps improve vehicle control abilities and decision-making skills in emergency situations efficiently to reduce the risk of crashes.

#### • *Response Efficacy*

Table 4 the research findings suggest that response efficacy influences decreased risky behaviors. According to the findings of this study (RE)<sup>1</sup>, when truck drivers feel that driving under speed limits reduces crashes, this awareness motivates drivers to reduce risky driving behaviors, consistent with the findings of Gillen and Compton, who examined anti-speeding campaign messages. Their study found that messages emphasizing response efficacy specifically, that reducing driving speed genuinely lowers the likelihood of accidents encouraged drivers to comply with legal speed limits [88], thereby leading to a decrease in risky driving behaviors. It is possible that exceeding speed limits not only leads to crashes and injuries but also increases the severity of crashes [89]. This could be one reason why truck drivers recognize that driving under speed limits can reduce the likelihood of injuries from crashes.

### • Behavioral Intention

Table 4 the research findings indicate that behavioral intention influences reduced risk behavior. According to the findings from the study (BI2), truck drivers' intention to strictly adhere to traffic regulations to reduce the risk of crashes aligns with previous research that highlights the importance of experience or consistent adherence to traffic rules in promoting road safety and effectively reducing the number of traffic crashes [73, 90]. These findings also suggest that campaigns focusing on encouraging truck drivers to adhere strictly to traffic regulations remain a crucial strategy for road safety, as they can significantly reduce risky behaviors among truck drivers.

### 4.3. Distribution of Random Parameters

According to Table 4, for the random sample characteristic of the model, this study tested all possible variables as random parameters obtained from truck drivers in industrial zones in Thailand. By exposing the significant meaning and standard deviation of the random parameters in the model, it was found that familiarity with the route is a random variable for truck drivers.

The negative coefficient of the random parameter reports that 95.37% of the variance of PS2, when truck drivers are aware that familiarity with the route from regular driving can help prevent crashes, is associated with the decreased likelihood of risky behavior. Meanwhile, 4.63% of the related variance indicates high-risk behavior. This is illustrated in Figure 4. This report aligns with findings from experimental psychology, social psychology, and sports psychology studies related to familiarity and expertise, showing that repetition significantly impacts the way human perceptual data processing works [66, 91]. Through repetition until humans become familiar and skilled, they are less overwhelmed [92], and the advantage of individuals familiar with specific situations is their ability to remember situations accurately and respond much faster in these specific situations [66, 93, 94]. These findings effectively confirm and explain the aforementioned discoveries.

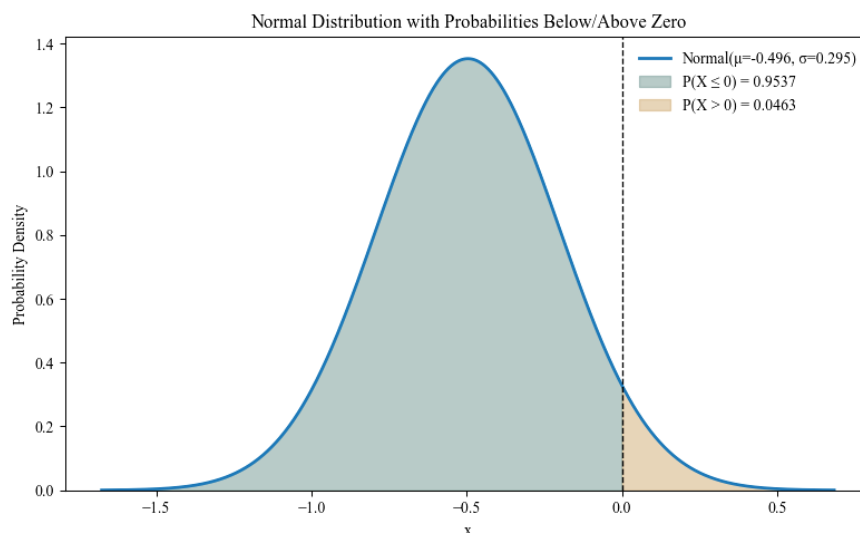


Figure 4. The distribution of random parameter model coefficients for truck driving behaviour: When drivers are familiar with the route

## 5. Conclusion and Implementations

This study developed a model to identify factors influencing risky driving behaviors among truck drivers in Thailand's main industrial zones, prompted by the high rate of fatalities from truck crashes, which rank second. Identifying key factors influencing truck drivers' risky behaviors is crucial for implementing road safety measures to reduce injuries and fatalities from crashes. The study surveyed 600 truck drivers in Thailand's main industrial zones, utilizing subtle characteristics not readily observable in the model, recording interrelated random parameters. Drawing from the Health Belief Model and the Protection Motivation Theory, the current findings reveal several previously overlooked but significant variables. It was found that perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, health motivation, and response efficacy significantly influence truck drivers' risky behaviors.

