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Optimizing Food Supply Chain Delivery in Indonesia: A Digital Supply Chain Twins (DSCT) Modeling Approach for PT Ternaknesia Farm Innovation (Ternakmart)

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ABSTRACT

This study aims to optimize the food supply chain in Indonesia using the Digital Supply Chain Twins (DSCT) method at PT Ternaknesia Farm Innovation (Ternakmart), a startup company focusing on halal food. The supply chain faces various challenges such as population growth, natural disaster risks, and financial crises. Ternakmart encounters issues related to product quality and delivery delays based on customer feedback data. This research employs the AnyLogistix software in the DSCT method to comprehensively understand the interactions among supply chain elements. The data used include sales invoice, customer data, prepare team, delivery team, and routing. The analysis results indicate that scenario 1 (ELT 2, Order Interval 3 days) provides more optimal outcomes compared to scenario 2 (ELT 3, Order Interval 5 days). Scenario 1 shows improvements in profit, service level, lead time, available inventory, peak capacity, fulfillment, and used vehicle. This study makes a significant contribution to optimizing the food supply chain at Ternakmart and the entire food industry in Indonesia, providing valuable guidance for the industry to address challenges and enhance operational efficiency.

INTRODUCTION

The supply chain in Indonesia is currently facing significant challenges [1], especially for domestic companies distributing their products within the country. These challenges include the continuous population growth, natural disaster risks, and financial crises that may result in losses for businesses [2]. Consequently, these challenges often lead to obstacles in product delivery and declining sales. Moreover, sustainability issues in supply chain management have become increasingly important and a primary concern for companies [3].

One of the domestic companies experiencing these challenges is PT Ternaknesia Farm Innovation (Ternakmart), a startup specializing in halal food business in Indonesia [4]. The company endeavors to distribute halal meat products of the highest quality through its supply chain. However, based on customer feedback data obtained from online and offline sales platforms such as Shopee and Retail Stores, there are indications that the quality of halal products in the supply chain is not yet optimal. Customers complain of receiving damaged or low-quality products and frequently experience delivery delays [5].

These issues suggest that despite PT Ternaknesia Farm Innovation's efforts to provide the best in its supply chain, there are still shortcomings in maintaining product quality and delivery speed. Such problems could reduce consumer trust in the halal products offered by the company. Therefore, it is crucial for the company to conduct a comprehensive evaluation of its production processes, quality control, and supply chain management. The company needs to enhance product supervision, ensure high-quality standards are maintained, and optimize delivery processes to ensure timely deliveries [6].

Previous research has utilized the Digital Supply Chain Twins (DSCT) approach as a method to address supply chain management issues. DSCT serves as a decision support tool with real-time data support, covering information on inventory data, demands, transportation routes, and other logistics parameters [7]–[9]. DSCT offers several advantages over other methods in supply chain management. Firstly, by using simulation technology, DSCT enables holistic modeling and analysis of the entire supply chain, gaining deep insights into the complex interactions between supply chain elements. Secondly, DSCT efficiently identifies and analyzes the impacts of specific changes in the supply chain, allowing for better decision-making and optimal strategy development.

Although there have been some studies applying DSCT in other industries, its implementation in the food industry in Indonesia remains limited [10]. The potential of DSCT is recognized as an innovation that can optimize logistics systems holistically and provide a basis for data-driven decision-making [11], [12]. By utilizing the DSCT approach, companies can conduct simulations to optimize supply chain performance, address existing challenges, and enhance operational efficiency. Through DSCT simulations, companies can achieve the best results to improve supply chain performance [13].

Therefore, this research focuses on implementing DSCT in the food supply chain in Indonesia, especially within companies like PT Ternaknesia Farm Innovation (Ternakmart). This study is highly urgent as it aims to provide guidance for food supply chain companies in Indonesia, particularly PT Ternaknesia Farm Innovation (Ternakmart), to optimize product delivery, enhance product quality, and tackle future supply chain challenges. The findings of this research also contribute significantly to the development of knowledge and supply chain management practices in Indonesia, particularly in applying DSCT technology to achieve sustainability and improved efficiency in the food industry's supply chain.

RESEARCH METHODS

The method used in this research is the digital twin method using AnyLogistix software. A digital twin is a virtual model of a real-world entity used to analyze and monitor the system to anticipate potential issues more quickly [14]. The purpose of using the digital twin method is to improve work efficiency and gather data directly from field observations to create solutions for existing problems [15].

