INTEGRATION OF GREEN LOGISTICS AND LAST-MILE DELIVERY AS CATALYSTS OF CUSTOMER LOYALTY: AN EMPIRICAL STUDY OF PT POS INDONESIA (PERSERO)

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Abstract. *The development of e-commerce in Indonesia has driven a transformation in logistics service requirements, emphasizing not only speed and accuracy but also environmental sustainability. This study examines the impact of integrating green logistics and last-mile delivery reliability on customer loyalty. The research employs a quantitative approach using Partial Least Squares Structural Equation Modeling (PLS-SEM). Data were collected from respondents who had used Pos Indonesia courier services within the last six months. The results of the analysis indicate that both environmentally friendly practices and delivery accuracy contribute positively to customer loyalty, with path coefficients of 0.209 and 0.717, respectively. Simultaneously, these two factors explain 75.3% of the variation in customer loyalty. The findings highlight the importance of integrating sustainability strategies and service reliability as a strategic approach to strengthening long-term customer relationships and maintaining competitive advantage in the increasingly competitive logistics industry.*

Keywords: *Customer Loyalty; Courier Services; Green Logistics; Last-Mile Delivery; Logistics Sustainability; PT Pos Indonesia.*

1. INTRODUCTION

The courier service industry serves a vital function in facilitating the rapid expansion of e-commerce, especially in developing economies such as Indonesia. The increasing volume of online transactions has intensified the demand for logistics services that are not only fast and reliable but also responsive to customer needs (UNCTAD, 2023; Accenture, 2024). In 2025, Indonesia's e-commerce market value is projected to exceed USD 82 billion, placing significant pressure on logistics service providers to strengthen infrastructure, improve service quality, and optimize supply chain operations (World Bank, 2022; McKinsey & Company, 2023). A key challenge faced by courier service companies is how to deliver high-quality services that are strongly oriented toward customer satisfaction while simultaneously supporting sustainable development agendas. This challenge is particularly relevant for PT Pos Indonesia (Persero), as the largest government-owned company operating in the courier service sector. As competition intensifies with private courier companies that aggressively innovate, Pos Indonesia must continuously transform its business model to remain competitive while fulfilling its public service mandate.

One of the most prominent operational challenges in the courier industry is the cost of last-mile delivery, which is estimated to account for up to 53% of total logistics costs (McKinsey & Company, 2023). This final stage of delivery is a critical determinant of service quality perception, as customers are highly sensitive to delivery speed, accuracy, and reliability (Dablanc et al., 2020). Chen et al. (2022) emphasize that last-mile delivery reliability represents a major factor influencing customer satisfaction and loyalty, as failures at this stage can undermine customer trust and are often difficult to restore.

At the same time, growing public awareness and regulatory pressure related to environmental issues have encouraged logistics companies to adopt green logistics principles

(Huang et al., 2021; Choi & Lee, 2023). Green logistics encompasses efforts to reduce carbon emissions, improve energy efficiency, utilize environmentally friendly vehicles, optimize delivery routes, and manage packaging waste. Increasing industrial and consumer concern for environmental sustainability has compelled companies to align their business processes with environmentally oriented industrial concepts, which later evolved into Green Supply Chain Management (GrSCM) (Purnomo, 2013).Previous studies indicate that the implementation of green logistics contributes not only to environmental cost reduction and regulatory compliance but also enhances perceived value and corporate image among customers who are increasingly concerned about sustainability issues (Zhang et al., 2022; Ali et al., 2024). Through the allignment of green innovation, firms can optimize resource efficiency, minimize environmental risks, and reinforce partnerships with business stakeholder (Purnomo et al., 2024). Thus, green logistics is no longer merely an ethical or regulatory obligation but has evolved into a competitive strategy for building customer loyalty.

Despite the growing body of global literature, empirical studies that simultaneously integrate green logistics and last-mile delivery reliability as determinants of customer loyalty remain relatively limited, particularly in the context of developing countries (Mangiaracina et al., 2023; UN ESCAP, 2024). In Indonesia, most existing studies focus on cost efficiency, infrastructure development, or technological adoption, while limited attention has been given to examining how sustainability dimensions and service reliability interact to influence customer loyalty in the national courier service industry. This gap represents an important area for further investigation.

Accordingly, the central issue explored in this study concerns the implementation of green logistics and last-mile delivery reliability, both partially and simultaneously, affects customer loyalty at PT Pos Indonesia (Persero). Being among the oldest and largest courier service operators in Indonesia, Pos Indonesia faces significant challenges in business transformation to compete with private sector players. While green logistics initiatives have become a strategic program to address sustainability challenges and support the government's carbon neutrality agenda, such initiatives must be accompanied by improvements in service reliability, particularly in last-mile delivery, which strongly influences customer experience. Failure to meet expectations of customers concerning speed, accuracy, and transparency may hinder the company's efforts to build customer loyalty, even when green initiatives are effectively implemented.

