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Terminal Safety and Security as an Implication of Terminal Location and Accessibility, Mediated by Service Reliability: A Case Study at Tanah Merdeka Freight Terminal

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Abstract: This study aims to analyze the influence of terminal location and accessibility on safety/security through service reliability among logistics companies operating at Tanah Merdeka Terminal, North Jakarta. A quantitative approach was employed using a survey method. The study population consisted of approximately 40 logistics companies in the research area, all of which were included in the sample using saturated sampling technique. Data collection was conducted through questionnaire distribution between March and June 2025. Data analysis was carried out using Structural Equation Modeling based on Partial Least Squares (PLS-SEM) with the assistance of SmartPLS version 4.1 software. The results indicate that service reliability has a significant influence on safety/security. Additionally, terminal location indirectly affects safety/security through service reliability. However, accessibility was found to have no significant direct or indirect effect on service reliability and safety/security. These findings highlight the critical role of enhancing service reliability as a key factor in improving logistics safety and security.

Keywords: Terminal Location, Accessibility, Service Reliability, Safety, Security, Logistics, PLS-SEM.

INTRODUCTION

The movement of goods in urban areas is driven not only by local economic activities but also by interregional distribution flows (Sakai et al., 2020). Jakarta, as the capital city and the national economic center under Law No. 2 of 2024 concerning the Province of the Special Capital Region of Jakarta, holds a strategic role in Indonesia's national logistics system. The high level of trade activities and the expansion of the e-commerce sector have increased the volume of goods movement, resulting in traffic congestion, transportation inefficiency, and growing freight traffic burdens within the city.

To support the smooth distribution of goods, adequate movement space and logistics nodes such as terminals and integrated warehousing zones are required (Susanto et al., 2025). The Provincial Government of DKI Jakarta has developed two Freight Vehicle Terminals Tanah Merdeka and Pulogebang — to support urban distribution. However, both terminals have yet to operate optimally and are often used merely as truck parking areas. The lack of loading and unloading facilities, insufficient security, and high retribution fees have made these terminals less attractive to logistics operators. Consequently, their strategic potential remains underutilized, and the flow of goods continues to concentrate on main roads, exacerbating congestion and Over Dimension Over Load (ODOL) violations.

The ODOL phenomenon has become a serious issue in Indonesia as it causes infrastructure damage and reduces traffic safety (Widyanti et al., 2025). Data from the Indonesian National Police Traffic Corps recorded 27,337 accidents involving freight vehicles, while the Ministry of Transportation estimated that road damage losses reached IDR 43.47 trillion per year. Despite the implementation of regulations and Weigh-In-Motion (WIM) technology, monitoring and law enforcement remain ineffective.

Moreover, accessibility plays a crucial role in the effectiveness of logistics terminals. Congested access roads, lack of modal integration, and limited supporting facilities hinder the efficiency of goods movement. According to Statistics Indonesia (BPS, 2024), the number of vehicles in Jakarta reached 12.05 million units, with 76% consisting of motorcycles, further worsening congestion and reducing logistics accessibility.

The determination of warehouse and terminal locations constitutes a strategic decision within the urban logistics system. Proper location selection can optimize the flow of goods, reduce transportation costs, and enhance distribution (Muerza et al., 2024). Therefore, optimizing the functions of terminals and warehousing zones through improved accessibility and multimodal integration is a crucial step toward establishing an efficient, sustainable, and competitive logistics system in Jakarta.

METHOD

This study employs a quantitative approach aimed at empirically and measurably testing causal relationships among variables through statistical analysis. This approach is considered the most appropriate as it allows the researcher to explain the interrelationships between terminal location (X1), terminal accessibility (X2), service reliability (Z), and safety/security (Y) based on numerical data collected from respondents.

The research was conducted at the Tanah Merdeka Freight Vehicle Terminal in East Jakarta, which serves as one of the key nodes within the urban logistics system. All logistics companies operating and utilizing the terminal were designated as research respondents, totaling 40 companies. Given the relatively small and well-defined population size, this study adopted a non-probability sampling technique using a saturation sampling approach, in which all members of the population were included as research samples. This method allows the research findings to comprehensively represent the actual conditions without respondent selection bias.

