Advance Sustainable Science, Engineering and Technology (ASSET)
Vol. 7, No.3, July 2025, pp. 02503022-01 ~ 02503022-18
ISSN: 2715-4211 DOI: https://doi.org/10.26877/asset.v7i3.1967

Digital Transformation of Import Logistics for Operational Efficiency: Case-Based Evidence from the Plastics Industry

Fajar Indra Kurniawan*, Firdaus Alamsjah

Industrial Engineering Department, BINUS Graduate Program - Master of Industrial Engineering, Bina Nusantara University, Jakarta 11480, Indonesia

*fajar.kurniawan004@binus.ac.id

Abstract. This study aims to explore the use of digital systems to reduce import process costs, increase the percentage of national direct deliveries from ports to consumers, and analyze the impact of proposed improvement measures. The research employs a single case study approach with data collected through observation, document analysis, and quantitative data collection from one of the biggest plastic resin distribution companies in Indonesia. The data were analyzed using the CIMO (Context-Intervention-Mechanism-Outcome) logic to understand the context and impact of the interventions implemented. The findings reveal that the application of digital technologies such as the Internet of Things (IoT), Blockchain, and cloud-based management systems with real-time container tracking digital applications can optimize supply chain processes and sustainability. There was a notable reduction in the national average container storage costs at ports from $2.4/Ton to $1.8/Ton and an increase in the average percentage of national direct deliveries from ports to consumers from 17.3% to 22.0% before and after the implementation of the container tracking system. These results confirm that adopting digital technologies in plastic resin distribution companies not only improves operational efficiency, provides a competitive advantage in the market but also reduces carbon emission by using single trip directly to customers. Companies are advised to enhance employee training related to new technologies and adopt integrated systems within supply chain processes. Furthermore, continuous innovation using technologies such as artificial intelligence is essential for maintaining industry competitiveness and sustainability.

Keywords: *Supply Chain Digitalization, IoT, Real-Time Monitoring, Container Logistics, Import Efficiency*

(Received 2025-06-14, Revised 2025-06-28, Accepted 2025-07-02, Available Online by 2025-07-17)

1. **Introduction**

Plastic resins are essential raw materials widely utilized in packaging, automotive, construction, electronics, and other sectors. However, according [1] currently the industry is facing major changes that have a significant impact on various sectors, along with the increase in plastic production globally. Trade policies in Indonesia also affect import costs [2]. Although there are several free trade agreements, protectionist policies often implemented to protect domestic industries continue to add to import burdens. Furthermore, [3] confirmed that the complicated import administration processes consume time and incur additional costs for importers. Plastic resin distribution companies in Indonesia face significant challenges related to import and logistics costs, especially with intense price competition in the industry.

Digital technologies, including the Internet of Things (IoT) and big data [4] and blockchain have brought improvements in efficiency and accuracy across various logistics processes. One of its main benefits is the ability to monitor the status of goods in real-time at every stage, from ordering to delivery to customers. Digitalization in the supply chain can reduce costs in several ways [5]. One of the key benefits of digitization is increased information transparency and connectivity, which allows for timely and accurate information sharing. In addition, monitoring capabilities offered by digital technology in real-time can improve the reliability and speed of supply chain response. With the ability to predict risks and make decisions based on rapid analysis of information, organizations can respond more efficiently to internal and external disruptions, which in turn can reduce operational costs. Digitization of the supply chain can contribute to lower costs [6]. One of the benefits identified is better inventory management and control, which can lead to reduced inventory levels and associated costs. Supply chain digitalization also reduces transportation and storage costs [7]. In terms of plastic resin distribution, a digitalization system increases the number of direct deliveries to consumers from ports. This information system will reduce the cost of loading and unloading in the warehouse as well as the cost of transportation back from the warehouse to the consumers. The research also support sustainability supply chain to reduce gasoline consumption can be impacted to pollutant emission reduction [8] by reducing the amount of transportation from warehouse to customers used to fulfill customer's orders.

This study focuses on three core issues faced by a leading plastic resin distributor in Indonesia: (1) reducing container storage costs at ports, (2) increasing the share of direct deliveries from ports to consumers, and (3) utilizing digital technologies to optimize import process costs and supply chain efficiency and sustainability, enhance container direct delivery efficiency. Using a single case study [9] design combined with CIMO-Logic [10], the research evaluates how real-time digital monitoring impacts operational outcomes and competitiveness in this sector and will made the business sustain.

The objective is to provide empirical evidence on the benefits of digitalization in supply chain cost control and delivery efficiency and supply chain sustainability, offering actionable insights for practitioners and policymakers aiming to improve import logistics in Indonesia.

2. **Methods**

2.1. Research Framework

The research utilizes a single case study approach combined with CIMO-Logic to investigate the impact of digital technologies on import process costs and delivery efficiency. The case company is one of Indonesia's largest plastic resin distributors, selected for its representativeness and the logistical challenges it faces. All data in the research is acknowledged and permitted by the company.

Quantitative data were collected from the company's ERP system covering import process costs, storage costs, and the percentage of direct deliveries from the ports to consumers. The data spans two periods: before implementation of the digital container tracking monitoring system (January to September 2024) and after implementation (November 2024 to January 2025). Four major Indonesian ports; Belawan (MDN), Tanjung Emas (SMG), Tanjung Perak (SBY), and Tanjung Priok (JKT)—were included in the study.

