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Influence of Safety Climate on Safety Behavior Intention among Ro-Ro Car Drivers in the Automotive Logistics and Distribution Network*

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Abstract

Purpose: This study investigates the influence of safety climate on Ro-Ro car drivers' intention to engage in safety behavior within the automotive logistics and distribution network. According to the Theory of Planned Behavior, the study considers attitudes toward safety behavior, subjective norms, and perceived behavioral control as key factors influencing the intention to engage in safety behavior. These factors function as mediators in the proposed framework. **Research design and methodology:** Data were gathered from 303 Ro-Ro car drivers at Laem Chabang Port—Thailand's major automotive distribution hub—using proportionate stratified sampling. The questionnaire was checked for validity and reliability. Data were analyzed using covariance-based structural equation modeling. **Results:** Safety climate significantly influences the intention to engage in safety behavior, with mediation effects of safety attitudes, subjective norms, and perceived behavioral control. These variables explain 69.0% of the variance in safety behavior intention among Ro-Ro car drivers within the automotive logistics network. **Conclusions:** The findings have beneficial implications for automotive logistics and distribution. Companies can improve their competitiveness in the global market by creating a safer and more efficient distribution network. This study provides insights regarding establishing a sustainable supply chain, emphasizing safety.

Keywords: Safety Climate, Safety Behavior Intention, Logistics Safety, Automotive Logistics, Distribution Network

JEL Classification Code: D91, J24, L91, L92, M12

1. Introduction

The automotive industry powers growth in many countries and generates substantial income through manufacturing, significantly influencing the Gross Domestic Product and creating considerable employment opportunities. China, Japan, the United States, Germany, South Korea, Thailand, Mexico, Spain, Brazil, and India are among the countries with a major automotive manufacturing

concentration in global markets (OICA, 2024). Automotive manufacturing is defined by connected supply chains, including manufacturing, transportation, and distribution networks, ensuring a continuous flow of goods across international trade routes and enhancing product delivery efficiency.

Functional logistics systems and distribution networks are essential for timely product delivery in the automotive industry. The distribution network in this industry, including

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warehouses, distribution centers, transportation systems, and information technology systems, must work toward improving the transportation of automotive vehicles and parts. Efficient distribution centers incorporating new technologies can swiftly store, sort, and deliver products to domestic and international markets, serving customer demand. In addition to effective cost management, logistics and distribution networks create competitive advantages, increase flexibility, and improve operational efficiency sustainably.

Roll-on/roll-off (Ro-Ro) shipping is a fundamental component of global automotive logistics and distribution networks. It facilitates the transportation of vehicles across international markets. Unlike traditional methods that use cranes to lift and lower vehicles, Ro-Ro cars facilitate direct loading and unloading, requiring only human labor to drive and maneuver them to their designated locations. This approach presents several advantages. First, it improves efficiency through streamlined processes, reducing turnaround times. Second, it reduces operating costs compared with conventional methods (Saab, 2024). Although Ro-Ro shipping enables swift vehicle transportation, safety issues exist because this method is mostly under human management. Under time restrictions, Ro-Ro drivers operate with a greater risk of safety concerns for Ro-Ro vehicles, as well as for themselves.

Continued operation of the supply chain depends on the safe transportation of vehicles within the Ro-Ro logistics system. Transport safety enhances competitiveness through risk reduction. Furthermore, it helps reduce long-term accident-related costs, minimize operational interruptions, improve efficiency, increase employee morale, and enhance trustworthiness, strengthening a company's reputation, and building confidence among customers and stakeholders in the global automotive sector (Techehs, 2024). The safety of Ro-Ro driving affects the seamless operation of the distribution network. As humans mostly conduct Ro-Ro logistics, inappropriate safety practices or an unsuitable safety environment can cause major accidents, disturbing the entire logistics process, damaging valuable goods, and, most importantly, harming the lives of the drivers involved.

A company's safety climate can promote safe behavior and reduce the incidence of accidents. It includes safety supervision, senior executive attitudes, safety training and education implementation, and the development of a safe production environment (Luo, 2020). Other crucial factors include management values, workplace safety practices, safety-related information sharing, and safety devices (Griffin & Neal, 2000). Safety climate is a significant predictor of safety behaviors and outcomes within the transportation sector (Griffin & Curcuruto, 2016). Enhancing the safety climate via open communication between supervisors and drivers, implementing restrictions

by supervisors or truck owners, and promoting role modeling by supervisors or truck owners will help manage risky driving behaviors, perceptions, and social factors (Hussain et al., 2019). A positive safety climate encourages personal safety behaviors while decreasing injuries and accidents (Luo, 2020). Research on safety climate has mainly focused on the broader transportation industry; however, comprehensive studies on the importance of safety climate in Ro-Ro logistics are limited. This operation relies on human labor and proceeds under time constraints, which may lead to high safety risks. Therefore, the safety climate should be a critical factor in the awareness of occupational safety and safe work practices to ensure the safe and effective transportation of Ro-Ro vehicles inside the global automotive logistics network. This study investigates how the safety environment affects Ro-Ro drivers' intention to encourage safe practices.

