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The Effect of E-Seal Implementation and Logistics Tracking Functions on Intermodal Movement in Increasing Goods Delivery Security in Logistics Company

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Abstract: In the dynamic landscape of global logistics, enhancing both efficiency and security in shipping processes is paramount. This paper explores the implementation of electronic seals (e-seals) within a logistics company, emphasizing their impact on operational performance and security measures. E-seals, equipped with advanced RFID technology, offer real-time tracking and tamper-evident features, significantly reducing the risk of cargo theft and unauthorized access. By integrating e-seals into the existing logistics framework, the company can streamline shipment monitoring, ensuring precise and timely delivery while minimizing human error and administrative overhead. This study presents a comprehensive quantitative analysis of the e-seal process, highlighting the technological, operational, and security benefits realized. Additionally, it examines the challenges encountered during implementation and provides strategic recommendations for optimizing e-seal usage. The findings underscore the transformative potential of e-seals in reinforcing the integrity and efficiency of shipping processes, ultimately enhancing customer satisfaction and competitive advantage in the logistics industry.
Keywords: *E-Seal, Tracking, Intermodal, Efficiency, Security, Logistics*

1. Introductions

In the modern era, aspect of Smart Products in 4.0 is their nature of continuous source of data about themselves, the environment they are immersed in, and the (advanced) interaction with the user. The Smart Machine is able to self-organize to meet the production necessities as derived from the Smart Product and the production environment, realizing ad-hoc production networks with other machines (Aceto et al., 2019). The essence of Industry 4.0 is to empower the role of digitalization in manufacturing and supply chains, involving the integration of information from various sources and locations. The utilization of this digital information is used to drive both manufacturing and physical distribution (Raza et al., 2020). Supply management, warehouse management, stock management, demand management, and distribution are crucial components of a logistics system. These components significantly impact logistics strategies, such as altering the types of products delivered to customers to create an efficient logistics system (Humaira Ninvika et al., 2023).

The complexity of multimodal transportation, which involves the use of multiple modes of transportation, presents significant challenges in terms of management and monitoring (Xiao & Liu, 2018). In light of the sustained growth of global transportation, it is imperative for logistics companies to consider the implementation of technologies that can optimise these processes (Liu & Zhu, 2022). The management of multimodal transportation systems is inherently complex due to their hierarchical and interconnected nature. In this context, logistics tracking solutions have emerged as a potential solution, facilitating real-time monitoring of the position and status of shipments (Assiri et al., 2020). The use of these two technologies is expected to reduce the incidence of misdelivered goods and increase customer satisfaction.

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One of the main challenges faced by logistics companies is the high rate of loss and damage to goods during the shipping process. A report by (Zimmerman et al., 2024) from the Council of Supply Chain Management Professionals (CSCMP) shows that the loss of goods can result in large financial losses for companies. Therefore, it is crucial to understand how E-Seal can contribute to mitigating these issues through the provision of better security.

The Indonesian government has established the requirement for E-seal as a condition for the transfer of imported goods storage locations designated as TPS (Temporary Storage Area for Imported Goods) as of 2016. The obligation is an implementation of the Minister of Finance Regulation (PMK) No. 23/2015 concerning customs zone and temporary stockpiles and the Minister of Transportation Regulation No. 117/2015 (Ayum Adiyuna et al., 2024). An electronic security device, the Electronic Seal is installed on the container or packaging of goods to detect any unauthorized opening or manipulation attempts. This technology allows logistics companies to monitor container activity in real-time, provide notifications in case of tampering, and ensure that goods arrive at their destination intact.

2. Literature review

Implementation of Electronic Seal

The logistics industry has experience a transformative shift with the widespread implementation of electronic seals (e-seal), a technology that has profoundly impacted the security and traceability of intermodal freight movements. The term implementation as used by (Ridwan et al., 2024) refers to an action, mechanism of a system or activity that is planned and seriously carried out based on certain norms in order to achieve the objectives of the activity. In the context of policy implementation, implementing a system is to complete the approved system design, test and document the necessary system programs and procedures, ensure that the personnel involved that the conversation of the old system to the new system can run properly and correctly (Rifqo & Wijaya, 2017). In theory (Edwards, 1980), there are several indicators that are used as a reference in implementing policies. Policy implementation is influenced by four variables: communication, resources, disposition and bureaucratic structure.