Qualitative data were gathered through semi-structured interviews with experts in the company conducted in depth to allow for in-depth exploration while remaining focused on the research topic [11], and observations of operational procedures. According to [12], the researcher acts as an observer of the participant to gain direct insight. Document analysis supplemented data collection by reviewing records and reports relevant [13] to import costs and delivery.

To ensure validity, triangulation of multiple data sources was applied. The CIMO-Logic framework guided the analysis as Figure 1, connecting the contextual (C) challenges with the digital interventions (I) implemented, the mechanisms (M) activated, and the outcomes (O) observed.[10] stated that CIMO-logic method appropriate for addressing practical industrial challenges and problems.

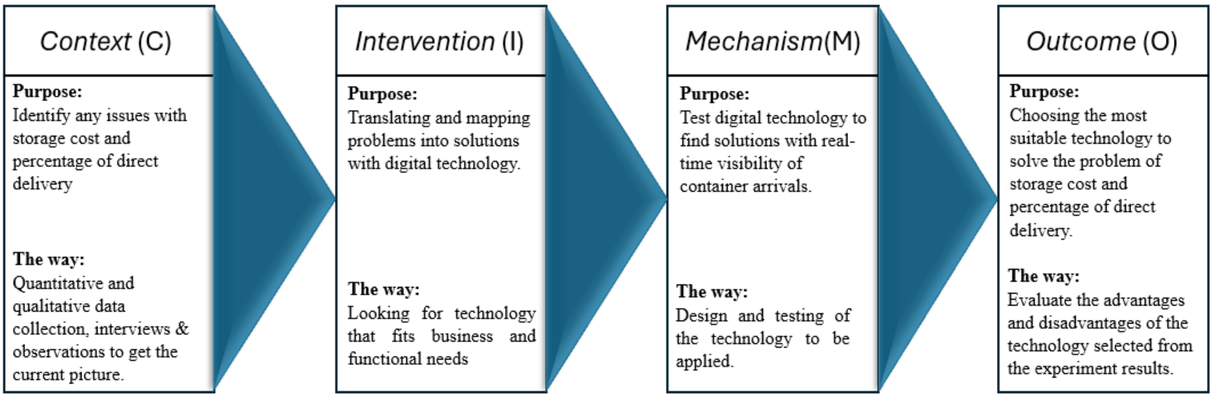

Figure 1. CIMO-Logic

Source: [14]

2.2. Data Analyze

Data from the use of real-time visibility digital technology will be compared with data on import process costs and the number of direct deliveries from ports to consumers taken from November 2024 - January 2025 and then compared with data before implementation, namely January 2024 - September 2024 by means of hypothetical methods [15] to measure how much change has occurred with formula t-Test Unequal Variance (Welch's t-Test): According to [16], it can be used if the variants of the two data groups are different (variant homogeneity is not met).

The formula used is:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \tag{1}$$

Noted:

$\bar{X}_1, \bar{X}_2$ = Average sample 1 and 2

s_1^2, s_2^2 = Sample variances 1 and 2

n_1, n_2 = Sample size of each group

3. **Results and Discussion**

3.1. Single Case Study Data Result

The observations result that have been made at each step of the process of carrying out the import process at one of the largest distributors in Indonesia can be seen in Figure 2. The current condition in the import process that is a problem in this study is in the process of shipping containers from the suppliers to the destination port in Indonesia carried out by the Shipping Line where if there is a change in ETA (Estimated Time Arrival) it is not detected directly so that sometimes these changes make the preparation less predictable, especially if there is a change in arrival so that it comes at the same time.

Inaccurate ETA information causes sales and warehouse teams to be unable to provide accurate predictions to accommodate the container unloading process at consumers and in the company's warehouse with a good schedule. The issues cause the cost of storage at the port because of the limited unloading capacity, and the number of direct deliveries from the port to consumers is not optimal