The Theory of Planned Behavior (TPB; Ajzen, 1991) posits that three factors affect the intention to engage in a behavior: attitude toward the behavior, subjective norm, and perception of behavioral control. Thus, Ro-Ro car drivers should behave in a manner that promotes safety by upholding a positive view of safe transportation in the context of Ro-Ro logistics, pushing themselves to follow safe practices, and considering the needs of stakeholders who support safe actions in line with the global automotive logistics network. Ultimately, employees must recognize behavioral control as their responsibility to engage in safe behaviors (Fogarty & Shaw, 2010). TPB in the logistics sector remains limited. Examining the circumstances under which Ro-Ro car drivers make safety judgments can enhance our comprehension of behaviors pertinent to such settings and understanding of the factors that promote safe behavior, facilitating the broader use of TPB in associated domains. The effective implementation of safe work practices is feasible within the constraints of the international commerce and logistics sectors.

Among the ASEAN countries, Thailand is a major participant in the automobile industry. With a continuously increasing trend, the total number of automobiles exported in 2023 (1,117,539) increased by 11.73% from 2022 (Federation of Thai Industries, 2023). Laem Chabang Port—Thailand's major automotive distribution hub—is the sole port in Thailand that offers export-import services for automotive items (Shipuniverse, 2025). According to work-related injuries, since 2016, the total number of motor vehicle road injuries was 76,946, an increase of 13.4% from that in 2000 (WHO, 2021). Therefore, transportation safety is a crucial factor for the global automotive industry. The safety transportation process directly affects moved goods and logistics workers. Accidents related to workers occur because of several factors, including being hit or run over by a vehicle in a working area and slipping on an unsafe

surface. Such accidents may cause serious injuries, loss of ability to work, or fatalities, affecting the quality of life and psychological well-being of workers and their families (ILO, 2023).

Thus, this study examines how safety climate influences Ro-Ro car drivers' intention to engage in safety behavior within the logistics and distribution sector of the automotive industry and explores the roles of safety attitudes, subjective norms, and perceived behavioral control as mediating factors. The study focuses on Laem Chabang Port.

The findings will provide insights regarding safety climate management for the logistics industry, enhancing the overall safety and efficiency of the global automotive logistics network. Further, they illustrate the necessity of promoting a distribution and logistics organizational culture that prioritizes safety. Moreover, these could help policymakers and executives create more efficient security standards to maintain a strong and competitive logistics system.

2. Literature Review

2.1. Safety Climate

Safety climate refers to the overall perception of safety within an organization, shaped by its policies, procedures, and practices, and reflects its commitment to workplace safety and influences employees' awareness of safety-related expectations. Zohar (1980) pioneered the study of safety climate by examining employees' perceptions of the extent to which their organization prioritizes safety. Key elements of the perception of safety climate include the following: perceived importance of safety climate, management's attitude toward workplace safety, the impact of safe practices on promotional opportunities, workplace risk levels, the impact of mandated work pace on safety, the status of safety officers, the impact of safe practices on social status, and the perceived status of the safety committee (Zohar, 1980). Moreover, Griffin and Neal (2000) pointed out the essential indicators of safety climate: management's concern for safety, quality of safety training, application of protective measures, clear communication about safety, and availability of safety equipment. Furthermore, Griffin and Curcuruto (2016) highlighted the role of supervision in shaping a safe climate.

According to Griffin and Neal (2000), safety climate directly improves adherence to safety regulations and participation in safety activities. Safitri et al.'s (2020) research on public transportation drivers in Jakarta revealed that safety behavior was positively influenced by aspects of the safety climate, including knowledge acquisition, safety communication, employee commitment to safety, and trust

in coworkers' safety competencies. Qu et al. (2022) conducted a study on truck drivers in private enterprises in Suzhou, China. Consequently, they found that proactive practices and encouragement of supervisory care are major determinants of driving behavior among these drivers. Nordfjaern et al.'s (2023) research on Norwegian home healthcare workers found that safety communication and learning helped reduce unsafe speeding practices.

2.2. Theory of Planned Behavior

According to TPB, intention significantly impacts how one performs or avoids certain behaviors (Ajzen, 1991). Influenced by the primary factors of attitude, perceived behavioral control, and subjective norms, intention determines real actions. An individual's attitude reflects their views on intended behavior. Perceived behavioral control is the degree to which an individual thinks they can control or engage in certain actions. Subjective norms are individuals' perceptions of social expectations regarding the suitability of a specific behavior. All three factors can affect a person's intention to participate in safety behaviors, ultimately leading to their participation.

Prior research has used the TPB for safety in logistics. Douglas et al. (2021) demonstrated how TPB variables influenced the safety intentions of large-truck drivers in the United States. Further, Etika et al. (2020) examined the driver speed compliance among multinational oil and gas companies operating in Nigeria. Man et al. (2021) combined the TPB with risk perception to investigate the use of personal protective equipment (PPE) among Hong Kong construction workers. Additionally, Kim and Jeong (2021) used the TPB to examine patient safety policies in Korean hospitals, demonstrating their flexibility in many other areas.

