

Logistics Technology Innovation and Operational Efficiency : Assesing Cost of Goods Sold (COGS) in Reduction in Medium- Sized Manufacturing Firms.

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ABSTRACT

This study aims to analyze the effect of logistics technology (logtech) management innovations on the reduction of Cost of Goods Sold (COGS) in medium-sized manufacturing firms. The study employs a quantitative approach using a survey method involving 30 respondents selected through purposive sampling. Data were analyzed using the Partial Least Squares – Structural Equation Modeling (PLS-SEM) method with the assistance of SmartPLS. The results indicate that logtech has a significant negative effect on COGS, with a coefficient of -0.73, a t-statistic of 6.21, and a p-value < 0.05. The coefficient of determination (R^2) of 0.61 indicates that the logtech variable explains 61% of the variation in COGS reduction. These findings suggest that increased adoption of logistics technologies, such as Warehouse Management Systems (WMS), Transportation Management Systems (TMS), and the Internet of Things (IoT), contributes to improved supply chain efficiency and reduced production costs. This study offers a theoretical contribution to the development of operations management literature as well as practical implications for companies in designing logistics digitization strategies to enhance cost efficiency and competitiveness.

Keywords: Logitech; COGS; Cost Efficiency, Manufacturing; PLS-SEM



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1. Introduction

Advances in digital technology have driven fundamental changes in corporate operational systems, particularly in the manufacturing sector. Digitalization not only transforms production processes but also impacts logistics systems and the supply chain as a whole [1]. In this context, cost efficiency has become one of the key indicators of successful technology implementation, as companies are required to generate optimal output at minimal cost.

One of the largest cost components in a manufacturing company is the Cost of Goods Sold (COGS), which includes the costs of raw materials, direct labor, and production overhead [2]. High COGS can reduce a company's profitability and competitiveness, particularly for medium-sized companies that typically face constraints in terms of capital, technology, and human resources. Therefore, controlling and optimizing COGS is a strategic priority in the company's operational management.

In the national context, the challenge of cost efficiency becomes increasingly apparent when considering the high logistics costs in Indonesia. According to data from the Central Statistics Agency, national logistics costs are a key indicator reflecting the efficiency of the distribution system and supply chain within the economy. Indonesia's logistics cost-to-Gross Domestic Product (GDP) ratio remains relatively high, at approximately 14.29% in 2022, and could even exceed 20% when export logistics components are included. This figure is significantly higher than that of developed nations, which typically range between 7–8%, indicating structural inefficiencies within the national logistics system.

In addition, logistics costs account for approximately 14.1% of the price of goods in Indonesia's domestic market, indicating that logistics play a significant role in product pricing. This situation directly contributes to the high cost of goods sold (COGS) borne by manufacturing companies. In other words, logistics inefficiencies not only impact distribution but also affect the overall production cost structure.

Data from the Central Statistics Agency also shows that the manufacturing sector is one of the main contributors to the national economy, with a cost structure that includes input costs, energy, labor, and logistics distribution. This underscores that



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efficiency in the supply chain, particularly in the logistics aspect, is a key factor in improving the performance of the manufacturing industry.

In practice, one of the main contributors to high COGS is inefficiency in logistics systems, such as distribution delays, waste in inventory management, and a lack of information integration within the supply chain. These issues often lead to increased storage and transportation costs, as well as product loss. Therefore, technology-based innovations are needed to improve the overall efficiency of logistics systems.

Innovation in logistics technology (logtech) serves as a strategic solution to address these challenges. Logtech encompasses the integration of technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Warehouse Management Systems (WMS), and Transportation Management Systems (TMS) into logistics operations [9]. These technologies enable companies to improve real-time supply chain visibility, optimize decision-making, and reduce waste in operational processes.

In addition, the implementation of logtech also plays a role in improving the accuracy of demand forecasting, enabling companies to avoid overstocking and stockouts, which can lead to increased operational costs. Thus, logtech serves not only as an operational tool but also as a strategic instrument for enhancing the efficiency and competitiveness of manufacturing companies.

Previous research indicates that logistics digitization has a positive impact on operational efficiency and the reduction of distribution costs [3]. Furthermore, the integration of technology into the supply chain can also enhance operational resilience and flexibility in the face of market uncertainty [4]. Other studies also confirm that the adoption of digital technology in logistics contributes to an improvement in overall company performance, both operationally and financially.