This research investigates the effects of green logistics implementation and last-mile delivery reliability on customer loyalty in the Indonesian courier service sector, with a specific focus on PT Pos Indonesia (Persero). The findings are expected to support the advancement of academic literature on sustainable logistics management in developing countries, while also providing strategic guidance for companies and stakeholders in designing efficient, environmentally friendly, and customer-oriented courier service business models.

The innovative aspect of this study is found in its effort to integrate two strategic dimensions—green logistics and last-mile delivery reliability—in analyzing their impact on customer loyalty within the national courier service sector. This research not only provides a theoretical contribution by extending customer loyalty prediction models in the courier service industry, but also offers practical implications offered through strategic recommendations for PT Pos Indonesia (Persero) in formulating sustainability initiatives that are aligned with service quality improvement. Accordingly, the company can develop a superior value proposition and strengthen its competitiveness amid increasingly dynamic and competitive industry conditions.

This study is anticipated to generate policy-relevant contributions that support the advancement of a national logistics ecosystem that is both environmentally responsible and inclusive. Emission reduction in the transportation and logistics sectors has been identified as a priority by the Government of Indonesia in the National Medium-Term Development Plan (RPJMN) and the Nationally Determined Contribution (NDC) documents to achieve the target

of carbon neutrality by 2060 or earlier (UN ESCAP, 2024). The results of this research are anticipated to support government efforts in formulating policies that encourage the application of eco-friendly logistics practices by courier service providers, without compromising service reliability, which remains a fundamental right of consumers.

2. LITERATURE REVIEW

2.1 Customer Loyalty

Customer loyalty in courier services is understood as customers' tendency to repeatedly use the same courier service and to recommend it to others. Loyalty is not merely the outcome of customer satisfaction but is also influenced by trust, perceived value, and the quality of the company–customer relationship (Sulistiowati et al., 2025). Fadli et al. (2024) demonstrate that the execution of environmentally sustainable logistics practices and the reliability of last-mile delivery significantly contribute to enhanced customer loyalty, as customer loyalty is directly influenced by customer satisfaction. Their findings emphasize that companies should not focus solely on pricing or delivery speed, but rather on overall service quality, including sustainability aspects and delivery reliability. Furthermore, social exchange theory explains that customer loyalty is formed when customers believe that the benefits they derive, including reliable, environmentally friendly, and secure services, outweigh the costs incurred, including time, money, and risk (Yuen et al., 2023). Consumer purchase interest reflects preferences and behavioral tendencies toward specific products or brands (Zebadiah et al., 2023). Therefore, customer loyalty represents the outcome of a complex interaction between service experience, perceived value, and perceptions of a company's commitment to meeting customer needs.

2.2 Green Logistic

Green logistics refers to a collection of logistics-related activities designed to minimize negative environmental impacts while maintaining operational efficiency and creating value for customers. These activities include the use of environmentally friendly vehicles, sustainable packaging, fuel-efficient route planning, and the implementation of reverse logistics for recycling products or packaging materials (Yuen et al., 2023). Fadli et al. (2024), as reported in their research of PT JNE, found that green logistics implementation highly influential affects customer satisfaction and loyalty. This occurs because consumers are increasingly concerned about sustainability and tend to appreciate companies that demonstrate environmental responsibility. Other studies, such as Yuen et al. (2023), further confirm that companies that consistently manage environmentally friendly practices can enhance customer trust and foster long-term loyalty. Consequently, green logistics has become a critical strategy for courier service companies to build sustainable competitive advantage through improved customer satisfaction and loyalty.

2.3 Last-Mile Delivery Reliability

Last-mile delivery reliability represents the capability of courier service offers to consistently fulfill delivery promises at the final stage of the distribution chain, including timely delivery, delivery in good condition, and compliance with the information communicated to customers. Delivery reliability is a key metric in the Supply Chain Operations Reference (SCOR) Model and reflects the extent to which a company can ensure service consistency at the most critical point in the supply chain, namely when products are received by customers (Restuputri et al., 2021). In the courier service industry, reliability encompasses delivery timeliness, accuracy of tracking information, physical condition of packages upon arrival, and effective communication between couriers and customers. Ejdys and Gulc (2020) show that courier service reliability not only influences immediate customer satisfaction but also builds trust, which forms the foundation of customer loyalty. Delivery reliability is crucial because

customers are highly sensitive to delays, damaged goods, and uncertainty regarding delivery information. Therefore, courier companies must invest in tracking systems, courier training, and logistics infrastructure to ensure reliable and consistent service delivery.