2.3. Research Hypothesis

Previous studies have shown that the safety climate affects three main factors: safety attitudes, subjective norms, and perceived behavioral control. Hussain et al. (2019) examined the safety behaviors among truck drivers in Pakistan, whereas Fugas et al. (2012) focused on operational employees in a transportation firm. Man et al. (2021) analyzed the use of PPE by construction workers in Hong Kong, whereas Kim and Jeong (2021) explored safety management approaches among surgical nurses in major Korean hospitals. Furthermore, Douglas et al. (2019) examined the safety behaviors of large-truck drivers in the United States. In another study, Mahasirikul et al. (2022) examined logistics drivers in a highway work zone in Thailand.

Several studies (Douglas et al., 2019; Fugas et al., 2012; Hussain et al., 2019; Kim & Jeong, 2021; Man et al., 2021) found that the safety climate significantly influences safety attitudes. Moreover, as role models, supervisors negatively affect risk drivers' attitudes (Hussain et al., 2019). Safety management systems positively influence attitudes (Kim & Jeong, 2021). Therefore, the first research hypothesis is as follows:

H1: The safety climate positively affects safety attitudes.

Safety climate also affects an individual's perception of social expectations regarding safety behavior or social norms (Douglas et al., 2019; Fugas et al., 2012; Hussain et al., 2019). Mahasirikul et al. (2022) found that safety measures, such as appropriate traffic control and risk management systems, help to create a supportive safety environment that influences drivers' perceptions of social expectations and affects their adherence to safety norms. Furthermore, open communication between supervisors and drivers, the role of supervisors as role models, and the rules set by supervisors negatively affect the social norms of truck drivers' risky driving behavior (Hussain et al., 2019). The second research hypothesis is as follows:

H2: The safety climate positively affects subjective norms.

The safety climate also affects perceived behavioral control (Fugas et al., 2012; Kim & Jeong, 2021; Man et al., 2021). Hussain et al. (2019) found that supervisor rules negatively influence beliefs about control power and risky driving behavior. However, Douglas et al. (2019) revealed no significant correlation between safety climate and perceived control over behavior. Consequently, the third research hypothesis is as follows:

H3: The safety climate positively affects perceived behavior control.

Several studies have examined attitudes toward safe behavior, subjective norms, and perceived behavioral control as significant determinants of the intent to engage in safe behavior. Related research on this topic covers various contexts. Ledesma et al. (2018) examined these factors among road users in an Argentinian city, while Douglas et al. (2019) focused on large-truck drivers in the United States. Etika et al. (2020) investigated driving behaviors among employees of multinational oil and gas companies in Nigeria. Kim and Jeong (2021) analyzed patient safety management practices during surgery, and Man et al. (2021) examined construction workers' acceptance of PPE in Hong Kong.

Previous studies have consistently shown that attitudes

influence the intention to engage in safety behaviors (Ledesma et al., 2018; Etika et al., 2020; Kim & Jeong, 2021; Man et al., 2021). Moreover, Douglas et al. (2019) found that attitudes serve as mediators between safety climate and safety intentions. Similarly, Fogarty and Shaw (2010) demonstrated that attitudes act as mediators between management perceptions and intentions to violate safety rules. Based on these findings, the fourth research hypothesis is as follows:

H4: Attitude toward safety positively affects Ro-Ro drivers' intention to engage in safety behaviors.

Research has shown that subjective norms influence the intention to behave safely (Douglas et al., 2019; Kim & Jeong, 2021; Man et al., 2021). However, Ledesma et al. (2018) and Etika et al. (2020) found no significant effect of subjective norms on safety behavior intention. Douglas et al. (2019) showed that norms mediate the link between safety climate and intentions. Fogarty and Shaw (2010) showed that norms mediate the link between how managers perceive safety rules and their intention to violate them. Based on these findings, this study proposes the fifth research hypothesis:

H5: Subjective norms positively affect Ro-Ro drivers' intention to engage in safety behaviors.

Perceived behavioral control influences the intention to engage in safety behaviors (Ledesma et al., 2018; Douglas et al., 2019; Etika et al., 2020; Kim & Jeong, 2021; Man et al., 2021). Furthermore, Fogarty and Shaw (2010) found that working under pressure mediated the relationship between management perceptions and the intention to violate safety rules. Based on these findings, the final research hypothesis is as follows:

H6: Perceived behavioral control positively affects Ro-Ro drivers' intention to engage in safety behaviors.

Figure 1 shows the conceptual framework of this study, derived from the literature review and research hypotheses.

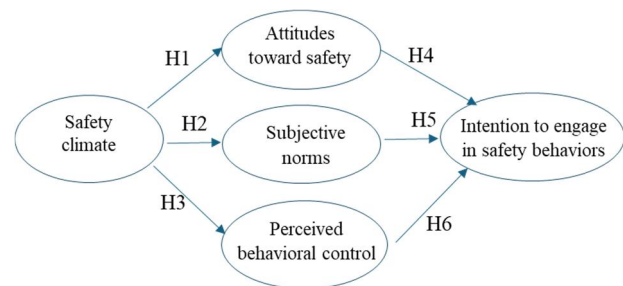


Figure 1: Conceptual Framework

3. Research Methodology

This quantitative study was approved by the Research Ethics Committee for Human Research at Kasetsart University, Sriracha Campus (COE No. COE67/026).

