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Planning for Terminal Service Integration and Parking Facility Improvement at Muara Angke Port, North Jakarta

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Abstract: This study aims to analyze the influence of parking inventory and parking utilization on terminal services and facility improvements at Muara Angke Port, North Jakarta. The background of this research is based on the current condition where the terminal is not yet located within the port area, requiring users to walk more than one kilometer and/or use other modes of transportation to reach the terminal. This research adopts a quantitative approach using survey methods through the distribution of questionnaires to respondents consisting of three main groups: regulators (port authorities), operators (terminal and parking managers), and consumers (passengers). The study involved a sample of 240 respondents, in accordance with the recommended number of indicators in statistical analysis as proposed by Hair et al. (2014). Primary data were collected through questionnaires, while secondary data were obtained from literature, scientific journals, and relevant regulations. Data analysis was conducted using Structural Equation Modeling (SEM) with the assistance of Smart PLS software. The model employed includes the outer model to test validity and reliability, and the inner model to test causal relationships among variables. The findings indicate that both parking inventory and parking utilization have a positive and significant influence on terminal services and facility improvements. These findings suggest that optimizing the parking function can serve as a basis for planning the integration of the terminal into the port area to enhance user comfort and service efficiency.

Keywords: Parking Investment, Parking Utilization, Terminal Service Enhancement, Facility Improvement, Muara Angke Port, Smart PLS.

INTRODUCTION

Transportation plays a vital role in achieving social welfare and sustainable mobility in Jakarta (Kadarisman et al., 2015). Consumer preferences are formed based on passengers' perceptions of the products and services they receive from land transportation providers, as the perceptions embedded in the consumers' minds ultimately shape their preferences (R. Indrawan

& Tantri, 2023). Several developed countries, such as Japan, Singapore, and those in Europe, have demonstrated that the integration between terminals and ports can enhance logistics efficiency, reduce travel time, and improve user experience through seamless intermodal connectivity. This concept serves as an inspiration for implementing an integrated transportation system at Muara Angke Port, which functions as the main gateway to the Thousand Islands tourism destinations.

The revitalization of Muara Angke Port, inaugurated in October 2022 by the Governor of DKI Jakarta, marks a significant step toward achieving mobility equity between mainland and island residents. Covering an area of 6,700 m², the port is equipped with modern facilities such as ramps, lifts, escalators, a waiting area with a capacity of 800 people, as well as an e-ticketing and CCTV system. However, the revitalization process is still ongoing and faces challenges, particularly in terminal service integration, accessibility, and parking management.

Jakarta continues to struggle with chronic traffic congestion caused by the increasing ownership of private vehicles. Data from Statistics Indonesia (BPS, 2025) indicate a significant rise in the number of motor vehicles, while the use of public transportation has declined to below 10% (JUTPI II). This situation highlights the urgency of developing a Park and Ride system to shift private vehicle users toward public transport modes. The Park and Ride concept can serve as an effective solution to reduce urban congestion and emissions.

The surge of passengers at Muara Angke, particularly during long holidays, has placed considerable pressure on terminal and parking capacities. Disorganized parking layouts, limited space, and poor zoning arrangements have led to inefficiencies and decreased user comfort (Risman et al., 2025). Furthermore, supporting facilities such as waiting areas, departure information systems, and queuing arrangements still require improvement to maintain passenger satisfaction (Risman et al., 2025).

Therefore, this study emphasizes the importance of planning terminal and port service integration based on a sustainable multimodal concept. The main focus is directed toward analyzing parking space utilization, accessibility, and service quality in supporting the implementation of the park and Ride system at Muara Angke Port. Synergy among regulators, operators, and users is essential to realizing an efficient, inclusive, and environmentally friendly transportation system in Jakarta's coastal area.

METHOD

This study employs a quantitative approach aimed at empirically and measurably testing causal relationships among variables through statistical analysis. This approach was selected because it allows the researcher to explain the interrelationships between parking investment (X1), parking utilization (X2), facility improvement (Z), and terminal service enhancement (Y) based on numerical data collected from respondents.

The research was conducted at Muara Angke Port, North Jakarta, which serves as the main maritime transportation gateway for residents traveling to the Thousand Islands tourism destinations. This location was chosen due to its significant potential for integration between terminal and port functions, particularly in supporting the improvement of parking facilities and terminal service quality. According to (D. Indrawan & Jalilah, 2021) the population refers to all individuals or elements of interest in a research study. The research population includes terminal users, transport operators, and parking service users within the Muara Angke Port area. The total number of respondents in this study was 280, as recommended by Hair et al. (2019).

The sampling technique used was non-probability sampling with a purposive sampling approach. This method was selected because the study population is relatively limited and homogeneous, and each respondent possesses characteristics aligned with the research criteria namely, individuals who have used or been directly involved in terminal and parking activities at Muara Angke Port for at least the past six months. Therefore, each member of the population is considered relevant and eligible to be included as a research sample.