Electronic seals have become a crucial technology for securing and tracking freight containers in the global supply chain (Shemaili et al., 2013). The use of electronic seals, or "e-seals," offers significant advantages over traditional mechanical seals. These include improved visibility into container movement and enhanced security against tampering or theft. According to (Scholliers et al., 2016), one of the primary benefits of e-seals is their ability to continuously monitor the status of containers, providing stakeholders with real-time visibility into the integrity of the shipment.

The implementation of electronic seal and advanced tracking technology has emerged as a critical aspect in enhancing the security and efficiency of intermodal logistics operations (Mccormack et al., 2010). The incorporation of state of the art tracking mechanism enable real-time monitoring of vehicle locations and movements, providing greater visibility and control over the entire logistics process.

In conclusion, the implementation of e-seals signifies a substantial advancement in the domain of logistics security and management. By integrating sophisticated tracking capabilities with augmented physical security measures, this technology addresses crucial challenges inherent to the contemporary supply chain, particularly within the context of intermodal freight transportation.

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Tracking Function

The practice of goods tracking has become a significant component of contemporary logistics and transportation management. According to (Wijaya et al., 2023a) , the technology can be classified into two main categories: passive tracking and active tracking. The process of goods tracking entails the reception of positional data obtained through the operation of tracking technology. The objective of this research project is the implementation of a tracking system with the intention of enhancing the customer experience and satisfaction (Fitra, 2023a).

As Saha and Zhao observe in (Eviani & Hidayat, 2021a), identified five key metrics that play an important role in evaluating the effectiveness of a vehicle tracking system: (1) Efficiency, the ease with which customers or users can access the website. (2) Reliability, the extent to which technical functions on a website provide accurate and up-to-date information. (3) Responsiveness, the capacity to respond to user issues pertaining to the retrieval of desired information and the provision of services in a prompt manner. (4) Fulfilment, the capability to fulfill services by delivering products within the specified timeframe. (5) Privacy, the ability to safeguard users' personal or confidential information from unauthorized disclosure. The five metrics of efficiency, reliability, responsiveness, fulfillment, and privacy collectively constitute a comprehensive framework for the evaluation and enhancement of the quality of vehicle tracking services.

This research offers significant insights into the key considerations that must be integrated into the development and implementation of an effective item tracking system. By understanding and optimizing these five metrics, companies can enhance the quality of their services, which will ultimately have a positive impact on customer satisfaction and operational efficiency.

Intermodal Movement

In the field of transportation logistics, the concept of intermodal transportation has increasingly come to the fore. Study case in (Gilang Prakasa, 2022), defines intermodal transportation as the movement of goods in a single vehicle utilizing multiple transportation modes without altering the handling of the goods. This definition highlights the significance of multimodal management and robust intermodal relationships for optimal goods handling.

As elucidated by (Gordon, 2012), the concept of intermodal transfer extends beyond the transportation of goods to encompass public transportation services. Gordon posits that an intermodal transfer represents a connection between disparate public transportation services, forming a vital component of a larger network.

According to (Wachid et al., 2006) the results show that there are two main groups of indicators that influence intermodal transport services. These groups of indicators can have the following definitions: (1) The group of stimulus indicators, which are measures of the actions or tasks necessary for users to obtain a particular service. Among the factors included in these indicators are the latency time and the cost of the platform. (2) The group of response indicators, these are indicators which are received by users as a result of the execution or application of the above stimulants. The indicators include safety, security, convenience and travel information.

The literature on intermodal transport collectively indicates that it serves a number of functions, with particular significance in the context of goods movement and public transport systems. This research highlights the significance of efficient intermodal transportation networks and identifies the key factors that influence the quality and effectiveness of intermodal services.

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Delivery Security

The concept of safety or security has its origin in the Latin word "sēurus", which signifies freedom from danger, fear, or threat. The term "national security" can be interpreted from two distinct perspectives. One such perspective is that of a region, which includes the following areas: external defense, internal security, public order, and disaster management. The other perspective is that of national security, which incorporates the following three categories: national security, community security, and personal security (Mardhani, 2020). According to (Hermawan, 2019), the security of electronic government systems includes ensuring the confidentiality, integrity, availability, authenticity and non-repudiation of resources related to data and information, electronic system infrastructure and electronic system applications. And the guarantee of non-repudiation referred to in Article 40(1) is implemented by applying digital signatures and trusted third party guarantees.