3.1. Population and Sample

The study population comprised 572 Ro-Ro car drivers from nine companies in Zone A of Laem Chabang Port in Thailand. Based on the total number of drivers in each company, the intended sample size was 330 participants using proportionate stratified sampling. Questionnaires were distributed to Ro-Ro car drivers at all companies between August and October 2024. In total, 303 completed questionnaires were obtained. According to Schumacker and Lomax (2010) and Tabachnick and Fidell (2018), this number is sufficient for structural equation modeling analysis because it exceeds the minimum recommended sample size of 100–200 participants.

3.2. Data Collection Instrument

A self-administered questionnaire with six sections was used as the data collection tool.

Section 1: Respondents' personal and job-related information: It included 12 closed-ended questions.

Section 2: The safety climate questionnaire, developed based on the concepts of Griffin and Curcuruto (2016), Griffin and Neal (2000), and related research, comprised 31 items measuring different dimensions of the safety climate. Examples of items for each dimension are as follows:

Management Concern for Safety: "Management has established appropriate policies, regulations, and safety standards for the transportation of Ro-Ro cars." Clear communication about safety: "Employees feel comfortable reporting workplace safety concerns and issues to their supervisors." Implementation of protective measures: "Your company's safety procedures are clear, easy to understand, and straightforward to implement." Effectiveness of safety training: "Your company provides employees with adequate knowledge and training on workplace safety, enhancing their safety awareness and skills." Availability of safety equipment: "Your company provides high-quality PPE, such as reflective vests, safety glasses, and fabric gloves." Safety supervision: "Your supervisor always promotes and encourages employees to be conscious."

Sections 3–5: Attitudes toward safety, subjective norms, and perceived behavioral control questionnaires based on the concept of Ajzen (1991, 2012) and other related research. Each section of the questionnaire comprised five items. Examples of items related to attitudes toward safety were "Following the procedures for safely moving Ro-Ro

cars is beneficial to your work" and "You are always aware that following safety procedures can help reduce accidents." Examples of items related to subjective norms included the following: "Family members, friends, and your supervisors encourage you to follow the safe procedures for moving Ro-Ro cars" and "Colleagues often warn you when they find that you are working in a risky manner unnecessarily." Examples of items related to perceived behavioral control include "Working safely is easy for you" and "You have knowledge and experience, so you are confident that you can handle work-related problems."

Section 6: The intention toward safety behavior questionnaire, developed based on the concepts of Ajzen (1991, 2012) and related research, comprised four items. Examples of such items included "Before moving Ro-Ro cars, you have understood the relevant procedures and safety regulations." and "You intend to report work hazards. You are aware that your work poses risks."

The questions in Parts 2–6 utilized a 5-point Likert scale to measure responses, with the rating levels defined as follows: 5 = very high, 4 = high, 3 = moderate, 2 = low, and 1 = very low.

3.3. Pre-data Collection Questionnaire Testing

Five experts—one academic concentrating on safety, two experts in industrial administration and development, a safety manager, and a safety officer—evaluated the questionnaire's content validity. With values ranging from 0.60 to 1.00, the Index of Item-Objective Congruent values for every item met the lowest required threshold of 0.5 (Zamanzadeh et al., 2015). Thirty participants completed a pilot test to assess the reliability. According to the results, except for the perceived behavioral control variable, all variables had Cronbach's alpha values higher than 0.7. One item was removed after consideration. Subsequently, Cronbach's alpha for the five variables ranged from 0.778 to 0.968, greater than the suggested threshold of 0.7 (Cronbach, 1990).

3.4. Data Analysis

General information on the respondents was described using frequencies and percentages as descriptive statistics. The characteristics of the variables were presented as mean, standard deviation, correlation coefficient, skewness, and kurtosis. Covariance-based structural equation modeling was used to investigate the interactions among safety behavior intention, safety climate, safety attitudes, subjective norms, and perceived behavioral control.

4. Results

4.1. General and Occupational Information of Respondents

A total of 303 Ro-Ro drivers from Laem Chabang Port participated in the survey. Of these, 63.4% were male; further, 42.58% were aged 30–39 years, and 31.35% were aged 40–49 years. In terms of education, 33.33% of participants had completed high school, whereas 29.04% had completed middle school; moreover, 17.82% had vocational and higher vocational certificates, and 10.90% had a bachelor’s degree. Additionally, 8.91% had completed elementary school education.

Table 1: Sample Demographics

Demographic	Category	Frequency	Percent
Gender	Male	192	63.4%
	Female	111	36.6%
Age	Below 30 years old	58	19.14%
	30-39 years old	129	42.58%
	40-49 years old	95	31.35%
	50 years old and above	21	6.93%
Education	Elementary school	27	8.91%
	Middle school	88	29.04%
	High school	101	33.33%
	Vocational and higher vocational certificates	54	17.82%
	Bachelor’s degree	33	10.90%
Work Experience	<1 year	64	21.12%
	1-2 years	107	35.32%
	3-4 years	45	14.85%
	5-9 years	46	15.18%
	≥10 years	41	13.53%

Regarding work experience in terms of the number of years, the sample distribution was as follows: for less than a year: 21.12%; 1–2 years: 35.32%; 3–4 years: 14.85%; 5–9 years: 15.18%; 10 or more years: 13.53%. Table 1 provides a detailed breakdown of the sample demographics.

4.2. Descriptive Statistics and Preliminary Correlational Analysis

The mean score for the overall safety climate was 4.246 (SD = 0.550), indicating a high level. The breakdown of each dimension is as follows.