However, most of these studies focus on large companies or global contexts with higher levels of technological readiness. Meanwhile, medium-sized manufacturing companies in Indonesia still face various challenges in adopting logistics technology, such as limited investment, a lack of human resource competencies, and low levels of information system integration.



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Furthermore, research specifically examining the direct relationship between logtech innovation and COGS reduction remains relatively limited. Most studies primarily highlight overall supply chain performance without specifically linking it to production cost components such as COGS. This indicates a research gap that warrants further investigation, particularly within the context of medium-sized manufacturing companies in Indonesia.

Based on the above discussion, this study offers both theoretical and practical contributions. Theoretically, this study enriches the literature on the relationship between logistics digitization and operational cost efficiency. In addition, logistics technology (logtech) is viewed as a strategic capability that enables firms to adapt to dynamic market conditions through the integration of advanced technologies, real-time information systems, and data-driven decision-making processes. The implementation of digital logistics capabilities can enhance operational flexibility, supply chain visibility, and organizational responsiveness, thereby supporting cost efficiency and competitive advantage. Practically, the findings of this study are expected to serve as a reference for companies in formulating strategies for implementing logistics technology to improve cost efficiency and competitiveness. Therefore, this study aims to analyze the impact of logistics technology innovation on COGS reduction in medium-sized manufacturing firms.

2. Materials and Methods

This study employs a quantitative approach using a survey method to examine the causal relationship between logistics technology (logtech) management innovation and the reduction of Cost of Goods Sold (COGS). The research design is explanatory, as it focuses on testing the influence between variables through inferential statistical analysis. A quantitative approach was chosen because it provides objective measurements and allows for the generalization of research results [5].

The population in this study consists of medium-sized manufacturing companies that have adopted technology in their logistics systems. A sample of 30 respondents was selected using purposive sampling with the following criteria: (1) the company



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has implemented logistics technology, (2) has been in operation for at least three years, and (3) maintains a well-documented cost-recording system [6].

Data collection was conducted using a questionnaire instrument based on a 1–5 Likert scale, which was used to measure respondents' perceptions of the level of logtech implementation and its impact on cost efficiency [7]. The research instrument was designed based on indicators that had been tested for validity and reliability.

The conceptual model in this study illustrates the causal relationship between the independent variable—logistics technology (logtech) management innovation—and the dependent variable—reduction in COGS. Logtech is positioned as a factor that influences operational efficiency through the optimization of logistics processes, which ultimately leads to a reduction in production costs. Conceptually, the relationship between variables in this study can be explained as follows: an increase in the level of logistics technology adoption will improve efficiency in supply chain management, including reductions in distribution costs, storage costs, and operational waste. This efficiency then directly contributes to a decrease in COGS.

The conceptual model of this study is simple (direct effect model), in which one independent variable directly influences one dependent variable. This model was chosen to provide a more focused understanding of the primary influence of logistics technology on cost efficiency without involving mediating or moderating variables.

Data analysis was conducted using the Partial Least Squares – Structural Equation Modeling (PLS-SEM) method with the assistance of SmartPLS software. This method was chosen because it is suitable for small sample sizes and does not require strict normality of distribution [8]. The analysis stages included evaluation of the measurement model (outer model) through tests of convergent validity, reliability, and discriminant validity, as well as evaluation of the structural model (inner model) through the coefficient of determination (R^2) and hypothesis testing using the bootstrapping technique.



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3. Result

Evaluation of the Measurement Model (Outer Model)

Table 1. Results of the Convergent Validity Test (Outer Loadings)

<u>Variabel</u>	<u>Indicator</u>	<u>Outer Loading</u>	<u>Criteria</u>	<u>Notes</u>
Logtech	LT1	0.82	> 0.70	Valid
Logtech	LT2	0.85	> 0.70	Valid
Logtech	LT3	0.78	> 0.70	Valid
Logtech	LT4	0.87	> 0.70	Valid
Logtech	LT5	0.84	> 0.70	Valid
COGS	CG1	0.81	> 0.70	Valid
COGS	CG2	0.83	> 0.70	Valid
COGS	CG3	0.79	> 0.70	Valid
COGS	CG4	0.82	> 0.70	Valid

Based on Table 1, all indicators under the logtech and COGS reduction variables have outer loadings above 0.70. This indicates that each indicator is effective in representing the latent construct being measured. Thus, it can be concluded that the research instrument meets the criteria for convergent validity.