3. HYPHOTHESIS DEVELOPMENT

3.1 The Role of Green Logistics in Achieving Customer Loyalty

Green logistics plays an important role in shaping customer loyalty through the creation of sustainable value that encompasses not only operational efficiency but also environmental responsibility. As public awareness of environmental issues increases, environmentally friendly logistics practices become a key differentiating factor in the courier service industry. Customers tend to exhibit higher loyalty toward companies that demonstrate social responsibility and sustainability in their business processes. This is because customers evaluate services not only based on functional performance but also on the ethical and environmental values upheld by the company (Yuen et al., 2023).

Fadli et al. (2024) reinforce this view by showing that green logistics directly influences customer loyalty by improving customer satisfaction. The incorporation of environmentally sustainable logistics practices, including the use of low-emission vehicles, reduction of packaging waste, and management of reverse logistics, contributes positively to perceptions of sustainable service quality. These positive perceptions strengthen customer trust, which in turn fosters long-term relationships between customers and service providers. Thus, green logistics is not merely an operational strategy but also a means of communicating corporate values that align with the preferences of environmentally conscious consumers.

3.2 The Role of Last-Mile Delivery Reliability on Customer Loyalty

Last-mile delivery service reliability is a crucial factor influencing customer loyalty in the courier service sector, as it represents the final and most direct point of contact between service providers and customers. Performance at this final stage significantly determines the overall customer experience. Timely delivery, accurate tracking information, and the condition of goods upon receipt are key elements in building perceptions of service quality. When customers receive their packages on time, in good condition, and in accordance with their expectations, they are more likely to maintain relationships with the company and recommend the service to others (Restuputri et al., 2021).

According to Ejdys and Gulc (2020), delivery reliability also influences the formation of customer trust. This trust is built through service consistency and effective communication, particularly when delays or delivery disruptions occur. In such situations, transparency of information and rapid response become crucial factors in maintaining customer loyalty. Therefore, courier companies must optimize route management, information systems, and courier service quality to deliver reliable services consistently.

Last-mile delivery reliability extends beyond logistical performance and reflects a company's professionalism, commitment, and customer orientation. In the long term, this reliability forms the foundation for sustained customer satisfaction, trust, and loyalty.

As a subsequent step, a theoretical framework was developed by integrating findings from previous studies and an in-depth literature review. This framework is designed to illustrate the associations among the variables tested within the research conceptual model. A visual representation of the the conceptual framework underpinning this research is shown in Figure 1, which serves as a conceptual foundation for formulating research questions and empirically testing the proposed hypotheses.
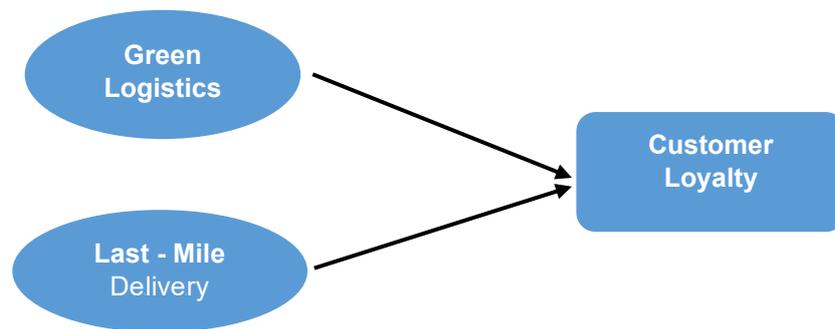
Figure 1. Research Model

Research Hypotheses:
- H1: The implementation of green logistics has a significant and positive effect on customer loyalty.
- H2: The level of reliability in the last-mile delivery process has a significant and positive effect on customer loyalty.

H3: The combination of green logistics practices and last-mile delivery service reliability simultaneously contributes significantly and positively to the formation of customer loyalty.

4. RESEARCH METHODS.

4.1 Research Design

This research design adopt an explanatory quantitative approach to identify causal relationships between green logistics and last-mile delivery reliability in relation to customer loyalty. Explanatory research is intended to identify and explain cause-and-effect relationships involving independent variables, namely Green Logistics (X_1) and Last-Mile Delivery Reliability (X_2), and the dependent variable, Customer Loyalty (Y).