The research data consist of primary and secondary data. Primary data were obtained through the distribution of closed-ended questionnaires delivered both directly in the field and online via Google Forms. The questionnaire contained statements measured using a Likert scale to assess respondents' perceptions of parking investment, parking utilization, facility improvement, and terminal service quality. Meanwhile, secondary data were obtained from various official sources such as the Jakarta Provincial Transportation Agency (Dinas Perhubungan DKI Jakarta), Pelindo, and relevant government regulations, including Law No. 22 of 2009 on Road Traffic and Transportation, and Government Regulation No. 55 of 2012 on Vehicles, as well as academic references and international journals supporting the analysis of terminal systems and transport facility integration.

Data analysis was carried out using the Structural Equation Modeling (SEM) method with the Partial Least Squares (PLS) approach, processed through SmartPLS version 4.1 software. This method was chosen because it can analyze causal relationships among latent variables, including mediating variables, even with relatively small sample sizes. The analysis was conducted in two main stages: (1) measurement model testing (outer model) to assess the validity and reliability of research indicators based on loading factor, Average Variance Extracted (AVE), and Composite Reliability (CR) values; and (2) structural model testing (inner model) to evaluate the relationships among variables using R-square, f-square, Q-square values, and hypothesis testing through p-values and t-statistics at a 5% significance level.

RESULTS AND DISCUSSION

The measurement model testing in this study was conducted to ensure that the variables parking investment (X1), parking utilization (X2), facility improvement (Z), and terminal service enhancement (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
Parking Investment (X1)	X1.1	0.823	Valid
	X1.2	0.868	
	X1.3	0.875	
	X1.4	0.892	
	X1.5	0.875	
	X1.6	0.880	
	X2.1	0.874	Valid

Parking Utilization (X2)	X2.2	0.813	
	X2.3	0.855	
	X2.4	0.844	
	X2.5	0.863	
	X2.6	0.839	
Facility Improvement (Z)	Z1	0.810	Valid
	Z2	0.836	
	Z3	0.822	
	Z4	0.828	
	Z5	0.835	
	Z6	0.837	
	Z7	0.831	
	Z8	0.866	
Terminal Service Enhancement (Y)	Y1	0.869	Valid
	Y2	0.850	
	Y3	0.846	
	Y4	0.863	
	Y5	0.823	
	Y6	0.866	
	Y7	0.861	
	Y8	0.883	

Source: Research data

Based on the validity test results presented in Table 1, the loading factor values for each indicator of the studied variables demonstrate a strong correlation with their respective latent constructs, confirming convergent validity. The detailed interpretation is as follows:

The Parking Investment (X1) variable consists of six indicators (X1.1–X1.6), each showing high loading factor values ranging from 0.823 to 0.892. These values exceed the minimum threshold of 0.70, indicating that all indicators consistently represent the underlying latent construct. Therefore, the measurement items used to assess Parking Investment are valid and meet the criteria for convergent validity.

The Parking Utilization (X2) variable is measured using six indicators (X2.1–X2.6), with loading factors ranging from 0.813 to 0.874. The consistently high factor loadings demonstrate that each indicator contributes significantly to the latent construct, showing that Parking Utilization is well measured and statistically valid.

The Facility Improvement (Z) construct comprises eight indicators (Z1–Z8) with loading factors between 0.810 and 0.866. These values show a strong correlation among the indicators and the construct, confirming that all measurement items effectively capture the underlying concept of Facility Improvement. This mediating variable therefore fulfills the requirements for convergent validity.

The Terminal Service Enhancement (Y) variable includes eight indicators (Y1–Y8), all of which display loading factor values between 0.823 and 0.883. These consistently high correlations confirm that each indicator strongly reflects the latent construct, indicating that the measurement of Terminal Service Enhancement is valid and reliable.

In conclusion, all constructs in this study exhibit strong evidence of convergent validity, as every indicator records a loading factor value above 0.70. This demonstrates that each indicator reliably measures its respective latent construct, confirming that the overall measurement model is robust, consistent, and suitable for further structural analysis.

Reliability Test Result

Reliability testing evaluates the internal consistency of the research instrument to ensure stability and trustworthiness in repeated measurements. 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)
Parking Investment (X1)	0.935	0.935
Parking Utilization (X2)	0.922	0.922
Facility Improvement (Z)	0.937	0.937
Terminal Service Enhancement (Y)	0.949	0.949

Source: Research data

Based on the reliability test results presented in Table 4.2, all constructs in this study parking investment (X1), parking utilization (X2), facility improvement (Z), and terminal service enhancement (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.