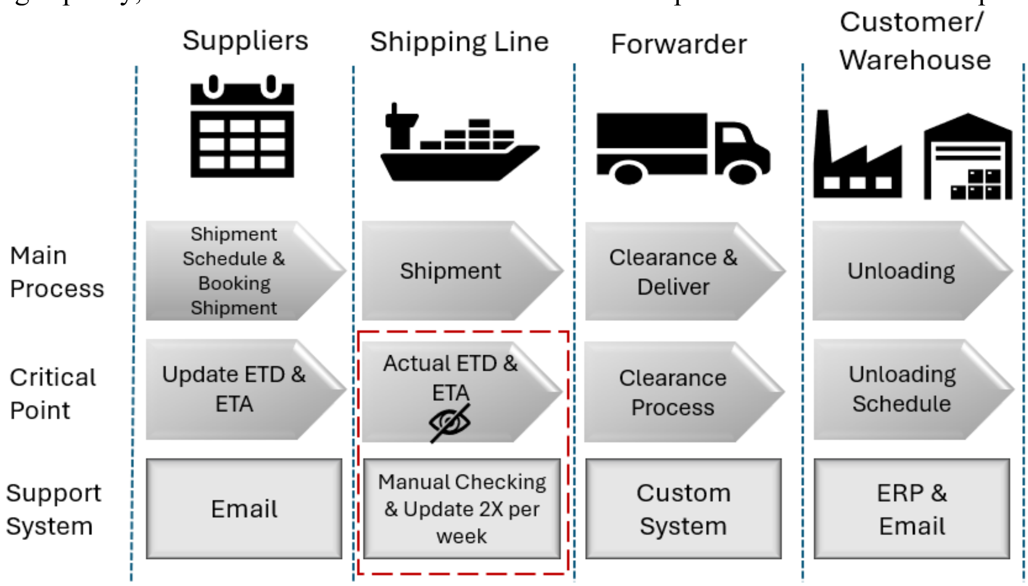

Figure 2. Import Process Before Implementation Digital Application

3.1.1. Quantitative Data Collection

Table 1. Storage cost data ($/Ton) Period January – September 2024

Tahun 2024	Belawan-MDN	Tanjung Emas - SMG	Tanjung Perak - SBY	Tanjung Priok - JKT	Average
Jan	2.1	1.2	3.0	3.1	2.5
Feb	4.5	2.2	4.1	3.4	3.5
Mar	2.2	2.0	1.8	2.9	2.5
Apr	2.6	1.8	3.6	2.8	2.7
May	2.1	1.5	2.5	2.5	2.2
Jun	2.5	1.4	2.2	2.7	2.3
Jul	1.8	0.9	1.7	1.9	1.7
Aug	1.8	1.1	1.6	2.1	1.8
Sep	3.2	1.3	2.1	2.4	2.1
Grand Total	**2.5**	**1.5**	**2.5**	**2.6**	**2.4**

Table 2. Percentage (%) Direct delivery January – September 2024

Tahun 2024	Belawan - MDN	Tanjung Emas - SMG	Tanjung Perak - SBY	Tanjung Priok - JKT	Average
Jan	13.7	14.5	10.8	12.1	12.8
Feb	14.0	7.5	7.9	13.0	10.6
Mar	14.0	6.4	2.1	15.0	9.4
Apr	10.4	10.4	15.7	13.9	12.6
Mei	4.3	14.5	25.9	20.6	16.3
Jun	13.8	27.9	29.9	24.2	23.9
Jul	21.9	31.0	26.7	21.3	25.2
Agt	12.8	31.0	24.0	20.8	22.2
Sept	22.0	25.7	21.2	21.7	22.6
Grand Total	**14.1**	**18.8**	**18.2**	**18.1**	**17.3**

The data on Table 1, collected for a single case study began with data related to the specific storage costs and the data on Table-2, percentage of direct delivery from the port to consumers before digital application to monitor container arrivals at 4 (four) ports in Indonesia. The data was taken from the ERP system during the period January 2024 – September 2024.

3.1.2. Qualitative Data Current Conditions

Qualitative data was taken from interviews with 3 experts in the field. The COO as Operational Director, GM Sales is responsible for the direct delivery schedule with the customers, and Logistics Senior Manager is responsible for arranging incoming materials at each site in Indonesia.

COO: reducing costs is urgently needed to increase profits and provide more competitive prices. Focus on reducing import costs using available systems, reducing port storage costs and logistics costs, and increasing the number of direct deliveries from the ports.

GM Sales: the information on the arrival of goods is not accurate, causing sales not optimally to provide schedules to customers. With better accuracy, it is easy to provide a delivery schedule directly to consumers. There are more frequent updates and real-time visibility.

Logistics Senior Manager: the process of updating the arrival schedule of goods is done manually and takes time, so updates can only be done 2 times a week There is a system that can help see real-time updates on the arrival of imported goods so that there is no manual update There is an application that can update the arrival schedule of imported goods automatically downloaded from the application.

3.2. Results of CIMO-Logic Application

3.2.1. Context

The observation and data collected from a single case study can be concluded in the context of the issue of the inability to monitor container arrivals in real-time, which can cause irregularities in the arrival of containers from any supplier from abroad to domestic ports. To solve the problem, the company must find a solution to monitor each container's arrival in real time. From the confirmed problems, the researcher then translates the problem with a repair plan that is a business need, as can be seen in Table 3. This business need is obtained from the results of interviews and discussions with experts on a single case study.

3.2.2. Intervention

The strategic action needed at this stage of intervention is more detailed, translating business needs into functional requirements for IoT and Blockchain applications. This functional requirement is very important in finding and selecting several applications that have been used so far by other parties. The functional requirements also include ensuring that this application can be used internally by the largest plastic resin distributor company in Indonesia. Functional requirements can be seen in Table 4.

Obtained the functional requirements, it is translated back into a technological solution that becomes a solution to the functional requirements and business needs after this application is used. The technological solution can be seen in Table 5.

3.2.3. Mechanism

The first step in conducting a tender for the selection of a digital real-time container tracking system applicator is to determine the technical solution that has been determined. The second step to conduct a meeting with each vendor should be held to explain the technical solution, functional requirements, and business needs. Third, ask each applicator to show the application that the consumers of the vendors have used; fourth, ask each vendor to adjust the digital container tracking system application according to what is required. Researchers and the company's team finally tried to use the 3 digital container tracking system applications and saw the features in them.

Table 6 compares the 3 applications. The names of the applicant and the application are not displayed because the Author has not obtained written permission to include them in this research report, but this does not reduce the similarity of the comparisons between applications. The tender team discussed and considered the suitability of the technology solution, considerable experience in the application of cargo and container tracking systems, and competitive prices against 3 vendors of digital container tracking applicators, one of the winners was Application number 2 because it meets all the criteria set.