In the study by (Robin & Evyanto, 2023), several indicators were identified as influencing the security of goods delivery. The following section outlines these indicators and their associated factors: (1) Security guarantee, the potential exploitation of personal data and transactions can be reduced by providing security guarantees, thus alleviating consumer concerns regarding data confidentiality. When consumers are reassured that their personal data is secure, they are more likely to engage in e-commerce transactions. (2) Data Confidentiality, the unauthorized release of personal information can have severe consequences for the owner. It is therefore crucial to maintain the confidentiality of customer information. (3) Delivery receipt number as proof of purchase, upon receipt of the goods, the delivery service issues a receipt with a unique number. This number can be used by the shipper or seller as proof of identification for future shipments and to monitor the status of the shipment.

The research findings indicate the existence of similarities in the multifaceted nature of security, which encompasses concerns at the national level, as well as the specific challenges encountered in e-government systems and e-commerce transactions. The evolution of the security concept is a reflection of the changing threat landscape and the growing importance of digital protection in our increasingly interconnected world.

2.1 Conceptual Model and Research Hypotheses

Based on all the above references, this study examines the factors that contribute to the success of logistics systems, such as technological innovation, mode of transport, logistics infrastructure, information accuracy, and management, as shown in Figure 1: This study present a conceptual model.

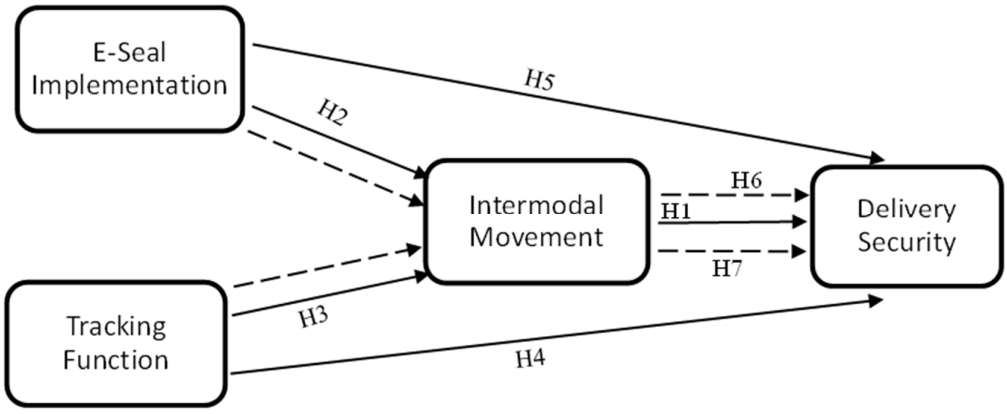

Figure 1 Conceptual Model of the Research

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Based on previous research on electronic seal systems, seven hypotheses are formulated.

Table 1 Research Hypothesis

NO		RESEARCH HYPOTHESIS
H_1	H_0	There is no significant impact of Intermodal Movement on Delivery Security
	H_1	There is a significant impact of Intermodal Movement on Delivery Security
H_2	H_0	There is no significant impact of E-Seal Implementation on Intermodal Movement
	H_1	There is a significant impact of E-Seal Implementation on Intermodal Movement
H_3	H_0	There is no significant impact of Tracking Function on Intermodal Movement
	H_1	There is a significant impact of Tracking Function on Intermodal Movement
H_4	H_0	There is no significant impact of Tracking Function on Delivery Security
	H_1	There is a significant impact of Tracking Function on Delivery Security
H_5	H_0	There is no significant impact of E-Seal Implementation on Delivery Security
	H_1	There is a significant impact of E-Seal Implementation on Delivery Security
H_6	H_0	There is no significant impact of E-Seal Implementation on Delivery Security in Intermodal Movement mediation
	H_1	There is a significant impact of E-Seal Implementation on Delivery Security in Intermodal Movement mediation
H_7	H_0	There is no significant impact of Tracking Function on Delivery Security in Intermodal Movement mediation
	H_1	There is a significant impact of Tracking Function on Delivery Security in Intermodal Movement mediation

Discussing hypotheses is essential it validates the theoretical framework, identifies significant relationships between variables, and informs practical implications for industry applications. This process also contributes to academic knowledge and ensures the overall rigor of the research.

Validation of Theoretical Framework
The hypotheses are derived from the theoretical framework underpinning the study. By testing these hypotheses, the research validates whether the theoretical concepts hold true in a practical, real-world context. This process helps confirm the reliability and applicability of the theoretical model within the logistics industry.