For management’s concern for safety (MV), the mean score was 4.118 (standard deviation [SD] = 0.708)—they have established rules and policies to ensure safe vehicle movement, including implementing regulations for the safe movement of Ro-Ro cars, investing in safety equipment,

such as helmets, and actively engaging in initiatives that improve operational safety.

For clear communication about safety (SC), the mean score was 4.219 (SD = 0.666)—companies inform their Ro-Ro drivers about safety policies, accident rates, causes of accidents, and other work-related incidents, as well as how they handle driver safety suggestions and complaints, and how well drivers convey safety concerns to their supervisors.

For implementing protective measures (SP), the mean score was 4.232 (SD = 0.663)—companies have updated safe operation procedures that align with their work methods. These clear and easy-to-understand procedures can be implemented effectively, ensuring high-level compliance with safety regulations.

For the effectiveness of safety training (ST), the mean score was 4.187 (SD = 0.723)—companies have a comprehensive safety training plan that covers the tasks to be performed. Safety training provides drivers with knowledge and skills related to safety (such as understanding the company’s rules and regulations, emergency skills, etc.), and drivers receive training when new procedures or tools are introduced at a high level.

For the availability of safety equipment (SE), the mean score was 3.973 (SD = 0.776)—companies provide high-quality tools and safety equipment for operations (such as traffic cones and batons) and PPE, such as reflective vests, sunglasses, and cloth gloves. They also provide emergency response equipment like fire extinguishers, first-aid kits, and life buoys.

For safety supervision (SS), the mean score was 4.246 (SD = 0.669)—supervisors play an important role in reinforcing safety compliance. They ensure adherence to safety regulations, enforce disciplinary measures for noncompliance, and actively engage with Ro-Ro drivers to address safety concerns.

The mean scores for attitudes toward safety, subjective norms, and perceived behavioral control were 4.486 (SD = 0.602), 4.278 (SD = 0.643), and 4.359 (SD = 0.620), respectively, indicating a high level for all measures. The mean score for intention to engage in safety behavior was 4.543 (SD = 0.518), indicating an extremely high level of intention.

The skewness values for all observed variables ranged from -1.260 to -0.478, and the kurtosis values ranged from -0.679 to 1.187. As these values remain within the acceptable ranges of ±3 for skewness and ±8 for kurtosis, the data can be considered normally distributed (Kline, 2005). Additionally, the correlation coefficients between the latent and observed variables ranged from 0.281 to 0.674, with no pair exceeding 0.80. This suggests that the variables do not exhibit strong linear relationships that can lead to multicollinearity issues (Hair et al., 2010).

4.3. Analysis of the Measurement Model

The researcher began by analyzing the measurement model for each latent variable. The factor loadings of all observed variables were over 0.7—the observed variables adequately reflected the properties of latent variables (Fornell & Larcker, 1981; Hair et al., 2010). Subsequently, a confirmatory factor analysis was used to evaluate the measurement model of all latent variables. The results indicated that the initial model was an acceptable fit for the empirical data. Table 2 presents the fit indices based on the defined criteria. The relative chi-square (CMIN/df) was below 3.00, whereas the comparative fit index (CFI), normed fit index (NFI), and Tucker-Lewis index (TLI) exceeded 0.90. The root mean square residual (RMR) was less than 0.05, and the root mean square error of the approximation (RMSEA) was less than 0.08.

Table 2: Model Fit Indices of the Measurement Model

Goodness-of-fit index	Acceptable fit criteria*	Initial Model
CMIN/df	< 3.000	2.701
CFI	> 0.900	0.936
NFI	> 0.900	0.903
TLI	> 0.900	0.927
RMR	< 0.050	0.023
RMSEA	< 0.080	0.075

*Hair et al. (2010); Schermelleh-Engel et al. (2003)

Table 3 presents the results of the validity and reliability analyses of these variables. All observed variables exhibit factor loading values ranging from 0.719 to 0.917, exceeding the threshold of 0.7 (Fornell & Larcker, 1981; Kline, 2015). Thus, the observed variables are related to the latent variables at acceptable levels. The composite reliability (CR) values, ranging from 0.891 to 0.948, exceeded the acceptable level of 0.70. The Cronbach’s alpha values, ranging from 0.889 to 0.974, also exceeded the acceptable level of 0.70. Therefore, the observed variables measuring the same latent construct demonstrate acceptable reliability and can be used to measure latent variables effectively (Fornell & Larcker, 1981; Hair et al., 2010).

The average variance extracted (AVE) values, ranging from 0.641 to 0.752, were above 0.50. These results indicate convergent validity by showing that latent variables may explain a large part of the observed variation in the variables (Fornell & Larcker, 1981). The square root of the AVE for each construct was higher than its correlation with other constructs (Fornell & Larcker, 1981)—each latent construct had discriminant validity (Table 4).