R^2 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
Terminal Service Enhancement (Y)	0.731	0.727	Strong
Facility Improvement (Z)	0.598	0.594	Moderate

Source: Research data

Based on Table 3, the Terminal Service Enhancement (Y) variable has an R-Square value of 0.731 and an Adjusted R-Square of 0.727, indicating a strong predictive power. This means that approximately 72.7% of the variation in Terminal Service Enhancement can be explained by the independent variables included in the model, while the remaining 27.3% is influenced by other factors not examined in this study. Meanwhile, the Facility Improvement (Z) variable records an R-Square of 0.598 and an Adjusted R-Square of 0.594, which falls under the moderate category. This implies that 59.4% of its variation is explained by the predictor variables within the model, suggesting a reasonably good level of explanatory strength for this mediating construct.

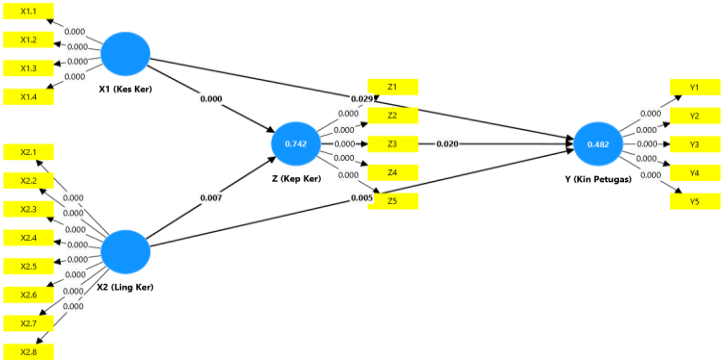
Overall, these results indicate that the structural model possesses robust explanatory capability, with both dependent variables—Facility Improvement and Terminal Service

Enhancement—showing acceptable levels of determination. This confirms that the model can reliably predict and explain the relationships among the studied variables.

Hypothesis Testing Result

This section presents the final analytical stage, focusing on assessing regression coefficients to determine the statistical significance of the relationships among variables. The hypothesis testing was carried out at a 5% significance level, where a hypothesis is accepted when the t-statistic value exceeds 1.980 and the p-value is less than 0.05 (Hair et al., 2014). A significant regression coefficient signifies a meaningful association between the examined variables, thus validating the proposed hypothesis.

The results of hypothesis testing were derived from data analysis using the Partial Least Squares (PLS) method through SmartPLS version 4.1.0.0. The analysis output is illustrated in the path diagram displayed in Figure 4.2, depicting the interrelationships among variables as assessed through the PLS model.



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 Parking Investment on Terminal Services	0.515	6,343	0.000	Accepted / supported.
H2	The Influence of Parking Investment on Facility Improvement	0.512	6,945	0.000	Accepted / supported.
H3	The Influence of Parking Utilization on Terminal Services	0.220	3,319	0.001	Accepted / supported.
H4	The Influence of Parking Utilization on Facility Improvement	0.341	3,817	0.000	Accepted / supported.
H5	The Influence of Facility Improvement on Terminal Services	0.218	3,102	0.002	Accepted / supported.

Source: Research data

Hypothesis 1

The results of hypothesis testing for H1 show that the P-value of 0.000 is smaller than the significance level $\alpha = 0.05$. Therefore, hypothesis H1 is accepted. This indicates a positive and

significant influence of parking inventory on terminal services. Statistically, this means that the better the implementation and management of parking inventory, the higher the terminal service quality perceived by users.

This finding is consistent with the study conducted by Mesa et al., (2022), which stated that effective parking system management—including the monitoring and reporting of parking capacity significantly enhances traffic efficiency and user satisfaction in terminal and public transportation station areas. They emphasized that integrating digital systems into parking inventory management also contributes to a more positive user perception of overall transportation services.

Hypothesis 2

The hypothesis testing results indicate that the P-value of 0.000 is smaller than the significance level $\alpha = 0.05$, thereby accepting hypothesis H2. This means that, statistically, at a 95% confidence level, there is a positive and significant influence of parking inventory perception on facility improvement. Accordingly, the better the perception of parking inventory management, the greater the improvement in facilities experienced by terminal users.

This finding aligns with the study by Ximenes, (2018) which revealed that structured management and inventory of parking areas can enhance the quality of supporting terminal infrastructure, particularly in parking facilities, waiting areas, and overall user comfort.

Hypothesis 3

Based on the hypothesis testing results, the P-value obtained was 0.000, which is smaller than the significance level $\alpha = 0.05$; therefore, hypothesis H3 is accepted. This indicates that, statistically, at a 95% confidence level, there is a positive and significant influence of parking utilization perception on terminal services. This finding suggests that the better users perceive parking utilization, the higher the level of terminal service quality they experience.