Understanding Key Relationships
Each hypothesis represents a specific relationship between variables (e.g., E-Seal Implementation, Tracking Function, Intermodal Movement, Delivery Security). Discussing these hypotheses allows for a detailed examination of how these factors influence each other. This understanding is crucial for identifying which aspects of logistics operations are most impactful and where improvements or interventions can be made.

Identifying Significant Effects
By testing and discussing the hypotheses, the research identifies which factors have statistically significant effects on outcomes like Delivery Security and Intermodal Movement. This helps prioritize the areas that logistics companies should focus on to achieve the greatest improvements in efficiency and security.

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Highlighting Areas for Further Research

The discussion of the hypotheses, especially when some are rejected (e.g., H6), highlights areas where the expected relationships were not observed. This opens up avenues for further research to explore why certain expected outcomes did not materialize, leading to a deeper understanding of the complexities within the logistics field.

Practical Implications for Industry

The results of hypothesis testing directly inform the practical recommendations provided to logistics companies. For instance, knowing that the Tracking Function has a strong positive effect on both Intermodal Movement and Delivery Security enables companies to make informed decisions about where to invest in technology and resources.

3. Research method

In this, a quantitative methodology was used. Quantitative research is a formal research step that involves collecting data through survey forms. This approach is based on using primary data to explain phenomena. Primary data is collected by providing questionnaires and parameters to logistics companies. Based on the study of (Loan, Vu, & Tuyen, 2023), which serves as a reference point for determining the expected sample size, the minimum sample size is five times the number of observed variables. This is the appropriate sample size for a study that employs Comrey factor analysis, where N = 5*m. In this case, m represents the number of questions in the survey. Consequently, the authors will conduct the survey using a number of questionnaires that exceeds 5 times m (votes). In this study, The Smart Partial Least Square Structural Equation (PLS-SEM) software version 4.0 was created and method was then used to test the data, as a result of the multivariate variable research. SEM is a technique that uses regression analysis (correlation analysis) and factor analysis, both of which are part of multivariate analysis. It examines relations between variables in a model, as well as the relationship between indicators and constructs. According, J.F. Hair et al., (2017) in the study (Kock & Hadaya, 2018), The most prevalent method for estimating the minimum sample size in PLS-SEM modeling is the "10-times rule," which is widely utilized in the field of Information Systems (IS) and other domains. The 10-times rule states that the sample size should be greater than 10 times the maximum number of inner or outer model links pointing at any latent variable in the model. Consequently, regardless of the strengths of the path coefficients, the minimum sample size estimation using the 10-times rule is 20.

This study used a census sampling method, also known as a saturated sample, to analyse The Effect of E-Seal Implementation and Logistics Tracking Functions on Intermodal Movement in Increasing Goods Delivery Security in Logistics Company in a population of 21 logistics companies. The census is used to count of all elements of the human population (Uma & Roger, 2013). According (Prof. Dr. Sugiyono, 2017), The definition of saturation sampling is a sampling method that is carried out when all members of the population can be used as research samples, this mechanism is carried out when the population is small, which is at least less than 30. The census sampling approach was selected for its capacity to facilitate a comprehensive examination of the research phenomenon, as it allows for the analysis of an entire population, rather than relying on a representative sample (Oribhabor & Anyanwu, 2019). Therefore, the sample in this study is representative of the population, comprising 21 logistics companies situated in a range of geographical locations.

Data collection was carried out by means of questionnaires distributed to representatives from 21 company with knowledge and authority in relation to e-seal implementation and logistics tracking functions, with a 100% response rate achieved. The questionnaire was structured using a 5-point Likert scale to measure the research variables.

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Score 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neutral (N), 4 = Agree (A), and 5 = Strongly Agree (SA). Respondents for this study were chosen from a group of individuals ranging in working period from 1 to more than 5 years, both genders, and last education. The questionnaire consisting of 10 questions for each variable to be studied, created using google form media. The questionnaire's data was collected from July until August, 2024.