From the statistical analysis, this study offers useful guidelines for road safety policymaking to reduce risky behaviors among truck drivers and consequently lower road injuries and fatalities. The recommendations are formulated based on the key variables identified from the model findings presented in Table 5.

**Table 5. Appropriate Guidelines Based on Model Findings**

| Variables                                                                                                    | Indicate | Guidelines                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I am aware that when driving, I may be at risk of having a crash. (PS1)                                      | (+)      | 1) Campaigning for awareness of the risks associated with driving trucks.<br>2) Incorporating lessons about the risks associated with driving trucks along with guidelines for handling appropriate crisis situations into the curriculum of driver training courses in particular.                                              |
| I know that familiarity with the route due to regular driving can help me avoid crashes. (PS2)               | (-)      | Promoting the selection of familiar routes for driving to reduce the risk of crashes.                                                                                                                                                                                                                                            |
| Crashes can significantly impact my work. (PV3)                                                              | (+)      | A campaign to raise awareness of the severe impacts of accidents on drivers' job performance.                                                                                                                                                                                                                                    |
| Each crash may cause damage to my property and consume time. (PV5)                                           | (-)      | Promoting awareness of the severity of crashes in terms of their time and property damage consistently.                                                                                                                                                                                                                          |
| I think following traffic rules enhances safety. (PB4)                                                       | (-)      | Promoting awareness of the benefits of consistently adhering to traffic rules while driving.                                                                                                                                                                                                                                     |
| Wearing a seatbelt makes me feel discomfort. (PR1)                                                           | (+)      | 1) Promoting awareness of the importance of wearing seat belts and the severe consequences of not wearing them while driving.<br>2) Promoting the involvement of safety equipment designers to make safety belts more convenient to use, aiming to reduce barriers to wearing seat belts.                                        |
| I think safety equipment for trucks is expensive and impractical to purchase. (PR2)                          | (+)      | 1) Promoting awareness of the severe consequences of not using safety equipment inside vehicles.<br>2) Increasing enforcement measures by authorities to inspect basic safety equipment inside trucks.<br>3) Policy collaboration between governments and drivers to access fundamental safety tools or equipment inside trucks. |
| Public awareness campaigns on safe driving make me constantly aware of the importance of safe driving. (CA2) | (+)      | Increasing the promotion of "safe driving" communication should focus on highlighting the severe negative consequences of unsafe driving. Distributing flyers is an effective media channel to achieve this.                                                                                                                     |
| Adequate rest is important for safe driving. (HM3)                                                           | (+)      | 1) Promoting awareness of the risk of road crashes due to inadequate rest.<br>2) Including lessons on sufficient rest hours and coping strategies for appropriate crisis situations in driver training content.                                                                                                                  |
| Driving within speed limits reduces the risk of crashes. (RE1)                                               | (-)      | Promoting attitudes and behaviors of driving within speed limits to reduce the risk of crashes continuously and monitoring the impact of campaigns to continuously influence attitudes in the long run.                                                                                                                          |
| I will strictly follow traffic rules to reduce the risk of crashes. (BI2)                                    | (-)      | Encouraging truck drivers to consistently adhere to traffic regulations                                                                                                                                                                                                                                                          |

(+) Indicates high possibility of risky behavior; (-) Indicates high possibility of safe behavior.

### Implementations:

The policy and measure for road safety proposed in this study are derived from the empirical findings, aiming to sustainably reduce risky driving behaviors among truck drivers and to mitigate road injuries and fatalities in alignment with the specific contextual factors. These recommendations comprise seven key strategies, as follows:

The first policy and measure to promote Perceived Susceptibility can be carried out through raising awareness about the risks involved while driving. This aims to create awareness and reduce overconfidence in unsafe driving, which is a significant variable in truck driver crashes. Additionally, incorporating lessons about perceived susceptibility to driving risks and appropriate crisis management strategies into the driver training curriculum is a crucial strategy widely recognized by previous studies [95, 96]. Furthermore, it has also been found that promoting the selection of familiar routes for driving is another important approach, as these variables can significantly reduce risky driving behavior among truck drivers.