Table 3: Factor Loadings, CR, AVE, and Cronbach’s Alpha

Construct	Items	Factor Loading	CR	AVE	Alpha
Safety Climate (SCM)	MV	0.856	0.948	0.752	0.974
	SC	0.915			
	SP	0.887			
	ST	0.879			
	SE	0.811			
Attitude toward safety (AT)	AT1	0.828	0.936	0.745	0.935
	AT2	0.917			
	AT3	0.831			
	AT4	0.860			
	AT5	0.877			
Subjective norms (SN)	SN1	0.804	0.899	0.641	0.895
	SN2	0.835			
	SN3	0.719			
	SN4	0.817			
	SN5	0.822			
Perceived behavioral control (PBC)	PBC1	0.791	0.892	0.674	0.890
	PBC2	0.796			
	PBC3	0.879			
	PBC4	0.816			
Intention (IN)	IN1	0.834	0.891	0.671	0.889
	IN2	0.813			
	IN3	0.800			
	IN4	0.829			

Table 4: The Correlation Coefficient between Latent Variables and the Square Root of the AVE

	SCM	AT	SN	PBC	IN
SCM	0.867				
AT	0.699	0.863			
SN	0.714	0.734	0.800		
PBC	0.664	0.711	0.748	0.821	
IN	0.575	0.781	0.734	0.783	0.819

Note: Bold values in the diagonal line represent the square roots of AVE. The correlation coefficient values are under the diagonal line.

4.4. Structural Model

The results of structural model analysis indicated that the initial model did not fit the empirical data. Therefore, three pairs of correlated error terms between the observed variables within the same latent construct were added to the structural model based on the modification indices suggested by the AMOS program. After modification, the model fitted the empirical data. Table 5 presents the goodness-of-fit indices.

Table 5: Model Fit Indices of the Structural Model (before and after model modification)

Goodness-of-fit index	Acceptable fit criteria*	Initial Model	Final Model
CMIN/df	< 3.000	3.188	2.782
CFI	> 0.900	0.917	0.933
NFI	> 0.900	0.884	0.900
TLI	> 0.900	0.907	0.924
RMR	< 0.050	0.044	0.039
RMSEA	< 0.080	0.085	0.077

*Hair et al. (2010); Schermelleh-Engel et al. (2003)

Table 6 and Figure 2 indicate that the safety climate has a significantly positive influence on attitudes, subjective norms, and perceived behavioral control ($p < 0.001$), supporting H1, H2, and H3. Furthermore, the intention to engage in safety behaviors was significantly affected by attitudes, perceived behavioral control ($p < 0.001$), and subjective norms ($p < 0.05$), supporting H4, H5, and H6. The results show that the safety climate significantly influences Ro-Ro car drivers' intentions to act safely by shaping their safety attitudes, subjective norms, and perceived control over their actions, with significance at the 0.001 level. This model explained 69.0% of the variance in safety behavior intention.

5. Conclusions and Discussion

This study examines the impact of the safety climate in the logistics and distribution sectors on the safety behavior intention of Ro-Ro car drivers, which can enhance distribution efficiency, reduce transportation risks, and improve the effectiveness of the global automotive supply chain. The results indicate that the intention to engage in

safety behavior among Ro-Ro car drivers in distribution work is influenced by the safety climate through attitudes toward safety behavior, subjective norms, and perceived behavioral control. The research findings are as follows:

1. Safety climate has a statistically significant positive influence on the safety attitudes of Ro-Ro car drivers (direct effect = 0.749, $p < 0.001$), supporting H1. Employees tend to have a more positive attitude toward safety when a strong organizational safety climate is present, characterized by effective oversight, clear procedural guidelines, safety communication, comprehensive training programs, leadership commitment to safety, and the availability of proper safety equipment. This is in line with previous research (Douglas et al., 2019; Fugas et al., 2012; Hussain et al., 2019; Man et al., 2021), which identified the influence of safety climate on safety attitudes.

2. Safety climate has a positive influence on Ro-Ro drivers' subjective norms with statistical significance (direct effect = 0.762, $p < 0.001$), supporting H2. The perceptions of Ro-Ro car drivers, including safety practices, adherence to established protocols, thorough training programs, efficient safety communication, availability and usage of suitable safety equipment, and management values, affect how socially pressured they are to adopt safe practices. These findings are in line with those of Fugas et al. (2012), Douglas et al. (2019), and Mahasirikul et al. (2022), which investigated transport drivers in work zones on highways in Thailand. All these studies found that various forms of safety climate affect compliance with safety norms.

3. Safety climate has a statistically significant positive influence on Ro-Ro car drivers' perceived behavioral control (direct effect = 0.726, $p < 0.001$), which supports H3. Thus, employees who recognize organizational commitment to safety, as reflected in factors such as supervision, procedures, communication, training, management values,

Table 6: The result of the safety climate's influence on the attitude toward safety, subjective norms, perceived behavioral control, and safety behavior intention.