Data were gathered via a survey-based method by distributing structured questionnaires to customers of PT Pos Indonesia (Persero). This research design was selected because it is suitable for examining direct as well as simultaneous effects among variables within the proposed research model using inferential statistical analysis. Through this design, the study is able to evaluate how each independent construct affects customer loyalty

4.2 Population and Sample

The target population of this research includes all customers of Pos Indonesia who have experience using courier delivery services and have interacted with the last-mile delivery services of PT Pos Indonesia (Persero). A purposive sampling technique was applied, whereby respondents were selected based on predefined criteria. The respondents included customers who had actively used Pos Indonesia's courier services within the past six months and had experience with last-mile delivery services provided by PT Pos Indonesia (Persero). To determine the minimum sample size for Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis, the "10-times rule" approach was employed (Hair et al., 2022). .This guideline explains that the minimum required number of samples is determined as ten times either the greatest number of indicators measuring a single construct or the maximum number of structural paths targeting a specific construct in the model, depending on which value is higher. In this study, each construct was measured using five indicators, and the maximum number of structural paths directed toward the dependent construct was two. Accordingly, this rule was used to calculate the minimum required sample size as follows: max ($10 \times 5 = 50$; $10 \times 2 = 20$), leading to a minimum required sample of 50 respondents

4.3 Research Instrument

The main research instrument is a structured questionnaire employing a five-point Likert scale. Each statement was rated by respondents on a scale ranging from "1 = Strongly Disagree" to "5 = Strongly Agree." The questionnaire was designed to measure customer perceptions of the independent variables, namely Green Logistics and Last-Mile Delivery Reliability, as well as the dependent variable, Customer Loyalty.

4.4 Data Sources and Sampling Technique

This study utilized primary data acquired directly from respondents using online survey instruments. The respondents consisted of Pos Indonesia customers who had used courier services within the preceding six months. The study utilized purposive sampling to determine the sample based on the following criteria:

1. The respondent had used PT Pos Indonesia's parcel delivery services at least once within the last six months.
2. The respondent was willing to complete the questionnaire fully and accurately.

Sample size selection was based on recommended criteria for Partial Least Squares Structural Equation Modeling (PLS-SEM), which generally requires an adequate sample size to produce stable and robust estimates. General guidelines suggest that the sample size must be at least tenfold the most complex structural path in the model or ten times the number of indicators of the most complex construct, while also considering the desired statistical power (Hair et al., 2021; Henseler et al., 2020). This approach guarantees that the collected data are relevant to the research objectives and sufficient for rigorous PLS-SEM analysis.

4.5 Data Analysis Technique

A quantitative data analysis approach was applied to the collected data. The analysis was conducted employing Partial Least Squares Structural Equation Modeling (PLS-SEM), a reliable approach to examining interractions among latent constructs, particularly in situations where data may not be normally distributed and sample sizes are relatively small to moderate (Hair et al., 2022). Evaluation of the measurement (outer) model was performed to confirm the validity and reliability of the constructs included in the study. The assessment of convergent validity was based on factor loadings exceeding 0.70 and an Average Variance Extracted (AVE) value greater than or equal to 0.50. The evaluation of discriminant validity relied on the Fornell–Larcker criterion, which stipulates that correlations among latent constructs should be below the square root of the AVE associated with each construct, ensuring clear distinction among constructs. The assessment of reliability was carried out using composite reliability and Cronbach's alpha indicators, both of to be greater than of 0.70.

The examination of the structural (inner) model involved analyzing the relationships among latent construct and measuring the magnitude of effects among the variables analyzed. This process included the assessment included T-statistics, P-values, and coefficients of determination (R^2). Accordingly, an R^2 value of 0.75 signifies a strong effect, 0.50 a moderate effect, and 0.25 a weak effect of exogenous variables on endogenous variables. According to the guidelines provided by Hair et al. (2021), relationships among the studied variables were interpreted as statistically significant at the 5% confidence level when the T-statistic surpassed 1.65 and the P-value was below 0.05. The data were analyzed using SmartPLS software. The results were interpreted to evaluate the contribution of each independent variable in terms of statistical significance in influencing customer loyalty and to test the proposed research hypotheses.

4.6 Variable and Indicator

Table 1 . Variable (V) & Indicator (I)

V	Definition	I	Reference
X_1 *Green Logistic*	A logistics management approach that emphasizes the reduction of negative environmental impacts through the planning, implementation, and control of efficient and environmentally friendly flows of goods and information.	Environmentally friendly vehicles,Emission reduction,Eco-friendly packaging, Reverse logistics, Employee awareness and training.	(Hanifah & Surachman, 2023; Yuen et al., 2023)
X_2 *Last-Mile Delivery Reliability*	The ability of courier service offers to consistently and punctually fulfill delivery promises at the final stage of the distribution chain.	On-time delivery performance, Good condition of goods upon receipt by customers, Accuracy of the delivery time estimates communicated to customers, Clarity of tracking information, The service provider's ability to communicate responsively with customers.	(Restuputri et al., 2021; Ejdys & Gulc, 2020).
Y **Customer Loyalty**	A strong commitment to continue using the service in the future, even in the presence of certain factors or marketing efforts that may encourage customers to switch. Loyalty encompasses behavioral intentions such as repeat usage, the tendency to recommend the service to others, and a strong preference for a particular brand or service provider.	The intention to repeatedly use PT Pos Indonesia's services, The tendency to recommend PT Pos Indonesia's services to others, Overall satisfaction that encourages repeat usage, Commitment to continue using the services despite the availability of alternative providers, Willingness to provide testimonials or positive reviews about the services.	(Sulistiowati et al., 2025; Fadli et al., 2024).