Table 3. Translation of problem areas into business needs

	Business Requirement							
	Improve operational & import cost performance				Digital transition to container monitoring			
Problem Areas	real-time container arrival	improve direct delivery plan	improve import clearance preparation	improve unloading warehouse preparation	auto detect ETD & ETA container per shipment	auto email if any change of ETA	auto calculated total qty per arrival date	auto detection of POD port
Manual update		x		x	x	x	x	x
Inaccuracy ETA POD	x	x	x	x	x	x		x
Lack of total qty container Arrival per date	x	x		x	x	x	x	
Ports storage cost		x	x	x	x		x	x

Table 4. Functional requirements

	Functional Requirements								
	Information and Visualization						Registered Data		
Business Requirement	Provides data *real-time ETD & ETA*	Can see the number of containers per *ETA date*	Can choose the display of material names	Can choose the display of the name of the Overseas Entrant	Can provide ship schedule information 1-4 weeks ahead	Can view the historical position of each PO's container	Register the ship booking number/ *Bill of Lading* and *Shipping Line*	Register the name of the Supplier	Email notifications if there is a change in *ETA*
Real-time container arrival	X	X				X	X	X	X
Direct Delivery Plans	X	X	X						X
Preparation for container custom clearance at the Ports	X	X				X			X
Preparation for unloading in the Warehouse	X	X							X
Container *ETD & ETA* automation	X								X
Automation of ETA change information	X				X				X
Automation detection of port of loading (POL) and port of destination (POD)	X					X	X	X	
Automation calculation of total containers per ETD & ETA	X	X		X			X		X

Table 5. Technology Solutions

	Solution Technology					
	Data Management & Usage					
Functional Requirements	Connectivity	Real-time Data Collection	Data Management	Data Analytics	Dashboard Data	Historical Data
Provides real-time ETD & ETA data	X	X		X		
Can see the number of containers per ETA date	X	X	X	X	X	
Can choose the display of material names	X		X	X		
Can choose the display of the name of the Overseas Entrant	X		X	X		
Can provide ship schedule information 1-4 weeks ahead	X		X	X	X	
Can view the historical position of each PO's container	X	X	X	X	X	X
Register the ship booking number/ Bill of Lading and Shipping Line	X			X		
Register the name of the Supplier	X		X	X		
Email notifications if there is a change in ETA	X	X		X		

Table 6. Comparison of digital container tracking system applications

Description	Application 1 (G)	Application 2 (C)	Application 3 (B)
Applicator	An India-based company engaged in the development of specialized container tracking systems and applications.	A major Dubai-based shipping company that leverages its network to create container tracking system application.	The Singapore-based company is engaged in the development of systems.
Technology Solutions	All can be made on request	Everything is already there according to the technical solution	All that can be made on request.
Functional Requirements	There is no shipment schedule for each port of origin and destination in the next 1-4 weeks.	There is already has feature of shipment schedule for each port of origin and destination in the next 1-4 weeks.	Unable to find a schedule that will run each port of origin and destination.
Business Needs	Fulfilled	Fulfilled	Fulfilled
Experience	Used Globally, 1st rank in container tracking system applications.	Used Globally	Regional and local Indonesian consumers that have been handled.
Competitive Pricing	The price is quite high because it needs to develop a customized application.	The price is competitive compared to other applications because it does not require more development and meets the criteria.	The price is competitive but still more expensive than Application-2.

3.2.3. Outcome

The selection of the digital container tracking application on Application number 2 and the implementation was carried out in November, December 2024 and January 2025. **The first result**: the features of the digital container tracking application in accordance with the technical solutions and functional requirements and business needs, some of the features can be seen in Figure 4 by displaying the calendar menu can be seen real-time Estimated Time Departure (ETD) and Estimated Time Arrivals ETA that the import team can prepare and/or follow up on import documents sent from suppliers that the discharge process at the port can be anticipated and inform the forwarder to remove the container faster from the port to avoid accumulation at the port, the number of containers per date in real-time, both departures and arrivals, that the warehouse team can prepare the storage area and the team involved in the unloading of containers, thereby reducing the risk of storage at the port or at the containers depo, Sales can select the materials they want to see, so that the sales team can schedule direct deliveries from the port to the consumer and the sales team of each branch can choose the arrival ports.

In Figure 5, there is also a menu feature of ship departure schedules for the next 1-4 weeks on the "Vessel Schedule" menu. The purpose of this menu is to propose the departure and arrival of ships to the overseas supplier according to the date required by the plastic resin distributor.