The data used in this research consist of both primary and secondary data. Primary data were obtained through the distribution of closed-ended questionnaires to logistics companies operating at the terminal, conducted both directly and online via Google Forms. Respondents were selected based on their active involvement in terminal operations for at least the past six months to ensure that their responses reflected the actual and current conditions. Meanwhile, secondary data were gathered from official government documents, relevant regulations (Law No. 22 of 2009 and Government Regulation No. 55 of 2012), reports from the Jakarta Provincial Transportation Agency, as well as academic literature and international journals supporting the analysis of terminal location, logistics accessibility, service reliability, and freight transport safety and security.

Data analysis was carried out using the Structural Equation Modeling (SEM) method with the Partial Least Squares (PLS) approach through SmartPLS software version 4.1. This method was chosen for its ability to simultaneously analyze causal relationships among latent variables, including mediating variables, even with a relatively small sample size. The analysis was conducted in two main stages: (1) the measurement model (outer model) to test the validity and reliability of the research instruments, and (2) the structural model (inner model) to test the relationships among variables based on R-square, f-square, Q-square values, and hypothesis testing using p-values and t-statistics at a 5% significance level.

This research was conducted over a twelve-month period, beginning with the preparation and instrument design phase from January to April 2025, field data collection from May to June 2025, data processing and analysis from July to August 2025, interpretation of results and discussion from September to October 2025, and the final report writing and revision stage from November to December 2025.

RESULTS AND DISCUSSION

The measurement model testing in this study was conducted to ensure that the variables Terminal Location (X1), Accessibility (X2), Service Reliability (Z), and Safety and Security (Y) were measured with both validity and reliability. Validity was assessed through convergent validity and discriminant validity. Convergent validity was confirmed when the Average Variance Extracted (AVE) values were ≥ 0.50, indicating that the indicators adequately represented their respective constructs. Discriminant validity was evaluated by comparing the square root of the AVE for each construct with the correlations between constructs, ensuring that every variable is conceptually distinct and measures a unique dimension of the terminal performance model. Reliability was tested using Composite Reliability (CR), with a threshold value of ≥ 0.70, to confirm the internal consistency of indicators within each construct. This indicates that the measurement items of each variable such as distance to transport networks, connectivity to economic centers, consistency of terminal services, and operational safety were stable and cohesive in measuring their intended dimensions.

Validity Test Result

Convergent validity testing was conducted using SmartPLS 4 with the Partial Least Squares (PLS) algorithm approach. An indicator is considered valid if it has a loading factor value of ≥ 0.70, indicating that the indicator strongly represents the measured construct.

Table 1. Results of Validity Testing

Variable	Indicators	Loading Factors	Description
Terminal Location (X1)	X1.1	0.880	Valid
	X1.2	0.892	
	X1.3	0.824	
	X1.4	0.910	
Accessibility (X2)	X2.1	0.909	Valid
	X2.2	0.878	
	X2.3	0.900	
	X2.4	0.889	
Service Reliability (Z)	Z1	0.896	Valid
	Z2	0.852	
	Z3	0.861	
	Z4	0.914	
Safety and Security (Y)	Y1	0.884	Valid
	Y2	0.877	

	Y3	0.848

Source: Research data

Based on the validity test results presented in Table 4.1, the loading factor values for each indicator of the studied variables demonstrate a strong relationship with their respective latent constructs, confirming convergent validity. The detailed interpretation is as follows:

The Terminal Location (X1) variable consists of four indicators (X1.1–X1.4), each showing high loading factor values ranging from 0.824 to 0.910. These values exceed the minimum threshold of 0.70, indicating that all indicators strongly and consistently represent the latent construct. Therefore, the measurement items used to assess Terminal Location are valid and meet the criteria for convergent validity.

The Accessibility (X2) variable is measured using four indicators (X2.1–X2.4), with loading factors between 0.878 and 0.909. These consistently high values demonstrate that each indicator has a significant contribution to the construct, reflecting that the variable Accessibility is well measured and statistically valid.

The Service Reliability (Z) construct comprises four indicators (Z1–Z4) with loading factors ranging from 0.852 to 0.914. The strong correlation values confirm that all indicators effectively capture the underlying concept of Service Reliability, ensuring that this mediating variable fulfills the criteria for convergent validity.

The Safety and Security (Y) variable includes three indicators (Y1–Y3), all of which display loading factor values between 0.848 and 0.884. These results indicate a strong and consistent relationship between each indicator and the latent construct, confirming that the measurement of Safety and Security is valid and reliable.