4. Result and discussion

4.1. Characteristics of Respondents

In order to obtain an overview of the characteristics of the respondents studied, the processing of the data was carried out through the statistical calculations of SmartPLS 3.0. Before the author details the findings related to this research, it is better to first look at the general description and characteristics of the respondents. In addition, it can be used to add information that will help clarify the characteristics of the respondents and explain the background of the respondent's situation. Company scale refers to the size or size of a company, which is usually classified based on a number of certain criteria such as the number of employees, turnover or revenue, assets, and operational area. The level of scale of logistics companies that are sampled in this study can be seen in the following table:

Table 2 Logistics Company Level of Scale

Company Scale Classification	Frequency (Companies)	Percentage %
<5000	1	5%
1000-5000	1	5%
201-500	10	48%
501-1000	3	14%
51-200	6	29%
Total	21	100%

Source: Processed Data, 2024

The table above shows that the scale classification of logistics companies in this study is mostly in the range of 201-500 employees, totaling 10 companies with a percentage of 48%. Companies with a scale of 51-200 employees amounted to 6 companies with a percentage of 29%. Furthermore, companies with a scale of 501-1000 employees amounted to 3 companies with a percentage of 14%. The companies with a scale of less than 5000 employees and 1000-5000 each amounted to 1 company with a percentage of 5%. Based on the results of the above recapitulation, the companies involved in this study are dominated by the scale of companies with a range of 201-500 employees.

4.2. Reliability and Validity Test

The validity test is a method used to show the extent of the measuring instrument used in a study. In other words, the validity test is used to determine whether or not a questionnaire is valid or not. The questionnaire is considered valid if each question item can reveal what the questionnaire is trying to measure. The validity of the measurement model with reflective indicators can be seen from the cross-loading value between measures and constructs. If the correlation between the measures and constructs is greater than the correlation with other constructs, it indicates that the latent constructs are better measured in their block than in other blocks (Ghozali, 2021). Based on (J. Hair et al., 2021) an indicator loadings above 0.708 are recommended because the construct explains more than 50% or 0.5 of indicator variance, indicating that the indicator has item reliability.

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The result of reliability and validity test that are path coefficient in this study can be seen in the following figure:

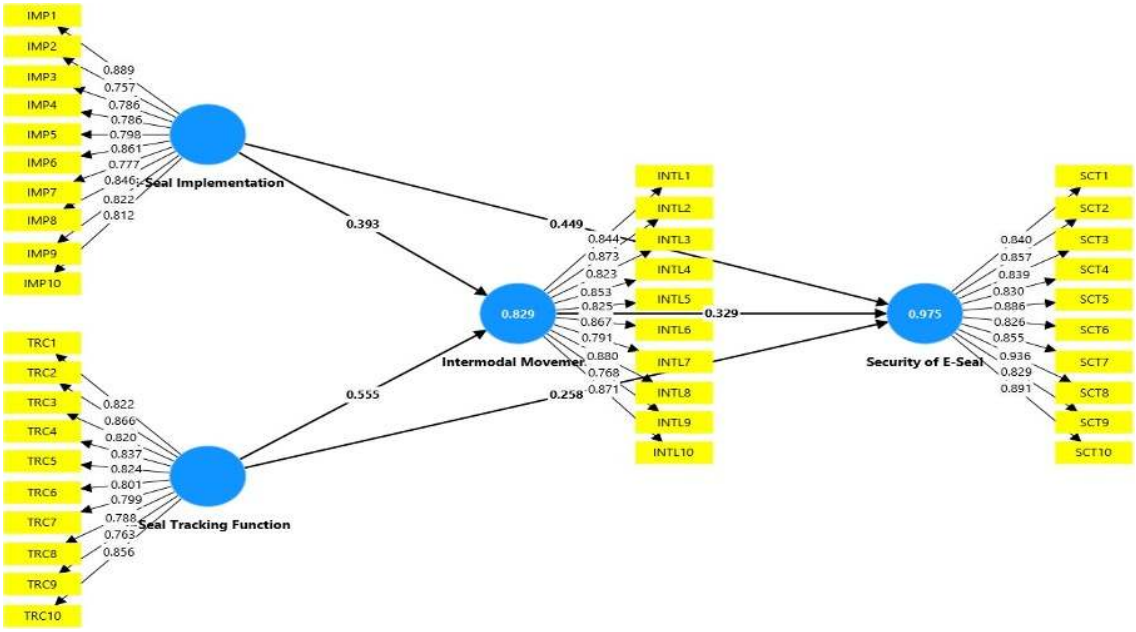

Figure 2 Result of Reliability, Validity Test and Path Coefficient

Figure 2 above shows that the reliability value of 0.70 and 0.80 means that it has completed the reliability assumption. Reliability is a method of evaluating a questionnaire as an indicator of a particular variable or construct (Ghozali & Latan, 2015). Variables are considered reliable if individual responses to statements in them are consistent or stable over time. Smart PLS 3.0 provides a tool to measure reliability through the Cronbach Alpha statistical test.