5. RESULTS AND DISCUSSION

5.1 Respondent Characteristics

Table 2. Demographics

Category	Criteria	F	%
Gender	Male	34	48,6%
	Female	36	51,4%
Age	< 20 years old	3	4,6%
	21–30 years	24	34,3%
	31–40 years	33	47,1%
	> 40 years old	10	14,3%
Educational background	Senior High School	10	14,3%
	Diploma holders (D3)	16	22,9%

	Bachelor Degree (S1/D4)	40	57,1%
	Master Degree (S2)	4	5,7 %
Have you used Pos Indonesia services in the last 6 months?	Yes	68	97,1%
	No	2	2,9%

Reference: Abad, 2025

This study involved a total of 70 respondents. The demographic characteristics of the respondents indicate an almost equal gender distribution, with 34 male respondents (48.6%) and 36 female respondents (51.4%). Most respondents were classified as being in the productive age bracket of 21–40 years (81.4%). Specifically, 4.6% were under 20 years old, 34.3% were aged 21–30 years, 47.1% were aged 31–40 years, and 14.3% were over 40 years old. Most respondents had attained a bachelor's level of education (S1/D4), accounting for 57.1%, followed by diploma holders (D3) at 22.9%, senior high school graduates at 14.3%, and master's degree holders (S2) at 5.7%. Regarding service usage, 97.1% of respondents had used Pos Indonesia's courier services within the last six months, while only 2.9% had not.

These characteristics indicate that the respondents possessed relevant experience and sufficient educational background to provide informed assessments of the implementation of green logistics performance and the reliability of last-mile delivery services at PT Pos Indonesia (Persero). Respondents within productive age groups and with higher educational attainment may demonstrate more critical evaluations of service quality and sustainability practices, thereby enhancing the credibility of the data collected.

5.2 Outer Structural Model Results (Measurement Model Evaluation) Validity and Reliability of Measurement Mode (Outer Model)

As reflected in the outer model analysis results in Table 3, all indicators for the research variables, namely Green Logistics (GL), Last-Mile Delivery Reliability (LMD), and Customer Loyalty (CL), satisfied the criteria for convergent validity. The results indicate that all factor loading values surpassed the 0.70 criterion, while AVE values for all constructs exceeded 0.50. These results indicate that the measurement model is valid and that each indicator significantly contributes to representing its respective construct.

The evaluation of discriminant validity utilized the Fornell–Larcker criterion (Table 4). The analysis shows that the square root of the AVE for each construct surpassed the correlations with other constructs, establishing that the constructs are distinct from one another. In addition to validity, the reliability of the measurement model was also confirmed. Composite reliability and Cronbach's alpha values for all constructs exceeded the 0.70 threshold, indicating strong internal consistency and reliable measurement.

Table. 3 Validity and Reliability of research variables

Vabl	Indt	FLo	Cr_α	Cops_Re	A-VE
***Green Logistics* (GL)**			0,862	0,874	0,646
GL1	Environmentally friendly vehicles,	0,703			
GL2	Emission reduction,	0,855			
GL3	Eco-friendly packaging,	0,844			
GL4	Reverse logistics	0,856			
GL5	Employee awareness and training.	0,745			

Last-Mile Delivery (LMD)			0,925	0,928	0,769
LMD1	On-time delivery performance,	0,868			
LMD2	Good condition of goods upon receipt by customers,	0,888			
LMD3	Accuracy of the delivery time estimates communicated to customers,	0,885			
LMD4	Clarity of tracking information,	0,908			
LMD5	The service provider's ability to communicate responsively with customers.	0,835			
Customers Loyality (CL)			0,899	0,905	0,712
CL1	The intention to repeatedly use PT Pos Indonesia's services,	0,828			
CL2	The tendency to recommend PT Pos Indonesia's services to others,	0,837			
CL3	Overall satisfaction that encourages repeat usage,	0,842			
CL4	Commitment to continue using the services despite the availability of alternative providers,	0,896			
CL5	Willingness to provide testimonials or positive reviews about the services.	0,812			

Tabel 4. Fornell-Larcker Criterion (Discriminant Validity)