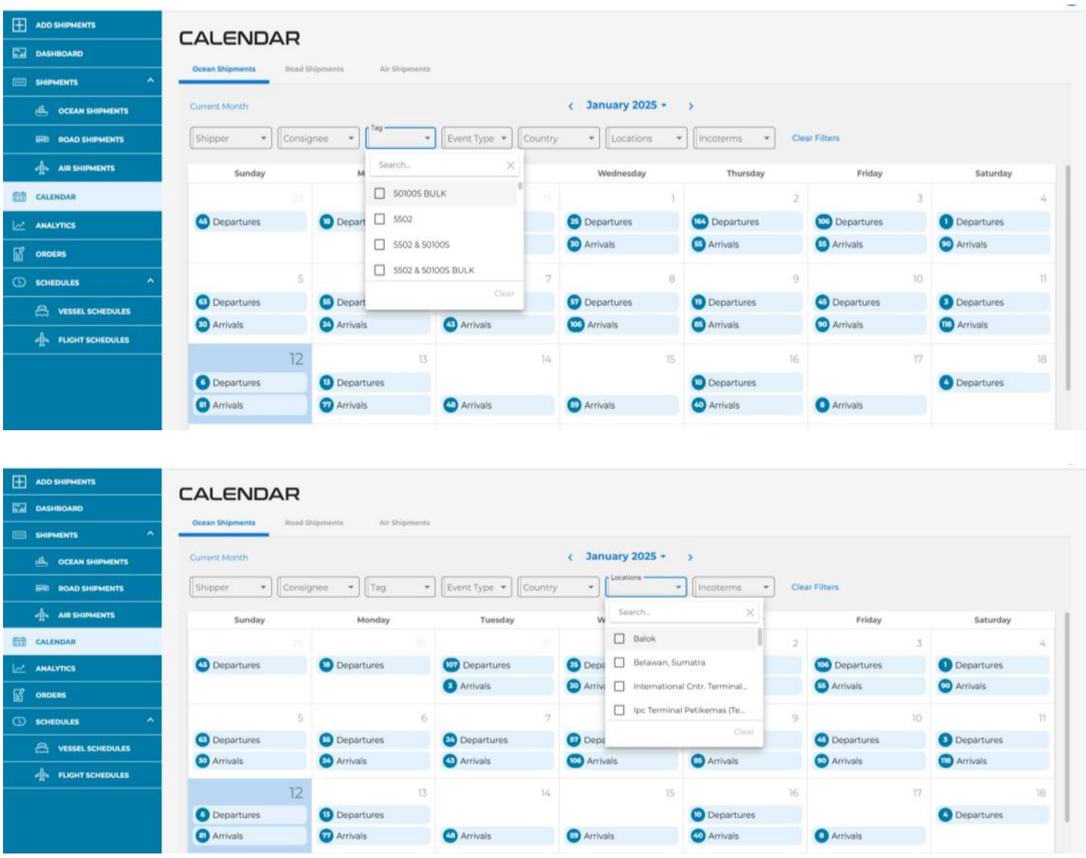

Figure 3. Features in the menu ”Calender”
Source: flow.cargoes.com (by DP World)

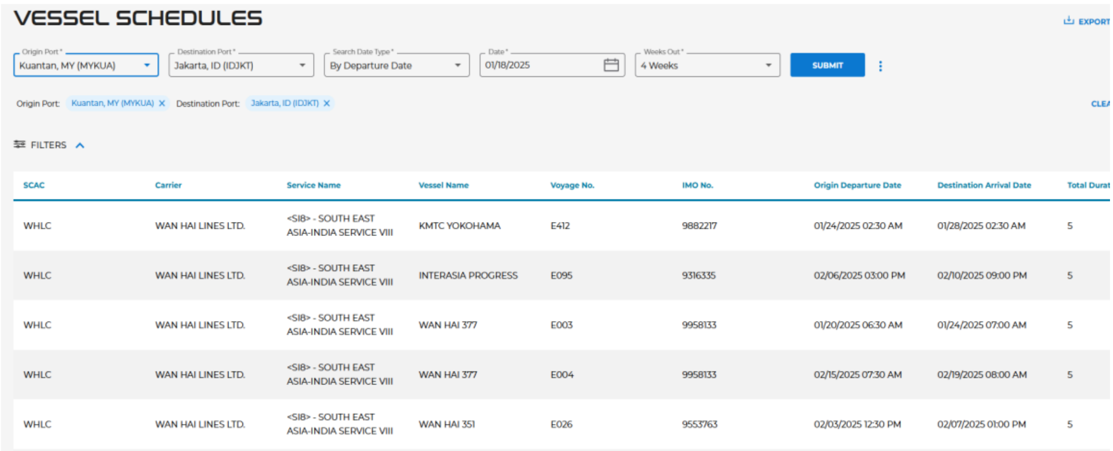

Figure 4. Menu Feature “Vessel Schedule”
Source: flow.cargoes.com (by DP World)

The second result: Data of decreasing in port storage costs at the beginning of implementing digital container tracking, as seen in Table 6 in November 2024 until January 2025, it had an average value of port storage cost $1.8/Ton, compared to the data in Table 1, with an average of $2.4/Ton.

Table 7. Table of port storage costs ($/Ton) after implementing digital applications

Bulan	Belawan-MDN	Tanjung Emas - SMG	Tanjung Perak - SBY	Tanjung Priok - JKT	Average
Nov-24	1.6	1.2	1.5	2.1	1.8
Dec-24	2.1	1.1	1.8	2.1	1.8
Jan-25	3.3	1.2	1.4	2.3	1.8
Grand Total	**2.3**	**1.1**	**1.6**	**2.2**	**1.8**

Statistical calculation with a t-test to prove whether there is a change from implementing digital applications. The results of the t-test are as in Table 7. The t-test uses a sample with two unique variations because the existing data differs in number. The test reflects data for 2024 before and after the use of the digital container tracking system application.