This result is consistent with the findings of Chowdhury et al., (2018) who stated that optimizing the utilization of parking spaces—including vehicle flow management and efficient parking area allocation directly contributes to user satisfaction and positive perceptions of public transportation services, particularly within terminal and station areas.

Hypothesis 4

Based on the hypothesis testing results, the P-value obtained was 0.024, which is smaller than the significance level $\alpha = 0.05$; therefore, hypothesis H4 is accepted. This indicates that, statistically, at a 95% confidence level, there is a positive and significant influence of parking utilization perception on facility improvement. This finding implies that the better users perceive the utilization of parking spaces, the greater the improvement in facilities experienced at the terminal.

Effendi et al., (2017), in Jurnal Ilmiah Teknik Sipil, also found that efficient parking management correlates with higher satisfaction toward terminal physical infrastructure in general. In terms of customer satisfaction, Firdaus & Gunawan, (2019) emphasized the critical role of perceived service quality and the strong correlation between customer satisfaction and service quality, suggesting that physical development of parking facilities is an essential aspect that must be continuously improved.

Hypothesis 5

The results of hypothesis testing for H5 show that the P-value of 0.002 is smaller than the significance level $\alpha = 0.05$; therefore, hypothesis H5 is accepted. This indicates that there is a positive and significant influence of facility improvement (Z) on terminal service enhancement (Y) at Muara Angke Port, North Jakarta. Statistically, this finding confirms that the higher users' perceptions of facility quality and completeness, the better the terminal services they experience.

The potential for further development related to passengers, terminals, and available land can be optimized; however, such efforts must be synergized from the early stages of planning,

implementation, and evaluation processes through coordination among the Central Government, Regional Government, and Strategic Partners (Sihombing & Teweng, 2021).

Table 5. Results of Indirect Hypothesis Testing

Hypothesis	Path	Original sample (O)	T statistics	P values	Result
H6	The Influence of Parking Investment on Terminal Services through Facility Improvement.	0.111	2,970	0.003	Accepted / supported.
H7	The Influence of Parking Utilization on Terminal Services through Facility Improvement.	0.074	2,126	0.034	Accepted / supported.

Source: Research data

Hypothesis 6

The results of hypothesis testing for H6 indicate that the indirect path coefficient of parking investment on terminal services through facility improvement is 0.111, with a P-value of 0.003, which is smaller than the significance level α = 0.05. Therefore, hypothesis H6 is accepted. This finding confirms that a positive perception of parking investment can stimulate facility improvement, which in turn enhances terminal service performance at Muara Angke Port, North Jakarta.

This result is consistent with the findings of Sari et al. (2023) which demonstrated that investments in supporting infrastructure, including parking facilities, have an indirect effect on passenger service satisfaction through improvements in terminal facility quality. The study emphasized that upgrading parking areas and physical accessibility generates a dual effect enhancing perceptions of facility quality while simultaneously increasing user satisfaction.

Hypothesis 7

The results of hypothesis testing for H7 indicate that the indirect path coefficient of parking utilization on terminal services through facility improvement is 0.074, with a P-value of 0.034, which is smaller than the significance level α = 0.05. Therefore, hypothesis H7 is accepted. This finding suggests that a positive perception of parking utilization promotes facility improvement, which in turn enhances the overall quality of terminal services at Muara Angke Port, North Jakarta.

This result is consistent with the findings of Sari et al. (2023), which emphasized that effective parking management and the optimization of supporting facilities have a significant impact on user satisfaction through the enhancement of terminal facility quality. The study highlighted that efficient utilization of parking facilities is one of the key factors in creating an effective and comfortable transportation experience.

CONCLUSION

This study demonstrates that both parking investment and parking utilization play a crucial role in enhancing terminal service quality at Muara Angke Port, North Jakarta, either directly or indirectly through facility improvement. The results confirm that parking investment significantly contributes to improving terminal services and facilities, highlighting the importance of structured infrastructure development and effective management in creating a positive service environment. Similarly, efficient parking utilization not only optimizes space use and traffic flow but also indirectly improves passenger comfort through better facilities.

Facility improvement serves as a mediating factor that strengthens the relationship between parking management and terminal service enhancement. The findings suggest that when parking areas are well-planned, monitored, and supported by digital systems, they contribute to a seamless passenger experience and overall service satisfaction.

From a managerial perspective, this research emphasizes the need for policymakers and terminal operators to integrate parking management strategies with broader terminal development plans. Collaboration among regulators, operators, and stakeholders is essential to ensure that parking investments are aligned with service quality objectives and sustainable mobility goals. Ultimately, the implementation of a well-integrated parking system can serve as a catalyst for improving terminal performance, supporting multimodal connectivity, and fostering an efficient and user-oriented transportation ecosystem in coastal urban areas such as Muara Angke.

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