Dependent variable	Effects	Safety climate	Perceived behavior control	Attitude	Subjective norms	Square multiple correlation
Attitude	Direct effect	0.749***	-	-	-	0.561
	Indirect effect	-	-	-	-	
	Total effect	0.749***	-	-	-	
Subjective norms	Direct effect	0.762***	-	-	-	0.581
	Indirect effect	-	-	-	-	
	Total effect	0.762***	-	-	-	
Perceived behavior control	Direct effect	0.726***	-	-	-	0.527
	Indirect effect	-	-	-	-	
	Total effect	0.726***	-	-	-	
Intention	Direct effect	-	0.404***	0.441***	0.128*	0.690
	Indirect effect	0.721***	-	-	-	
	Total effect	0.721***	0.404***	0.441***	0.128*	

Note: *** $p < 0.001$, * $p < 0.05$

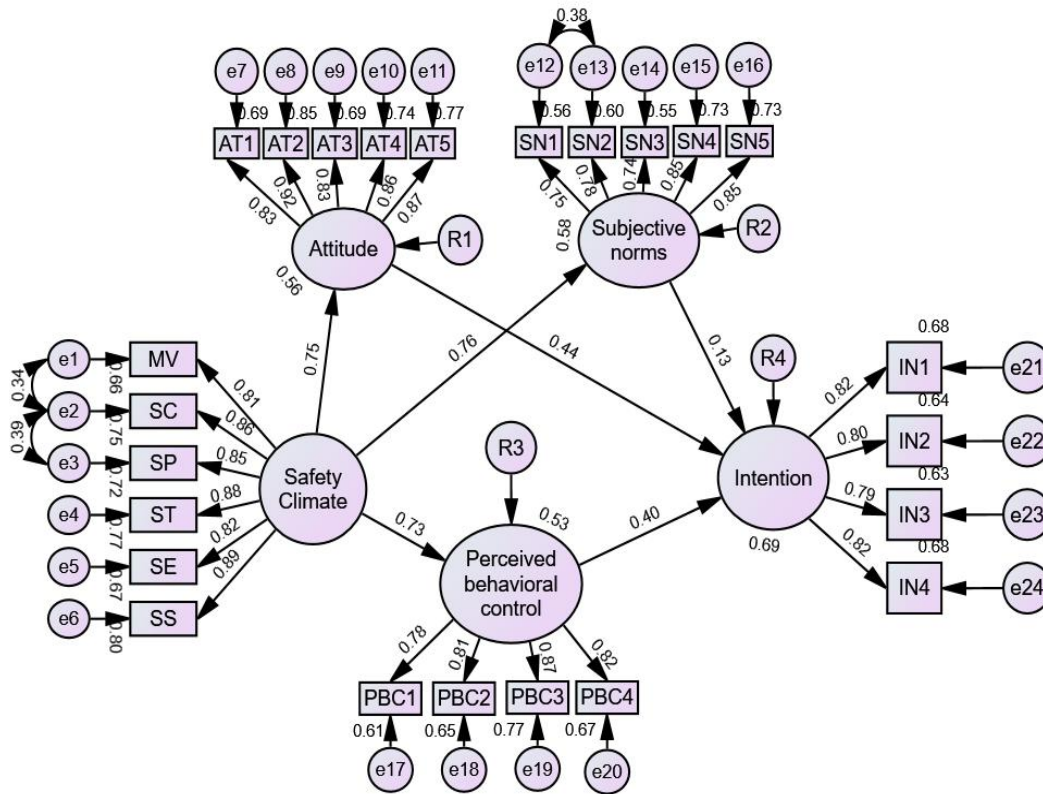


Figure 2: SEM Result: The Influence of Safety Climate on Safety Behavior Intention

and safety equipment, are more likely to feel confident in their ability to manage and engage in safety behaviors within the demanding environment of the international automotive logistics network. These results are similar to those of Fugas et al. (2012) and Kim and Jeong (2021).

4. Attitude toward safety has a statistically significant positive influence on the intention to engage in safety behavior (direct effect = 0.441, $p < 0.001$), which supports H4. Thus, if Ro-Ro car drivers have a more positive attitude toward safety, they tend to engage in safety behaviors, such as wearing protective gear, reporting risks, and adhering to safety procedures. These findings are consistent with those of Ledesma et al. (2018), Douglas et al. (2019), and Etika et al. (2020).

5. Subjective norms have a statistically significant positive influence on the intention to engage in safety behaviors (direct effect = 0.128, $p < 0.05$), which supports H5. Therefore, a Ro-Ro car driver’s intention to act safely is influenced by their perceptions of expectations or pressure from colleagues, supervisors, or the company. When drivers feel that their coworkers expect them to follow safety regulations, they are more likely to adopt practices that enhance their workplace safety. These findings are

consistent with those of Douglas et al. (2019) and Kim and Jeong (2021).

6. Perceived behavioral control has a statistically significant positive influence on the intention to engage in safety behaviors (direct effect = 0.404, $p < 0.001$), which supports H6. If Ro-Ro car drivers have confidence in their capacity to act safely because of adequate resources, skills, or the authority to adhere to safety practices, they will perform safety-related behaviors in the workplace. These findings are consistent with those of Douglas et al. (2019), Man et al. (2021), and Kim and Jeong (2021).

7. Safety climate has a positive influence on intention to engage in safety behaviors through attitudes towards safety behavior, subjective norms, and perceived behavioral control with statistical significance (indirect effect = 0.721, $p < 0.001$). A positive safety climate helps Ro-Ro car drivers develop more positive attitudes toward safety, influences how they perceive social expectations related to safety, and boosts their self-efficacy in executing safe practices. These factors work together to strengthen their intention to engage in safety behaviors. This is in line with the findings of Douglas et al. (2019) and Fogarty and Shaw (2010).