The results of the t-test, the interpretation: statistical tests showed that the t-value of 2.15 exceeded the critical value (about 2.06 at df = 25) and the p-value of 0.0415 was smaller than the α (0.05). This indicates that there is a significant difference in stacking costs before and after the implementation of digital applications. Because the p-value < 0.05, we can state that the use of digital applications statistically has the impact of significantly lowering stacking costs. Percentage Decrease: Based on average data, the cost of stacking decreased from about $2.29 to $1.81 per ton, which is a decrease of about: 2,292.29−1.81×100%≈21%. Practical significance: This 21% reduction in costs shows a considerable effect.

The percentage of direct delivery from the port to consumers differs from the average of 17.3% in Table 2. After using container tracking system data on the percentage of direct delivery for November 2024 - January 2025, the average value was 22.0% in Table 8.

Table 8. T-test results on port storage costs ($/Ton = $1:IDR. 15,500)

Hypothesis

H0: There is a significant difference in the average decrease in stacking costs

H1: There is no significant difference in the average decrease in stacking costs

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	2.294444444	1.809419039
Variance	0.664539683	0.389921686
Observations	36	12
Hypothesized Mean Difference	0	
df	25	
t Stat	2.148720829	
P(T<=t) one-tail	0.020766418	
t Critical one-tail	1.708140761	
P(T<=t) two-tail	0.041532836	
t Critical two-tail	2.059538553	

Table 9. Table of percentage of direct delivery (%) after implementing digital applications

Month	Belawan- MDN	Tanjung Emas - SMG	Tanjung Perak - SBY	Tanjung Priok - JKT	Average
Nov-24	15.4	59.1	15.9	17.8	27.1
Dec-24	14.1	29.1	20.2	18.1	20.4
Jan-25	10.3	30.6	18.9	14.2	18.5
Grand Total	**13.3**	**39.6**	**18.3**	**16.7**	**22.0**

Table 10. T-test results of percentage (%) of direct delivery

Hypothesis

H0 = There is a significant increase in the percentage of direct shipments

H1 = There is no significant increase in the percentage of direct shipments

t-Test: Two-Sample Assuming Unequal Variances

	Variable 1	*Variable 2*
Mean	0.172783333	0.219716667
Variance	0.00592898	0.017147142
Observations	36	12
Hypothesized Mean Difference	0	
df	14	
t Stat	-1.17567882	
P(T<=t) one-tail	0.129665	
t Critical one-tail	1.761310136	
P(T<=t) two-tail	0.259330001	
t Critical two-tail	2.144786688	

Since the p-value of 0.26 is greater than $\alpha = 0.05$, we cannot reject the null hypothesis. Thus, there is no statistical evidence to show a significant increase in the percentage of shipments directly from ports to consumers after the implementation of digital applications. However**,** from the observation of the average data: The percentage of direct shipments increased from about 17.3% to 22.0%, which is about **27% increase**. 17,322.0−17.3×100% ≈ 27%. **Impact:** Although not statistically significant, this positive trend indicates an improvement in the efficiency of direct delivery that needs to be further monitored with more data or a longer observation period.

3.3. Impact on Operational Sustainability

The reduction in container port storage costs and the increase in direct deliveries achieved through digital container tracking directly support sustainability principles by reducing waste, minimizing unnecessary handling, and improving resource efficiency. These outcomes align, according to [17], with the triple bottom-line framework of sustainability, where economic gains are coupled with environmental and social benefits..

From an environmental perspective, reducing storage times and increasing direct delivery decrease idle times and associated carbon emissions, which directly affect air quality and public health [18] from redundant transportation and handling operations. Economically, lower costs enhance competitiveness, while social aspects improve through better supply chain transparency and stakeholder collaboration.

3.4. Digital Infrastructure as a Catalyst for Sustainable Supply Chains

The deployment of IoT and blockchain-enabled real-time tracking represents a mature digital infrastructure framework that enhances connectivity, data integration, and trust among supply chain partners; the infrastructure provides the technical foundation for supply chain visibility and resilience, enabling rapid response to disruptions and proactive risk management, which are crucial for sustainable operations [19].

Empirically, the tracking container system created a mechanism for continuous monitoring and data sharing, which not only eliminates information asymmetries but also builds a digital ecosystem fostering transparency and strategic decision-making by users, which is consistent with frameworks like the Digital Supply Chain Infrastructure Model, which emphasizes the role of integrated digital technologies in achieving agility and sustainability.

3.5. Discussion

3.5.1. Translating Requirements into Digital Applications

In the Supply Chain, quite a few digital application technologies can increase visibility in real-time and predictive capabilities [20], making them useful for every stakeholder in the company. This research regarding digital monitoring container arrivals demonstrates this.

The many existing applications are tailored to the basic business needs and financial readiness analyzed by the author. They must be useful for the plastic resin distributor company where the research was conducted. From business needs that will be translated into specific digital technology, this research must be carried out so that business targets and user targets can achieve results from the application of digital technology. To obtain this digital technology, research must collaborate with platform providers IoT and blockchain [21]; [22].