In conclusion, all variables in this study show strong evidence of convergent validity, as every indicator records a loading factor value above 0.70. This demonstrates that each indicator is a reliable and valid measure of its respective latent construct, confirming that the measurement model is robust and appropriate for subsequent structural analysis..

Reliability Test Result

Reliability testing evaluates the internal consistency of the research instrument to ensure stability and trustworthiness in repeated measurements (Taherdoost, 2018). This study employs Cronbach's Alpha and Composite Reliability as the main indicators. A construct is considered reliable if Cronbach's Alpha > 0.6 (exploratory) or > 0.7 (confirmatory), and Composite Reliability > 0.7 (Ghozali, 2016). The results of both indicators are presented as follows.

Table 2. Results of Reability Testing

	Cronbach's alpha	Composite reliability (rho_c)
Terminal Location (X1)	0.899	0.930
Accessibility (X2)	0.917	0.941
Service Reliability (Z)	0.904	0.933
Safety and Security (Y)	0.839	0.903

Source: Research data

Based on the reliability test results presented in Table 4.2, all constructs in this study Terminal Location (X1), Accessibility (X2), Service Reliability (Z), and Safety and Security (Y) have Cronbach's Alpha and Composite Reliability values exceeding 0.70. These results indicate that each construct demonstrates high internal consistency, meaning that all indicators within the same variable are correlated and consistently measure the intended latent construct.

Therefore, it can be concluded that the measurement instruments used in this study are reliable and appropriate for further analysis, ensuring the robustness of the measurement model

in capturing the relationship between terminal location, accessibility, service reliability, and safety within the logistics terminal context.

R² Test Result

The coefficient of determination (R^2) represents the proportion of variance in the dependent variable that can be explained by the independent variables within the model. According to Hair et al. (Hair et al., 2014), R^2 is derived by squaring the correlation coefficient. To assess the explanatory power of the model, the R^2 value can be interpreted as follows: a value above 0.67 indicates a strong level of explanatory power, a value between 0.33 and 0.67 reflects a moderate level, while a value between 0.19 and 0.33 suggests a weak level of influence. The following model summary table presents the R^2 values for each dependent construct in the study.

Table 3. Results of Coefficient of Determination (R^2)

Variable	R-square	R-square adjusted	Result
Safety and Security (Y)	0.741	0.719	Strong
Service Reliability (Z)	0.512	0.486	Moderate

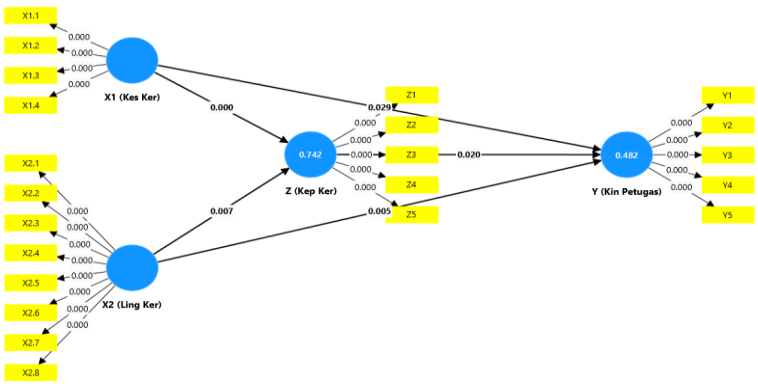
Source: Research data

Based on Table 3, the Safety and Security (Y) variable has an R-Square of 0.741 and an Adjusted R-Square of 0.719, indicating a strong predictive power. This shows that 71.9% of its variation can be explained by the independent variables. The Service Reliability (Z) variable records an R-Square of 0.512 and an Adjusted R-Square of 0.486, categorized as moderate, meaning 48.6% of its variation is explained by the model. Overall, these results demonstrate that the structural model has good explanatory power and can reliably predict the relationships among variables.

Hypothesis Testing Result

This section outlines the final stage of analysis, which involves evaluating the regression coefficients to examine the significance of relationships between variables. Hypothesis testing is conducted at a 5% significance level, where a hypothesis is accepted if the t-statistic exceeds 1.980 and the p-value is below 0.05 (Hair et al., 2014). A significant regression coefficient indicates a meaningful relationship between the tested variables, thereby supporting the proposed hypothesis.