	GL	LK	LMD
GL	0,900		
CL	0,422	0,912	
LMD	0,188	0,923	0,914

Reference: Abad, 2025

5.3 Inner Structural Model Results (Structural Model Evaluation/Inner Model)

The structural model was analyzed using three key parameters: the coefficient of determination (R-squared), T-statistics, and P-values. These parameters are essential for assessing the explanatory power and significance of linkages between latent constricts in the proposed model. Based on the information presented in Table 5, the obtained R-squared value exceeds 0.5, indicating that the model demonstrates a reasonably strong ability to explain the variance of the dependent variable. In this context, the independent variables, namely Green Logistics (GL) and Last-Mile Delivery reliability (LMD), are shown to have a significant influence on the dependent variable, Customer Loyalty (CL). The analysis results (Table 5) indicate that the R-squared value for Customer Loyalty is 0.753, meaning that 75.3% of the variability in Customer Loyalty can be jointly explained by Green Logistics and Last-Mile Delivery reliability. Therefore, these findings provide empirical support that the proposed model structure is consistent with theoretical expectations and is capable of offering a representative depiction of the dynamics of the relationships among variables in this study.

Table. 5 *R-Square (Determinant Coefficient)*

|	R. Sq	R. Sq A
Customer Loyality	0,753	0,746

R_Sq = R Square; R_Sq_A = R Square Adjusted.　　Reference: Abad, 2025

Table. 6 Kesimpulan Hypothesis Testing Untuk Semua Hipotesis

Hypothesis	β	O	SDD	T_Sta	P_Va	Hy_TC
Hyp1: GL ⟶ CL	0,209	0,211	0,100	2,084	0,037	ALccelpteld
Hyp1: LMD ⟶ CL	0,717	0,709	0,086	8,306	0,000	ALccelpteld

Hyp = Hypothesis; β = Path Coefficients; O = Original Sample; SDD = Standard Deviation;
T_Sta = T Statistics; P_Va = P Value; Hy_TC = Hypothesis Testing Conclusion.
Reference: Abad, 2025

The relationships among variables were examined for statistical significance at the 95% confidence level, using a t-statistic cutoff of 1.65 and a p-value threshold of 0.05. According to the analysis findings presented in Table 6, all research hypotheses demonstrate statistically significant validity. These findings confirm the existence of a significant and positive direct relationship among the examined variables. Accordingly, Hypothesis 1 and Hypothesis 2 are accepted and supported by the empirical data.
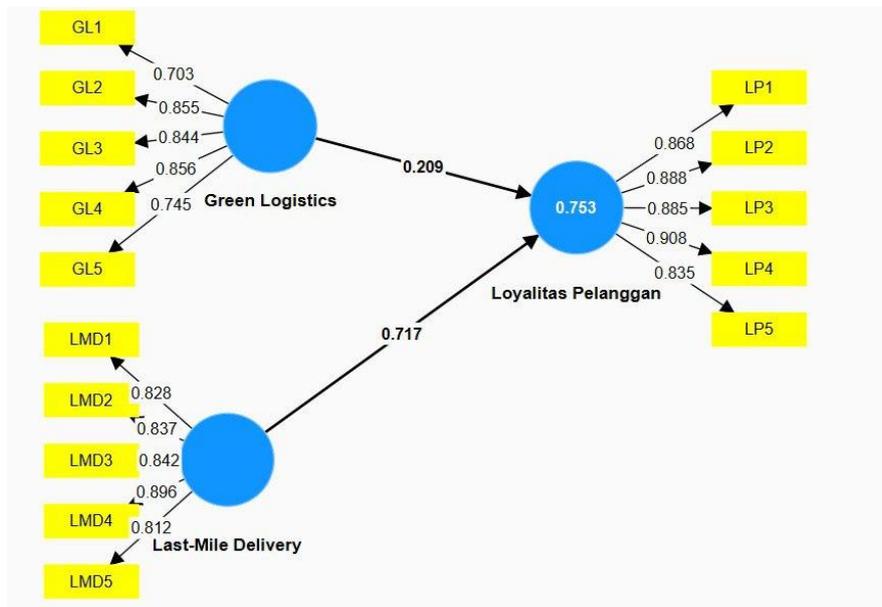
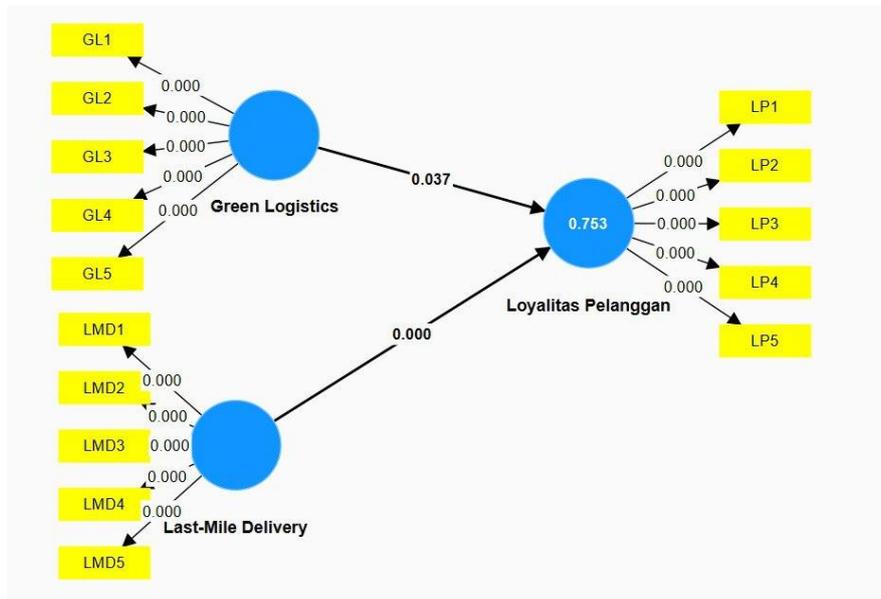**Figure 2**. PLS Algorithm Calculation. Reference: Abad, 2025