Table 3 Reliability and Validity the Measurement Model's

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)	Result
E-Seal Implementation	0,943	0,946	0,952	0,663	Fulfilled
E-Seal Tracking Function	0,945	0,948	0,953	0,669	Fulfilled
Intermodal Movement	0,953	0,956	0,960	0,706	Fulfilled
Delivery Security	0,960	0,961	0,966	0,739	Fulfilled

Source: SEM-PLS Data, 2024

From the table above, the composite reliability value > 0.70 means that it has met the reliability assumption. The validity test is accepted with the evaluation of AVE > 0.50 and the questionnaire is considered reliable if it has an Alpha-Cronbach coefficient > 0.60. The conclusion of the composite reliability test is as follows:

a. The E-Seal Implementation (X1) variable is reliable because the α values E-Seal Implementation (X1) value is 0.943 > 0.60
b. The variable E-Seal Tracking Function (X2) is reliable because the value of the α values E-Seal Tracking Function (X2) is 0.945 > 0.60

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c. The Intermodal Movement (Z) variable is reliable because the α values Intermodal Movement (Z) value is 0.953 > 0.60
d. The variable Delivery Security (Y) is reliable because the value of the α values Security of E-Seal (Y) is 0.960 > 0.60

4.3. Statistical Significant and Relevance of the Indicators Weights

According to (J. Hair et al., 2021), the metric used in this measurement is the evaluation of the statistical significance of the hypothesis test results with standard T-values greater than 2.576 (=0.01) or greater than 1.960 (=0.05). In this study, the statistical test for each hypothesized relationship was performed using the bootstrapping method on samples for which the significance of the hypothesis test was evaluated using standard T-values greater than 1.960. The following are the results of this research hypothesis test:

Table 4 Result of Hypothesis Test

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
E-Seal Implementation -> Intermodal Movement	0,393	0,425	0,143	2,747	0,007
E-Seal Implementation -> Delivery Security	0,449	0,447	0,111	4,041	0,000
E-Seal Tracking Function -> Intermodal Movement	0,555	0,532	0,133	4,186	0,000
E-Seal Tracking Function -> Delivery Security	0,258	0,280	0,107	2,406	0,018
Intermodal Movement -> Delivery Security	0,329	0,316	0,116	2,825	0,006
E-Seal Implementation -> Intermodal Movement -> Delivery Security	0,129	0,135	0,073	1,773	0,079
E-Seal Tracking Function -> Intermodal Movement -> Delivery Security	0,183	0,168	0,076	2,406	0,018

Source: SEM-PLS Data, 2024

Table 5 Conclusion of Result and Interpretation

	Conclusion of Result and Interpretation
H_1	Because p-value = 0.006 < α = 0.05 and T statistic 2.825 > 1.960. The researchers accept the one hypothesis. So, this value means that there is a significant relationship between Intermodal Movement and Delivery Security.
H_2	Because p-value = 0.007 < α = 0.05 and T statistic 2.747 > 1.960. The researchers accept the one hypothesis. So, this value means that there is a significant relationship between E-Seal Implementation and Intermodal Movement.
H_3	Because p-value = 0.000 < α = 0.05 and T statistic 4,186 > 1.960. The researchers accept the one hypothesis. So, this value means that there is a significant relationship between E-Seal Tracking Function and Intermodal Movement.
H_4	Because p-value = 0.018 < α = 0.05 and T statistic 2,406 > 1.960. The researchers accept the one hypothesis. So, this value means that there is a significant relationship between E-Seal Tracking Function and Delivery Security.

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H_5	Because p-value = 0.000 < α = 0.05 and T statistic 4,041 > 1.960. The researchers accept the one hypothesis. So, this value means that there is a significant relationship between E-Seal Implementation and Delivery Security.
H_6	Because p-value = 0.079 > α = 0.05 and T statistic 1,773 < 1.960. The researchers accept the null hypothesis. So, this value means that there is no significant impact of E-Seal Implementation on Delivery Security in Intermodal Movement mediation
H_7	Because p-value = 0.018 < α = 0.05 and T statistic 2,406 > 1.960. The researchers accept the one hypothesis. So, this value means that there is a significant impact of Tracking Function on Delivery Security in Intermodal Movement mediation

Source: SEM-PLS Data, 2024

4.4. Discussion of Research Result

The Effect of Intermodal Movement on Delivery Security at Logistics Company

The results show that Intermodal Movement has a positive effect on Delivery Security in the use of e-seal for container seals, H_1 is accepted, this is in accordance with the assessment of the significance and relevance of the structural model relationship (J. Hair et al., 2021). These results indicate that the higher the intermodal movement using e-seal, the higher the delivery security in logistics company.