The hypothesis testing results were obtained through data analysis using Partial Least Squares (PLS) with SmartPLS version 4.1.0.0. The output of this analysis is visualized in the path diagram shown in Figure 4.2, which illustrates the relationships among variables as evaluated through the PLS approach.



Source: Research data

Figure 2. Path Diagram

The table below presents the regression coefficient values for each independent variable in relation to the respective dependent variable being tested.

Table 4. Results of Direct Hypothesis Testing

Hypothesis	Path	Original sample (O)	T statistics	P values	Result
H1	The influence of terminal location on safety and security.	0.217	1.426	0.154	Rejected / not supported
H2	The influence of terminal location on service reliability.	0.54	3.062	0.002	Accepted / supported
H3	The influence of accessibility on safety and security.	0.343	2.527	0.012	Accepted / supported
H4	The influence of accessibility on service reliability.	0.278	1.552	0.121	Rejected / not supported
H5	The influence of service reliability on safety and security.	0.453	2.823	0.005	Accepted / supported

Source: Research data

Hypothesis 1

The hypothesis testing results show that the P-value is 0.154 > α 0.05, indicating that Hypothesis H1 is rejected. Therefore, it can be concluded that the location of the Tanah Merdeka Freight Vehicle Terminal does not have a significant positive influence on the aspects of terminal safety and security. This finding is particularly interesting because, theoretically, a strategically located terminal should contribute to improved operational safety and traffic security in its surrounding area.

Based on the indicators used in the terminal location variable such as proximity to major transportation networks, accessibility to economic centers, land capacity, and compliance with spatial planning these aspects are theoretically expected to promote efficiency and order, which in turn could reduce the risks of accidents and logistics-related crimes. However, the test results indicate that these factors are not sufficiently strong to explain improvements in safety and security levels at the terminal.

Hypothesis 2

The hypothesis testing results indicate that the P-value is 0.002, which is smaller than α = 0.05, thus Hypothesis H2 is accepted. This means that, statistically, at the 95% confidence level, there is a significant positive influence between the perception of terminal location and service reliability at the Tanah Merdeka Freight Vehicle Terminal. Accordingly, the better the perception of the terminal's location, the higher the level of service reliability perceived by terminal users.

In the context of this study, the terminal location variable was measured through indicators such as proximity to major transportation networks, accessibility to economic centers, land capacity, and compliance with spatial planning. These indicators reflect the functional efficiency of the terminal and its ease of integration within the logistics network. A positive perception of these aspects suggests that the strategic placement and management of the terminal location directly contribute to providing services that are more reliable, timely, and standardized (Le et al., 2020).

Hypothesis 3

The hypothesis testing results show that the P-value is 0.012, which is smaller than α = 0.05, indicating that Hypothesis H3 is accepted. This means that, statistically, at the 95% confidence level, there is a significant positive influence between the perception of terminal accessibility and the level of safety and security at the Tanah Merdeka Freight Vehicle Terminal. This finding implies that the better users perceive the accessibility of the terminal, the higher the level of safety and security they experience.

In this study, the terminal accessibility variable was measured based on indicators such as the freedom of movement within the terminal, the distance between the terminal and markets or suppliers, and the speed of goods delivery processes. Good accessibility creates optimal mobility space for logistics vehicles, reduces internal traffic congestion, and minimizes the potential for accidents and intermodal conflicts. Therefore, a positive perception of accessibility directly supports perceptions of safety and security both in terms of traffic management and the protection of assets and goods (Jamei et al., 2022).

Hypothesis 4

The hypothesis testing results show that the P-value is 0.121, which is greater than α = 0.05. Therefore, Hypothesis H4 is rejected. This means that, statistically, at the 95% confidence level, there is no significant positive influence between accessibility and service reliability at the Tanah Merdeka Freight Vehicle Terminal. This result indicates that although terminal accessibility is an important aspect of logistics services, users' perceptions of accessibility do not directly enhance the reliability of the services they receive.

In this study, the accessibility variable was measured through indicators such as ease of access to the terminal, availability of parking facilities, connectivity with other modes of transport, and convenience for users with special needs. Meanwhile, service reliability encompasses dimensions such as timeliness, process consistency, and the accuracy of logistics information. The absence of a significant relationship between these two variables suggests that improvements in accessibility do not necessarily guarantee more reliable services from the users' perspective.