Reliability and Construct Validity Tests

Table 2. Results of Reliability and AVE Tests

<u>Variabel</u>	<u>Cronbach's Alpha</u>	<u>Composite Reliability</u>	<u>AVE</u>	<u>Criteria</u>
Logtech	0.89	0.92	0.70	Meets
COGS	0.85	0.90	0.68	Meets

Table 2 shows that all variables have Cronbach's Alpha and Composite Reliability values above 0.70, indicating that the research instrument has a high level of internal consistency. Furthermore, the AVE values for each variable are above 0.50, meaning that the constructs account for more than 50% of the variance in their respective indicators. Thus, it can be concluded that the model meets the criteria for construct reliability and validity.



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Discriminant Validity Test

Table 3. Results of the HTMT Test

Variabel	Logtech	COGS
Logtech	-	0.72
COGS	0.72	-

The HTMT value between the logtech and COGS variables is 0.72 (<0.90), indicating that both constructs exhibit good discriminant validity. This means that each variable in the research model has distinct characteristics and there is no construct overlap.

Structural Model Evaluation (Inner Model)

Table 4. Coefficient of Determination (R^2)

Dependent Variable	R^2	Category
COGS Reduction	0.61	Strong

An R^2 value of 0.61 indicates that the logtech variable accounts for 61% of the variation in COGS reduction. Meanwhile, the remaining 39% is influenced by other variables outside the research model. Based on the criteria established by Hair et al. (2021), this value falls into the “strong” category, indicating that the model has good predictive power [8].

Hypothesis Testing

Table 5. Bootstrapping Results

Variabel	Coefficient (β)	t-statistic	p-value	Notes
Logtech \rightarrow COGS	-0.73	6.21	0.000	significant

The results of the hypothesis test indicate that the logtech variable has a negative and significant effect on COGS reduction, with a coefficient of -0.73. A t-statistic of 6.21 (>1.96) and a p-value of 0.000 (<0.05) indicate that this effect is statistically significant. A negative coefficient indicates that an increase in the adoption of logistics technology will be followed by a decrease in COGS. In other words, the higher the level of logtech adoption, the greater the cost efficiency achieved by the



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company. Thus, Hypothesis H1, which states that logtech has a significant effect on COGS reduction, is accepted.

4. Discussion

The research results show that logistics technology has a significant negative effect on the reduction of Cost of Goods Sold (COGS). These findings indicate that the higher the level of logistics technology adoption, the greater the cost efficiencies a company can achieve. This negative relationship confirms that logistics technology plays a key role in reducing production costs through the optimization of logistics processes and the supply chain as a whole.

Theoretically, these results align with the concept of the digital supply chain, which emphasizes the importance of technology integration in enhancing operational efficiency and reducing costs [1]. From this perspective, technology functions not merely as a supporting tool but as the primary enabler in creating an adaptive, responsive, and efficient logistics system. The implementation of technologies such as the Warehouse Management System (WMS) enables companies to improve inventory tracking accuracy, accelerate picking and packing processes, and reduce operational errors that can lead to cost wastage.

In this case, the use of a Transportation Management System (TMS) has a significant impact on distribution optimization, particularly in determining efficient routes, reducing travel time, and controlling transportation costs [9]. The integration of Internet of Things (IoT)-based technology also enables real-time monitoring of goods and distribution processes, thereby minimizing the risk of damage, loss, and delivery delays.

Furthermore, from an operations management perspective, the implementation of logtech aligns with the principles of lean management—a systematic effort to eliminate waste in operational processes. Logistics technology plays a role in reducing various types of waste, such as overproduction, waiting time, excess inventory, and transportation inefficiencies, which directly impact the reduction of COGS. Thus, logtech not only improves technical efficiency but also supports the transformation toward a leaner and more sustainable production system.



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The findings of this study are also consistent with various recent empirical studies. Research by [10]. shows that digital transformation significantly improves supply chain performance through increased operational efficiency and information integration. These findings reinforce the results of this study, which indicate that the implementation of logtech can reduce operational costs by improving logistics visibility and coordination.

Furthermore, research by Zhen and Shang (2025) found that corporate digitalization has a significant effect on improving supply chain efficiency through process optimization and enhanced managerial capabilities. This is in line with the results of this study, which show that logtech contributes to a reduction in COGS through logistics process efficiency.

Research by Tian and Cui (2025) also confirms that digitalization can improve efficiency by reducing information costs, accelerating decision-making, and optimizing inventory management [12]. This supports the finding that technologies such as IoT and real-time data-driven systems can reduce waste and improve production cost efficiency.