Platform digital applications for monitoring and controlling container arrivals in real-time has become a trend to be used by cargo shipping ship owners to detect the position of their ships and cargo to ensure the vessel is positioned according to plan and also to provide up-to-date information regarding delivery times from the port of origin and arrival at the port of destination to its customers. *The Advanced Container Tracking* System (ACTS) is proposed as an innovative solution to meet these needs. The technology offers *real-time* monitoring and automated notifications to strengthen container security and improve logistics efficiency [23]

This research, carried out by researchers at one of Indonesia's largest plastic resin distributor companies, has chosen a digital application container tracking system with platform experience that other exporter and importer companies have used. It's just that this application has limitations when the shipping company has not collaborated with the parent company of this application, so the digital application cannot detect it. To be connected and monitored, you must first register with the development team to be added to the application.

This application will be updated if you enter the booking number, bill of lading number, container number, or name of the ship carrying it, along with other detailed information. The connection of these numbers also depends on the application platform provided on the website of each shipping container. A clear division of tasks in implementing this application is fundamental, especially import team personnel who receive each delivery schedule for plastic resin materials must immediately inform the department that inputs and updates the booking no. or B/L no. and information on the product name and estimated departure from the port of delivery and estimated arrival at the port of destination as soon as the data is inputted and uploaded into the application.

3.5.2. Linking Findings to Sustainability Theory

The empirical findings illustrate how digitalization drives sustainable supply chain practices by embedding principles of lean operations and circular economic thinking. For instance, reducing port storage times reduces material holding and potential wastage, which is an application of lean inventory management [6] contributes to sustainability.

These results support the view from supply chain sustainability frameworks that highlight visibility as a critical enabler of environmental and social responsibility alongside economic performance. Real-time data empowers companies to make more informed decisions, reduce overstocking, prevent delays, and minimize environmental footprints.

3.5.3. Digital Infrastructure Frameworks Guiding Implementation

The case study substantiates theoretical models that regard IoT, blockchain, and cloud-based platforms as key enablers of a digital supply chain infrastructure capable of supporting sustainability goals. The digitized container tracking system acts as a structural mechanism fostering transparency, trust, and coordination among fragmented supply chain actors, which, in turn, drives operational efficiency and sustainability [24].

Moreover, these technologies fit well within the Design Science Research paradigm applied in supply chain studies, validating the use of digital innovation to address complex supply chain challenges, including inefficiencies and opacity in import operations.

3.5.4. Limitations and Future Directions

While digitalization improved internal supply chain processes and sustainability outcomes, external disruptions such as customs system failures persist as barriers. Future research is recommended to incorporate multi-stakeholder collaboration frameworks and advanced AI-driven [25] infrastructure further to enhance the adaptive capacity and sustainability of supply chains.

4. Conclusion

Applying digital technology such as the Internet of Things (IoT), Blockchain, and cloud-based management systems with support for real-time container tracking applications can significantly optimize supply chain processes [23]. This study notes a decrease in the average storage cost of containers nationally from \$2.4/Ton to \$1.8/Ton and an increase in direct deliveries from ports to consumers from 17.3% to 22.0% before and after implementing this technology. These findings indicate that digitalization in plastic resin distribution companies improves operational efficiency and provides significant competitive advantages in the market and made the business sustain. From an environmental perspective, reducing storage times and increasing direct delivery decrease idle times and associated carbon emissions, which directly affect air quality and public health [18] from redundant transportation and handling operations.

Therefore, companies should increase employee training regarding new technology [26] and adopt a more integrated system in the supply chain process. Apart from that, continuous innovation through the use of advanced technology, such as artificial intelligence [25] as noted from [27] predictive analytics can also enhance capacity planning to have efficiency, must continue to be developed to strengthen competitiveness and maintain industrial sustainability in the future by addressing risk factors in supply chain area. According to [19], by addressing risk factors, the resilience of the entire supply chain can be enhanced, leading to greater stability and sustainability.

Acknowledgements

This research was supported by the management of one of the distributors of resin plastics in Indonesia. The Author has permission from management to mention summaries of data and also permission from the container tracking system principal to attach figures to this journal.

References

[1] Ľ. Kubíková and S. Rudý, “The Current Global Situation of Plastics and Forecast of Plastic Waste,” pp. 128–137, 2024, doi: 10.53465/edamba.2023.9788022551274.128-137.

[2] D. J. Teece, “Business models and dynamic capabilities,” *Long Range Plann.*, vol. 51, no. 1, pp. 40–49, 2018, doi: 10.1016/j.lrp.2017.06.007.

[3] H. Fatorachian and H. Kazemi, “A critical investigation of Industry 4 . 0 in manufacturing :