Hypothesis 5

The hypothesis testing results show that the P-value is 0.005, which is smaller than α = 0.05, indicating that Hypothesis H5 is accepted. This means that, statistically, at the 95% confidence level, there is a significant positive influence between service reliability and safety and security at the Tanah Merdeka Freight Vehicle Terminal. The findings suggest that the higher the reliability of services provided, the greater the perceived level of safety and security among terminal users.

In the context of this study, service reliability includes indicators such as the punctuality of terminal operational schedules, consistency in service delivery, the ability to handle customer complaints, and the availability of accurate information. When terminal services operate consistently and reliably, they foster a sense of safety among users by reducing uncertainty and the likelihood of operational disruptions that could lead to accidents or other security risks.

Table 5. Results of Indirect Hypothesis Testing

Hypothesis	Path	Original sample (O)	T statistics	P values	Result
H6	The influence of terminal location on safety and security through service reliability.	0.245	2.312	0.021	Accepted / supported.

H7	The influence of terminal accessibility on safety and security through service reliability.	0.126	1.318	0.188	Rejected / not supported.

Source: Research data

Hypothesis 6

The hypothesis testing results show that the P-value is 0.021, which is smaller than the significance level α = 0.05. Therefore, Hypothesis H6 is accepted, indicating that, statistically, at the 95% confidence level, there is a significant positive influence of terminal location on safety and security, mediated by the variable of service reliability. This finding implies that the strategic placement and design of terminal locations contribute to enhancing perceptions of safety and security when supported by reliable service performance.

In this context, the terminal location theory includes indicators such as ease of access to the terminal, proximity to distribution networks, minimal traffic disruption around the terminal area, and physical layout arrangements that facilitate logistics flow. A terminal that is well-integrated with major transportation systems and easily accessible enables services to be delivered more punctually, consistently, and with minimal operational disturbances. Such conditions enhance service reliability, particularly in terms of schedule accuracy, stability of loading and unloading processes, and efficient field coordination.

Hypothesis 7

The hypothesis testing results show that the P-value is 0.188, which is greater than the significance level α = 0.05. Therefore, Hypothesis H7 is rejected, indicating that, statistically, at the 95% confidence level, there is no significant positive influence of accessibility on safety and security when mediated by service reliability. In other words, although accessibility is considered an important factor in terminal operations, in the context of this study, accessibility has not been statistically proven to enhance safety and security when mediated through service reliability.

Accessibility which includes indicators such as ease of reaching the terminal through various modes of transport, the availability of directional signage, and supporting infrastructure for terminal entry and exit theoretically has the potential to influence service reliability and, ultimately, safety and security. However, the results of this study indicate that improvements in accessibility do not necessarily guarantee enhancements in service reliability that would translate into better operational safety outcomes.

CONCLUSION

This study provides empirical evidence on the influence of terminal location and accessibility on safety and security, with service reliability as a mediating variable, at the Tanah Merdeka Freight Vehicle Terminal. in East Jakarta. The findings reveal that terminal location significantly affects service reliability, while accessibility significantly influences safety and security. Moreover, service reliability itself plays a crucial role in enhancing safety and security within terminal operations.

The results also indicate that the direct effect of terminal location on safety and security is not significant, implying that the physical placement of the terminal alone does not guarantee improved operational safety unless supported by reliable and consistent services. Similarly, accessibility was found to have no direct impact on service reliability, suggesting that ease of access must be complemented by effective management systems to ensure service consistency.

Furthermore, the mediation analysis shows that service reliability strengthens the relationship between terminal location and safety and security, highlighting its strategic role as an operational linkage between spatial efficiency and safety performance. However, the mediating effect of service reliability between accessibility and safety/security was not

statistically significant, indicating that improvements in accessibility do not automatically translate into enhanced safety outcomes through reliability mechanisms.

Overall, this study underscores the importance of integrating spatial planning, infrastructure development, and service reliability management in the design and operation of urban freight terminals. To achieve a safer and more efficient urban logistics system, terminal management and policymakers should focus on optimizing location functionality, improving accessibility infrastructure, and strengthening service reliability standards as part of a holistic logistics governance framework.

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