Figure 3. Bootstapping Calculation.   Reference: Abad, 2025

Figures 2 and 3 present a summary of the results of the calculate algorithm and bootstrapping analyses conducted using the PLS-SEM method. These visualizations illustrate the structure of relationships among latent constructs in the model, along with information on factor loading values and p-values for each indicator employed. Based on the model, it is evident that Green Logistics (GL) and Last-Mile Delivery reliability (LMD) have direct effects on Customer Loyalty (CL). These effects are reflected in path coefficients of 0.209 (p = 0.037) for GL and 0.717 (p = 0.000) for LMD, both of which indicate statistical significance as the observed p-values are considerably lower than 0.05. In addition, the R-squared value of 0.753 clearly indicates that 75.3% of the variance in Customer Loyalty can be explained by these two variables. Taken together, the results show that the measurement instruments incorporated in this research meet the criteria for reliability and validity, and that the resulting model provides a robust understanding of the important roles of Green Logistics and Last-Mile Delivery reliability in enhancing Customer Loyalty.

5.4 Discussion

The results demonstrate that both green logistics and last-mile delivery reliability have statistically significant and positive effects on customer loyalty. Individually, green logistics exerts a positive influence with a path coefficient of 0.209 (P = 0.037), while last-mile delivery reliability has a more dominant contribution, reflected in a path coefficient of 0.717 (P = 0.000). Collectively, these variables explain 75.3% of the variance in customer loyalty (R^2 = 0.753), indicating a very strong predictive model within the context of Indonesia's courier service industry.

These results are in accordance matching the results documented by Fadli et al. (2024) and Yuen et al. (2023), which demonstrate that green logistics practices contribute to enhanced customer loyalty through improved perceptions of service quality and corporate social responsibility. The findings also align with the work of Ejdys and Gulc (2020) and Chen et al. (2022), who emphasize that reliability in last-mile delivery serves as an important factor influencing customer satisfaction and loyalty.

This study extends prior research by empirically validating the simultaneous effects of green logistics and last-mile delivery reliability within the Indonesian context, which has been scarcely examined in the local academic literature. The results indicate that customer loyalty

in the courier service industry is influenced not only by cost efficiency and delivery speed but also by broader values such as environmental sustainability and trust in service reliability.

Customers of PT Pos Indonesia (Persero) perceive the use of environmentally friendly vehicles, emission reduction initiatives, and efficient packaging management as indicators of the company's environmental responsibility, which positively shapes corporate image and customer perception (Zhang et al., 2022; Ali et al., 2024). Simultaneously, last-mile delivery reliability serves as a direct indicator of operational service quality, as reflected in accurate tracking information, responsive communication, and timely delivery (Chen et al., 2022). These factors collectively build customer trust, which ultimately leads to increased customer loyalty, as emphasized by Ejdys and Gulc (2020).

CONCLUSION

Overall, the findings derived from this research emphasize the essential role of a holistic approach in building customer loyalty within the courier service sector. The combination of sustainable innovation through green logistics and operational reliability in last-mile delivery has demonstrated its effectiveness as a strategic approach for establishing and maintaining customer loyalty. Amid growing environmental awareness and intense competition in the logistics service industry, companies such as PT Pos Indonesia (Persero) must balance these two aspects in order to remain relevant and competitively superior. This study paves the way for the development of a national logistics business model that is more sustainable, inclusive, and customer-oriented.

Practical Implications

These findings provide several important implications for the management of PT Pos Indonesia (Persero) and other logistics industry players. First, green logistics strategies need to be integrated comprehensively into the company's operational systems, rather than being treated merely as symbolic initiatives. Second, investment in tracking technologies and human resource training at the last-mile delivery stage is crucial to ensure service consistency and quality. Third, marketing and brand communication should emphasize sustainability and service reliability as key differentiating values in the increasingly competitive courier service industry.