The analysis of the intermodal transportation supply chain system, especially the internal and external challenges that the intermodal system faces, focused on the specific issues that intermodal transportation poses to SC security and the policies that the US adopted to improve the security of the US intermodal system (Szyliowicz, 2022).

The Effect of E-seal Implementation on Intermodal Movement at Logistics Company

The results show that E-seal Implementation has a positive effect on Intermodal Movement in the use of e-seal for container seals, H_2 is accepted, this is in accordance with the assessment of the significance and relevance of the structural model relationship (J. Hair et al., 2021). These results indicate that the higher the e-seal implementation for the container, the higher the intermodal movement in logistics company.

Study discusses the implementation of e-seal as a unique form of electronic signature based on a cryptographic system to secure data transmission in intermodal movement. Increased data transmission security, faster document processing, cost and time savings, regulatory compliance, and increased transparency through real-time tracking are the potential impacts of implementing e-seal (Le et al., 2023a).

The Effect of Tracking Function on Intermodal Movement at Logistics Company

The results show that Tracking Function has a positive effect on Intermodal Movement in the use of e-seal for container seals, H_3 is accepted, this is in accordance with the assessment of the significance and relevance of the structural model relationship (J. Hair et al., 2021). These results indicate that the higher the tracking function for the container location, the higher the intermodal movement in logistics company.

Technology-focused company providing modular LoT systems to optimize, manage and monitor container movements along port-based intermodal corridors. The company tends to automate rail access and vessel scheduling, and is open to the integration of new applications that may be developed by port authorities, shippers, or other stakeholders in the intermodal chain (Muñuzuri et al., 2020).

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The Influence of E-seal Implementation on Delivery Security at Logistics Company

The results show that E-seal Implementation has a positive effect on Delivery Security in the use of e-seal for container seals, H_4 is accepted, this is in accordance with the assessment of the significance and relevance of the structural model relationship (J. Hair et al., 2021). These results indicate that the higher the e-seal Implementation for the container, the higher the delivery security in logistics company.

The integration of Industry 4.0 technologies with RFID has the potential to enhance business value through operational excellence. To achieve this, RFID technology implementation in the supply chain must consider the specific needs of the business, the technological infrastructure available, and the industrial strategies in place (Unhelkar et al., 2022).

The Influence of Tracking Function on Delivery Security at Logistics Company

The results show that Tracking Function has a positive effect on Delivery Security in the use of e-seal for container seals, H_5 is accepted, this is in accordance with the assessment of the significance and relevance of the structural model relationship (J. Hair et al., 2021). These results indicate that the higher the tracking function for the container location, the higher the delivery security in logistics company.

A logistics service model for real-time tracking based on RFID and sensors was proposed as a means of improving and monitoring the maritime industry, ensuring efficient service, reliable inventory, and production operations. An investigation was conducted on a machine-to-machine basis into electronic security devices for freight containers, as proposed by the US Department of Homeland Security (M'hand et al., 2019a).

The effect of E-seal implementation on Delivery Security mediated by intermodal Movement at Logistics Company

The results show that E-seal implementation, mediated by Intermodal Movement, has a direct negative effect on Delivery Security, H_6 is rejected, this is in accordance with the assessment of the significance and relevance of the structural model relationship (J. Hair et al., 2021). Further analysis is required to determine whether there is a mediating effect of Intermodal Movement on the relationship between e-seal implementation and delivery security.

The effect of Tracking Function on Delivery Security mediated by intermodal Movement at Logistics Company

The results show that Tracking Function, mediated by Intermodal Movement, has a direct positive effect on Delivery Security, H_7 is accepted, this is in accordance with the assessment of the significance and relevance of the structural model relationship (J. Hair et al., 2021). The results are consistent with, Tracking Function has a direct positive effect on Delivery Security, and Intermodal Movement has a direct significant effect, then Tracking Function on Delivery Security has an effect on logistics companies both mediated by Intermodal Movement.