Theoretical operationalization framework Hajar Fatorachian , Hadi Kazemi,” *Prod. Plan. Control.*, vol. 29, no. 8, pp. 1–40, 2018.
[4] S. Demir, I. Yilmaz, and T. Paksoy, *Augmented Reality in Supply Chain Management*, no. March. 2020. doi: 10.1201/9780429327636-14.
[5] X. Wang, V. Kumar, A. Kumari, and E. Kuzmin, “Impact of Digital Technology on Supply Chain Efficiency in Manufacturing Industry,” *Lect. Notes Inf. Syst. Organ.*, vol. 54, no. April, pp. 347–371, 2022, doi: 10.1007/978-3-030-94617-3_25.
[6] A. Haddud and A. Khare, “Digitalizing supply chains potential benefits and impact on lean operations,” *Int. J. Lean Six Sigma*, vol. 11, no. 4, pp. 731–765, 2020, doi: 10.1108/IJLSS-03-2019-0026.
[7] M. Akbari and J. L. Hopkins, “Digital technologies as enablers of supply chain sustainability in an emerging economy,” *Oper. Manag. Res.*, vol. 15, no. 3–4, pp. 689–710, 2022, doi: 10.1007/s12063-021-00226-8.
[8] X. Feng, R. Song, W. Yin, X. Yin, and R. Zhang, “Multimodal transportation network with cargo containerization technology: Advantages and challenges,” *Transp. Policy*, vol. 132, pp. 128–143, 2023, doi: https://doi.org/10.1016/j.tranpol.2022.12.006.
[9] R. K. Yin, *Case study research and applications: Design and methods*, 6th ed. Sage Publication, 2017.
[10] D. Denyer, D. Tranfield, and J. E. Van Aken, “Developing design propositions through research synthesis,” *Organ. Stud.*, vol. 29, no. 3, pp. 393–413, 2008, doi: 10.1177/0170840607088020.
[11] S. Kvale, S., & Brinkmann, *InterViews: Learning the craft of qualitative research interviewing*, 2nd ed. SAGE Publications, 2009.
[12] J. W. Creswell, *Qualitative inquiry and research design: Choosing among five approaches*, 3rd ed. SAGE Publications, 2013.
[13] G. A. Bowe, “Document Analysis as a Qualitative Research Method,” *Qual. Res. J.*, vol. 9, no. 2, pp. 27–40, 2009, [Online]. Available: doi:10.3316/qrj0902027
[14] R. Kalaiarasan, T. K. Agrawal, J. Olhager, M. Wiktorsson, and J. B. Hauge, “Supply chain visibility for improving inbound logistics: a design science approach,” *Int. J. Prod. Res.*, vol. 61, no. 15, pp. 5228–5243, 2023, doi: 10.1080/00207543.2022.2099321.
[15] David S. Moore., G. P. McCabe, and C. B. A., *Introduction to The Practice of Statistics*, Sixth. 2009.
[16] D. M. Jessusek and D. H. Volk-Jessuses, *Statistics Made Easy*, 6th ed. DATAtab e.U, 2025.
[17] P. Goel, “Triple Bottom Line Reporting: An Analytical Approach for Corporate Sustainability.,” *J. Financ. Account. Manag.*, vol. 1, no. 1, 2010.
[18] A. M. Arifai and M. F. Arsyad, “Urban Expansion , Climate Vulnerability , and Transportation Resilience : Insights for Sustainable Development,” vol. 7, no. 2, pp. 1–12, 2025.
[19] Haswika, Agus Mansur, and Meilinda F. N. Maghfiroh, “Risk Mitigation Strategies for Sustainable Poultry Supply Chain Management,” *Adv. Sustain. Sci. Eng. Technol.*, vol. 6, no. 4, p. 02403011, 2024, doi: 10.26877/asset.v6i4.997.
[20] A. Calatayud, J. Mangan, and M. Christopher, “The self-thinking supply chain,” *Supply Chain Manag. An Int. J.*, vol. 24, no. 1, pp. 22–38, Jan. 2019, doi: 10.1108/SCM-03-2018-0136.
[21] M. Ben-Daya, E. Hassini, and Z. Bahroun, “Internet of things and supply chain management: a literature review,” *Int. J. Prod. Res.*, vol. 57, no. 15–16, pp. 4719–4742, 2019, doi: 10.1080/00207543.2017.1402140.
[22] M. Giannakis, K. Spanaki, and R. Dubey, “A cloud-based supply chain management system: effects on supply chain responsiveness,” *J. Enterp. Inf. Manag.*, vol. 32, no. 4, pp. 585–607, Jan. 2019, doi: 10.1108/JEIM-05-2018-0106.
[23] S. N. Rajan, P. Sharma, D. Srivastava, K. Koul, S. Aluvala, and Shashikant, “An Advanced Container Tracking System for Real-Time Monitoring and Automated Alerting of Container Security and Logistics,” in *2024 3rd International Conference on Sentiment Analysis and Deep Learning (ICSADL)*, 2024, pp. 581–586. doi: 10.1109/ICSADL61749.2024.00100.

[24] A. Brun, H. Karaosman, and T. Barresi, “Supply chain collaboration for transparency,” *Sustain.*, vol. 12, no. 11, 2020, doi: 10.3390/su12114429.

[25] Masdiana *et al.*, *Revolusi Plastik dan lingkungan*. Makassar: CV. Tohar Media, 2023. [Online]. Available: https://repository.unifa.ac.id/id/eprint/1133/1/13. EBOOK PLASTIK_compressed.pdf

[26] J. A. G. Gandía, S. G. Gavrila, A. De Lucas Ancillo, and M. T. Del Val Núñez, “RPA as a Challenge Beyond Technology: Self-Learning and Attitude Needed for Successful RPA Implementation in the Workplace,” *J. Knowl. Econ.*, 2024, doi: 10.1007/s13132-024-01865-5.

[27] H. Kusumo, D. Marlina, and A. Solechan, “Sustainable Digital Transformation in Healthcare: Challenges and Directions in the Society 5.0 Era,” *Adv. Sustain. Sci. Eng. Technol.*, vol. 7, no. 1, 2025, doi: 10.26877/asset.v7i1.876.