Theoretical Implications

Future research is encouraged to expand the scope of respondents across different regions and user demographics, including those of private courier companies. Moreover, a mixed-methods research approach was utilized may be employed to explore qualitative dimensions of customer loyalty, such as emotional value and user experience. Incorporating mediating constructs, including customer satisfaction and perceived value, provides a deeper explanation of the mechanisms connecting green logistics and service reliability with customer loyalty.

REFERENCES

Ali, M., Zhang, X., & Lee, S. (2024). Green logistics practices and customer loyalty: Evidence from emerging markets. *Journal of Cleaner Production*, 426, 139–151. https://doi.org/10.1016/j.jclepro.2023.139151

Accenture. (2024). *Sustainable logistics 2024 outlook: Driving value through environmental performance*. Accenture Insights. Retrieved from https://www.accenture.com

Chen, J., Li, Y., & Sun, Y. (2022). Reliability in last-mile delivery: Impacts on consumer satisfaction. *Transportation Research Part E: Logistics and Transportation Review*, 164, 102785. https://doi.org/10.1016/j.tre.2022.102785

Choi, T. M., & Lee, H. L. (2023). Green logistics and circular supply chains: Emerging research trends. *International Journal of Production Economics*, 257, 108760. https://doi.org/10.1016/j.ijpe.2023.108760

Dablanc, L., Beziat, A., & Giuliano, G. (2020). Last-mile delivery innovations and their impacts on urban logistics. *Transportation Research Procedia*, 46, 3–10. https://doi.org/10.1016/j.trpro.2020.03.002

Huang, Y., Wang, J., & Liu, Q. (2021). Drivers of green logistics adoption: A systematic literature review. *Sustainable Production and Consumption*, 28, 1299–1314. https://doi.org/10.1016/j.spc.2021.07.021

Mangiaracina, R., Perego, A., Salvadori, G., & Tumino, A. (2023). Customer experience in last-mile delivery: New challenges in the e-commerce era. *Supply Chain Management Review*, 29(2), 17–25.

McKinsey & Company. (2023). *Reimagining last-mile delivery for sustainable growth in ASEAN*. Retrieved from https://www.mckinsey.com

UNCTAD. (2023). *E-commerce and development report 2023*. United Nations Conference on Trade and Development. Retrieved from https://unctad.org

UN ESCAP. (2024). *Sustainable transport and logistics in Asia-Pacific: Policy report 2024*. United Nations Economic and Social Commission for Asia and the Pacific. Retrieved from https://www.unescap.org

World Bank. (2022). *Indonesia logistics performance index and challenges*. World Bank Group. Retrieved from https://www.worldbank.org

Zhang, M., He, Y., & Wang, Y. (2022). The impact of green supply chain management on customer loyalty: The mediating role of perceived value. *Journal of Business Research*, 144, 123–134. https://doi.org/10.1016/j.jbusres.2022.01.021

Fadli, M., Rahman Roni, S., Thabah, A., & Alfaridi, N. (2024). The influence of green logistics and service quality on customer satisfaction and loyalty at PT JNE. *Advances in Transportation and Logistics Research*.

Yuen, K. F., Lee, G., Wong, Y. D., & Ma, F. (2023). Managing sustainable practices and logistics value to improve customer loyalty: Importers vs. freight forwarders. *WMU Journal of Maritime Affairs*, 22, 345–363.

Restuputri, D., Masudin, A., & Sari, R. (2021). Customer perception on last-mile delivery services using Kansei engineering and conjoint analysis. *Logistics*, 6(2), 29.

Ejdys, J., & Gulc, A. (2020). Trust in courier services and its antecedents as a determinant of perceived service quality and future intention to use courier service. *Sustainability*, 12(21), 9088.

Purnomo, A., Syafrianita, Rahayu, M., Rohyana, C., Lestiania, M.E., Supardi, E., & Yanto, R.T.Y. (2024). Leveraging green innovation and green ambidexterity for green competitive advantage: The mediating role of green resilient supply chain. (2024). *Uncertain Supply Chain Management, 12*(4). 2683–2698.

Zebadiah, D. C., Mulyati, E., & Purnomo A. (2023). Pengaruh Electronic Word Of Mouth Dan Brand Image Terhadap Minat Beli Melalui Fitur Tiktok Shop Di Pt. XYZ". (2023). *Jurnal Cahaya Mandalika*, *4*(3), 1348-1360. https://doi.org/10.36312/jcm.v4i3.2118

Purnomo, A, 2013. "Performance Analysis of Green Supply Chain Management in PT Tirta Investama Subang". International Seminar on Industrial Engineering and Management (ISIEM The 6th), Haris Hotel, Batam, February 12–14, 2013, ISSN : 1978-774X.