Furthermore, recent studies on digital logistics indicate that the implementation of logistics technology not only improves operational efficiency but also impacts a company's financial efficiency through enhanced system integration and better cash flow management. Meanwhile, other research shows that supply chain digitization significantly contributes to enhancing the competitiveness of industrial companies, meaning that reducing COGS through logtech also has strategic implications for a company's competitive advantage.

Overall, the findings of this study are consistent with global trends indicating that the digitization of logistics and supply chains has a significant impact on operational efficiency and cost reduction. However, this study makes an additional contribution by specifically focusing on COGS reduction, employing an empirical PLS-SEM-based approach, and examining the context of medium-sized manufacturing companies in Indonesia—a sector that remains relatively under-researched.

In addition to improving operational efficiency, the implementation of logistics technology (logtech) also reflects a firm's strategic capability in responding to market



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uncertainty and increasing supply chain complexity. The integration of digital systems such as WMS, TMS, IoT, and AI enables firms to enhance operational visibility, improve forecasting accuracy, and support faster decision-making processes. However, despite the positive impact on COGS reduction, the effectiveness of logtech implementation may vary depending on organizational readiness, digital infrastructure, and managerial capability.

Critically, the findings indicate that technology adoption alone does not automatically guarantee efficiency improvements. Several previous studies have highlighted that digital transformation initiatives often fail due to resistance to organizational change, lack of employee digital competencies, and inadequate integration between systems. In medium-sized manufacturing firms, these challenges are more significant because companies often face financial limitations, limited technological expertise, and lower digital maturity compared to large enterprises.

Furthermore, while logtech contributes to reducing operational costs, excessive dependence on digital systems may also create new risks, such as cybersecurity threats, system disruption, and high maintenance costs. This suggests that companies should not only focus on technology investment but also strengthen risk management, employee training, and digital governance practices.

From a strategic perspective, the successful implementation of logtech should be supported by organizational alignment, continuous innovation, and long-term digital transformation planning. Therefore, logistics technology should be viewed not merely as an operational tool, but as a strategic resource that supports sustainable competitive advantage and organizational resilience in dynamic business environments.

In the Indonesian context, these findings are particularly relevant given the high national logistics costs, which remain a major challenge to industrial competitiveness. The implementation of logtech in medium-sized companies can serve as a strategic solution to address these inefficiencies, particularly by enhancing information integration, process transparency, and decision-making speed. However, the implementation of logistics technology is not without challenges, such as the need



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for relatively high initial investment, resistance to organizational change, and limitations in human resource competencies. Therefore, the success of logistics technology implementation is determined not only by technological aspects but also by organizational readiness, corporate culture, and appropriate managerial strategies.

The practical implications of this study are that companies need to consider investing in logistics technology as a long-term strategy to improve efficiency and profitability. Additionally, companies also need to develop human resource competencies and build a robust data integration system to ensure that logtech implementation runs optimally.

On the other hand, this study has limitations, particularly regarding the relatively small sample size and the use of a direct relationship model without mediating or moderating variables. Therefore, future research is recommended to develop more complex models, for example, by incorporating operational performance or digital capability variables as mediators, to gain a more comprehensive understanding of the mechanisms through which logtech influences cost efficiency.

5. Conclusions

This study aims to analyze the effect of logistics technology (logtech) management innovations on the reduction of Cost of Goods Sold (COGS) in medium-sized manufacturing companies. Based on the results of the analysis using the PLS-SEM method, it was found that logtech has a negative and significant effect on COGS. This indicates that increased implementation of logistics technology can reduce production costs through improved operational efficiency, particularly in inventory management, distribution, and information integration within the supply chain.

These findings reinforce the theories of the digital supply chain and lean management, which emphasize the importance of technology integration in reducing waste and improving cost efficiency. Furthermore, these results are consistent with recent empirical studies showing that logistics digitization contributes to improved operational performance and financial efficiency for companies. Practically, this research implies that manufacturing companies, particularly medium-sized ones, need to consider investing in logistics technology as a long-term strategy to improve



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efficiency and competitiveness. However, the implementation of logtech must be supported by organizational readiness, human resource competencies, and adequate information system integration.

This study has limitations in terms of its relatively small sample size and the use of a relatively simple research model that does not incorporate mediating or moderating variables. Therefore, future research is recommended to expand the sample size, employ more complex models, and consider other variables such as operational performance, digital capabilities, or organizational factors to gain a more comprehensive understanding.

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