These findings underscore the importance of a strong safety climate in enhancing safety behavior among Ro-Ro

car drivers, ultimately improving distribution reliability and supply chain performance. Companies investing in safety initiatives reduce accident risks and strengthen their logistics efficiency and market competitiveness.

6. Implications

6.1. Practical Implications

This study emphasizes the crucial role of a strong safety culture in enhancing supply chain resilience to reduce delays, injuries, and accidents. Moreover, it increases operational efficiency by encouraging employees to engage in safety behaviors that reduce the number of accidents and lead to less costly and more effective transportation. Furthermore, this study highlights the beneficial effects of on-time product delivery and the reduction of automotive damage during transit. The study's findings provide the following recommendations for increasing employee awareness and encouraging safety-conscious behaviors:

1. Companies should be concerned with the safety climate because it influences employees' intentions to behave safely. Safety is critical in automotive distribution systems to ensure the seamless and safe movement of vehicles over several phases—from factories to ports and then to end markets. Ro-Ro operations require meticulous coordination among transport providers, port operators, and logistics personnel. Minor mistakes in safety measures during vehicle loading or transportation can lead to costly damage, operational disruptions, or injuries. Companies should implement the following measures to strengthen their safety climates:

1.1 Supervisors must establish clear and effective communication to convey safety policies, risks, and procedures to their employees. Given the dynamic nature of Ro-Ro logistics in which vehicles are frequently loaded onto vessels, driven across terminals, and secured for long-haul transportation, miscommunication can lead to unsafe conditions.

1.2 Companies should provide continuous safety training tailored to real-world logistics. Ro-Ro car drivers should be aware of weight distribution, proper lashing techniques, and the impact of environmental factors, such as wind, rain, or shifting cargo during transit. They should understand how to handle high-risk situations in the automotive logistics sector, such as emergency braking while driving vehicles onboard or handling unplanned mechanical failures, for safe and effective performance in the global automotive logistics network.

1.3 Companies should invest in safety monitoring technologies, such as GPS tracking, dash cameras, and real-time reporting platforms. Therefore, supervisors can

monitor Ro-Ro car movements and detect unsafe driving behaviors, improper vehicle handling, or potential hazards. For example, automated alert systems can notify drivers if they exceed the speed limit in port areas or car-holding yards, helping enforce strict safety measures.

1.4 All logistics operations must standardize and implement safety practices. Thus, Ro-Ro car drivers, warehouse personnel, and port staff can follow the defined protocols for moving cars within ship decks, port terminals, and multi-level storage facilities. Guidelines on car spacing, brake application during parking, and adherence to designated driving lanes will help reduce congestion and lower accident risks.

1.5 Management must demonstrate a strong commitment to safety by bringing it up as a primary corporate value, showing that commitment involves investing in safety equipment, frequently reviewing safety standards, and listening to and dealing with employee concerns about unsafe working conditions. Employees are reminded to continue performing safe behaviors when safety becomes ingrained in the workplace environment.

1.6 Supervisors must play an active role in maintaining safety standards, ensuring adherence to protocols, and guiding employees toward safe work practices. Monitoring safety performance allows the early identification of potential risks and provides ongoing support. Ro-Ro terminals should perform daily preoperative checks to remove obstructions from loading ramps, confirm correct vehicle positioning during boarding, and inspect the lashing equipment for stability. Engaging with employees frequently helps reinforce a collective commitment to workplace safety.

By integrating safety into every aspect, a company can reduce Ro-Ro car accidents, enhance efficiency, and build a more resilient supply chain. A good safety culture protects employees and assets and strengthens the company's position in the competitive global automotive logistics industry.

2. Subjective norms exert the greatest influence on the intention to participate in safety behaviors. Ro-Ro drivers are more likely to adhere to safe car transportation practices when they perceive that their colleagues, supervisors, and customers value and expect such procedures. Companies should establish clear communication expectations, promote positive motivation, and develop group-level standards by emphasizing the importance of safety as a core value in automotive logistics networks. Moreover, companies create norms and raise safety standards within the broader automotive logistics network by fostering a shared sense of responsibility among all stakeholders in the supply chain, publicly acknowledging and rewarding individuals and teams that demonstrate exemplary safety performance within the context of the automotive logistics network, and

encouraging collaboration and information sharing among all stakeholders in the automotive logistics network to enhance safety awareness and best practices.

6.2. Future Research

This study proposes the following directions for future research. First, interested academics may study safety behaviors in other parts of the automotive supply chain. This includes the following: employee safety behavior in manufacturing and assembly plants, such as working with machines; safety behaviors in warehouses and distribution centers for moving and storing automotive parts, such as operating a forklift and storing flammable EV batteries; safety behaviors in inbound logistics for transporting automotive parts, such as truck driving by employees transporting parts from suppliers to manufacturing plants; safety behaviors in outbound logistics, such as the transportation and distribution of finished vehicles by other means.

Second, future research can consider other factors that may affect the safety intentions of Ro-Ro drivers in the model, such as leadership styles, safety motivations (financial and non-financial), and company culture. Furthermore, it can study moderating variables in the model, such as workload and fatigue, to examine how these factors influence the safety behavior intentions of Ro-Ro drivers.

Third, Further research ought to examine how the safety climate and safety behavior of Ro-Ro drivers impact the supply chain, enhancing transportation efficiency or cost reduction within it.

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