The second measure to promote Perceived Severity can be implemented by raising awareness about the severity of crashes and their serious impact on the drivers' life and work. By creating awareness about the severity of undesirable outcomes, it can lead to higher acceptance of safe driving behaviors [9]. Another important approach is to promote awareness of the severity of crashes that consistently cause damage to time and property. Since these variables can significantly reduce risky behaviors among truck drivers, they can continually promote safe driving attitudes and behaviors among them.

The third measure to promote Perceived Benefits can be implemented by emphasizing the advantages of following traffic rules while driving, which remains a fundamental strategy in consistently promoting safe attitudes and driving practices among truck drivers. This awareness serves as a vital guideline that can significantly diminish risky behaviors among truck drivers.

The fourth measure to promote perceived barriers can be implemented by advocating awareness of the importance of wearing seat belts and the severe consequences of not wearing them while driving, as well as promoting awareness of the serious consequences of not using additional safety equipment inside vehicles. Additionally, enhancing enforcement measures by authorities can focus on thorough inspections of basic safety equipment inside trucks [97]. This should be coupled with collaboration between government policies and drivers to access basic safety tools or equipment within trucks for better cooperation in a positive direction in the future. Furthermore, another crucial approach is to promote workforce involvement related to the design of safety equipment, particularly seat belts. This should

earnestly consider the variables in using these tools during the equipment design process to make them more user-friendly, reducing barriers to wearing seat belts. These guidelines serve as aids in improving attitudes and raising awareness of the importance of using additional safety equipment within trucks.

The fifth measures aimed at promoting cues to action can be implemented by increasing advocacy for "safe driving" communication. This study suggests that for certain groups of truck drivers, encountering messages that support safe driving may not be sufficient to stimulate acceptance and adherence. However, the study recommends that advocacy should focus on highlighting the severe negative impacts of unsafe driving through the distribution of flyers, as they are a more effective communication channel, reaching more than 70% of the target audience [81]. This is aimed at stimulating greater acceptance of such behaviors among truck drivers.

The six measures to promote health motivation can be implemented by raising awareness of the risks of road crashes due to inadequate rest. Another effective approach is to include lessons on the importance of sufficient rest hours and coping strategies for appropriate crisis situations in driver training content. Fatigue resulting from insufficient rest is a significant factor contributing to risky behaviors and reduced driving efficiency [98-101]. However, drivers must also be equipped with the ability to handle crisis situations appropriately [102] to reduce the likelihood of serious crashes, coupled with improving attitudes and behaviors towards safer truck driving.

The seven measures to promote response efficacy can be implemented by promoting attitudes and behaviors of driving within speed limits consistently to reduce the risk of crashes. Since these variables can significantly reduce risky driving behaviors among truck drivers, monitoring the impact of campaigns is considered crucial in the long run [103] to continuously influence attitudes and promote safe driving practices among truck drivers.

### 5.1. Limitations and Further Research

While this study has provided valuable insights, there are still limitations to be addressed in future research. The survey of driving behavior focused on truck drivers in the main industrial zones of Thailand, so implementing safety policies and measures must be done cautiously, especially in areas different from industrial zones.

## 6. Declarations

### 6.1. Author Contributions

Conceptualization, M.S. and R.K.; methodology, M.S., C.S., and P.W.; formal analysis, M.S. and R.K.; investigation, M.S. and R.K.; data curation, M.S., C.B., and K.T.; writing—original draft preparation, M.S. and R.K.; writing—review and editing, V.R., S.J., T.C. and R.K.; visualization, M.S.; project administration, R.K.; funding acquisition, R.K. All authors have read and agreed to the published version of the manuscript.

### 6.2. Data Availability Statement

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

### 6.3. Funding

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### 6.5. Ethical Approval

This research was approved by the Human Research Ethics Committee, Suranaree University of Technology (COE No.94/2565, 07 July 2022).

### 6.6. Conflicts of Interest

The authors declare no conflict of interest.

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