Most and Least Influential on Delivery Security in Logistics Company

Based on the hypotheses testing results, the Tracking Function has the most significant influence on both Intermodal Movement and Delivery Security. This is evident from the highest T-Statistic value of 4.186 for the effect of Tracking Function on Intermodal Movement, and a strong effect on Delivery Security with T-Statistic value of 4.041. These findings suggest that enhancing the Tracking Function, which includes real-time monitoring of container locations, significantly improves both the movement of goods across different transportation

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modes and the overall security of deliveries. This aligns with the technology-focused approach to optimizing containers movements and ensuring efficient service in logistics companies.

On the other hand, the mediating effect of Intermodal Movement on the relationship between e-seal implementation and delivery security to be the least influential. The hypothesis H_6 was rejected, as the results showed that the e-seal implementation mediated by intermodal movement has a direct negative effect on delivery security, with a T-Statistics value of 1.773 and P-Value of 0.079. this indicates that contrary to expectations, the intermodal movement does not enhance the relationship between e-seal implementatiom and delivery security, highlightinga potential area for further research and analysis.

In conclusion, tracking function stands out as the most influential factor in improving both intermodal movement and delivery security within logistics companies, whereas the mediating role of intermodal movement between e-seal implementation and delivery security is the least impactful and even counterproductive in this context.

5. Conclusion

The success of an electronic seal system depends on its quality, which determines the security of deliveries in the logistics industry. Easy-to-use, accurate and secure seals with innovative features such as real-time location and asset tracking and efficient logistics management contribute to the quality of electronic seals. Easy-to-apply and secure seals are essential for user retention, and stakeholder support is a key factor in securing delivery during intermodal movements. A good security system is likely to maintain customer confidence, as seal quality, tracking and intermodality affect the security of delivery. A study on the use of e-seals by logistics companies found that respondents highly valued the intermodal movement tracking function of using e-seals, which has a positive impact on the security of logistics shipments. However, the indirect hypotheses test shows that the implementation of e-seal in intermodal security is not considered good because it lacks flexibility, requires further analysis, and depends on user experience.

H1, Intermodal movement has a significant impact on delivery security. H2, E-seal implementation has a significant impact on intermodal movement. H3, Tracking function has a significant impact on intermodal movement. H4, Tracking function has a significant influence on delivery security. H5, E-seal implementation has a significant influence on security of delivery. H6, E-seal implementation does not have a direct significant effect on delivery security mediated by intermodal movement. H7, Tracking functionality has a direct significant effect on delivery security mediated by intermodal movement. To maintain and improve delivery security with e-seal, providers should focus on providing a good user experience and increasing their users' trust.

6. Implications

Based on the result, it shows that the implementation of e-seal and tracking function affects the security of shipments in logistics companies, including increasing the efficiency and security in supply chain management. The implementation of e-seal technology in logistics enhances security by reducing the risk of tampering and loss during transit. The combination of e-seals with blockchain improves data integrity and transparency, offering real-time tracking and better supply chain control. This leads to increased efficiency and security, thereby boosting customer confidence and trust in logistics service (Le et al., 2023a).

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Based on the research findings, several practical implications can be drawn for logistics companies to enhance their operations and security measures effectively:

Enhanced Security Protocols through E-Seal Implementation
E-Seal technology improves shipment security by detecting unauthorized access, reducing risks like theft, and enhancing brand reputation (M'hand et al., 2019b; Robin & Evyanto, 2023b).

Optimization of Intermodal Movement
E-Seals and tracking systems improve efficiency between transport modes, reduce costs, and expedite deliveries (Gilang Prakasa, 2022b; Wachid et al., 2006b).

Real-time Tracking for Enhanced Transparency and Customer Satisfaction
Implementing advanced tracking enhances transparency, customer satisfaction, and loyalty (Eviani & Hidayat, 2021b; Fitra, 2023b; Wijaya et al., 2023b).

Data-Driven Decision Making
E-Seal and tracking data enable companies to optimize operations, reduce costs, and manage risks proactively (Le et al., 2023b).

7. Research limitations

This research also has limitations, such as the high cost of implementation for this new technology and the need for adequate support infrastructure. Additionally, the success of the system is highly dependent on the training and readiness of human resources to operate the technology. The effectiveness of this system when integrated into a larger network may also be hampered by the lack of standardization of technology and procedures among logistics companies. As a result, further research is needed to develop a more economical and effective solution that can be implemented by a variety of stakeholders in the logistics industry.

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