Digital Supply Chain Twins (DSCT) is a detailed simulation model of the supply chain that utilizes real-time data to predict the dynamics of the supply chain. DSCT allows for a better understanding of the behavior of the supply chain, prevention of delays, testing changes and development of supply chain designs, risk monitoring, and efficient transportation planning [16]. By using DSCT, companies can optimize supply chain operations, reduce risks, improve efficiency, and respond better to market changes.

Figure 1 Digital Supply Chain Twins [17]

anyLogistix supply chain software

Figure 2 Software AnyLogistix [17]

In Figure 1 above, DSCT employs digital twin technology, which involves creating accurate digital replicas of the physical supply chain system. Data related to all elements of the supply chain are integrated into a single digital platform, enabling more accurate and responsive decision-making. DSCT also facilitates the analysis of supply chain interactions with demand changes, rapid issue forecasting, scenario testing, and enhanced responsiveness to demand fluctuations [18].

In this research **Figure 2**, AnyLogistix software is used to build the DSCT model. AnyLogistix is specifically designed to manage supply chains and improve company efficiency

[19]. The adoption of the digital twin method presents a new challenge in the industry, particularly in Indonesia, where public knowledge about this technology is limited. However, by implementing DSCT, companies in the food sector, such as PT Ternaknesia Farm Innovation (Ternakmart), can enhance the efficiency, sustainability, and responsiveness of their supply chains [20].

The study is centered around the analysis and optimization of Ternakmart's food supply chain, a retail company specializing in halal meat and fruit products situated in Surabaya, East Java, and Central Java, Indonesia. The analysis focuses on chicken, beef, fish, and various fruits, aiming to elevate supply chain operations' efficiency and quality through the application of the Digital Supply Chain Twins (DSCT) approach. The research involves a comprehensive collection of data, spanning sales invoices, customer details, preparation, and delivery team information, as well as routing data. These datasets have been meticulously chosen to encapsulate the complexities of DSCT and offer profound insights into product distribution. The case study uncovers the intricate supply chain challenges faced by Ternakmart, an innovative halal food startup, including issues like compromised product quality and frequent delivery delays, all substantiated by consumer feedback data.

RESULTS AND DISCUSSION

SIM Distribution Network Analysis

Table 1 Simulation Scenario

Scenario Setting	Order Duration	Description
Expected Lead Time: 2	Order Interval: 3	The simulation was conducted assuming that the expected lead time for the product delivery process is 2-time units. The interval between each order is 3-time units.
Expected Lead Time: 3	Order Interval: 5	The simulation was conducted assuming that the expected lead time for the product delivery process is 3-time units. The interval between each order is 5-time units.

The fundamental difference between the two scenarios lies in the values of Expected Lead Time and Order Interval used in the simulation. The first scenario has a shorter Expected Lead Time (2-time units) and a shorter Order Interval (3-time units), while the second scenario has a longer Expected Lead Time (3-time units) and a longer Order Interval (5-time units). The selection of scenario 1 (ELT 2, Order Interval 3) and scenario 2 (ELT 3, Order Interval 5) is based on the comparison of the effects of these two variations in inventory management, namely Expected Lead Time and Order Interval.

Scenario 1 depicts a condition in which the expected waiting time to fulfill orders is relatively shorter, with more frequent order placements, thus expecting more responsive order fulfillment to customer demands. On the other hand, scenario 2 reflects a situation with a longer waiting time and less frequent order placements, leading to more centralized inventory planning and higher operational efficiency. Through this comparison, the study aims to analyze the inventory performance, customer service levels, and effectiveness of inventory management between these two distinct approaches, with the hope of providing better insights for decision-making in inventory management.

Model Network and Object Visibility

In this phase, the research is conducted by forming a network model and object visibility within the context of the supply chain. Data regarding the locations of Ternakmart at various ports and warehouses have been previously inputted, including areas such as DCs Berbek Industri, DCs Wonosalam, DCs Diponegoro, and Tanjung Perak Surabaya Port. Additionally, the study also considers the utilization of three different types of vehicles to simulate more realistic deliveries: container shipments from suppliers to the port, lorry vehicles for journeys from the port to DCs, and pick-up vehicles for delivering products from warehouses to customers. Another crucial aspect is the implementation of Full Truckload (FTL) deliveries while maintaining a minimum load ratio of 0.8 between all objects involved in the delivery process. With this approach, the existing data becomes more valuable, and the supply chain simulation becomes closer to reality, including the appropriate selection of vehicle types based on their roles and the implementation of the specified load ratio.

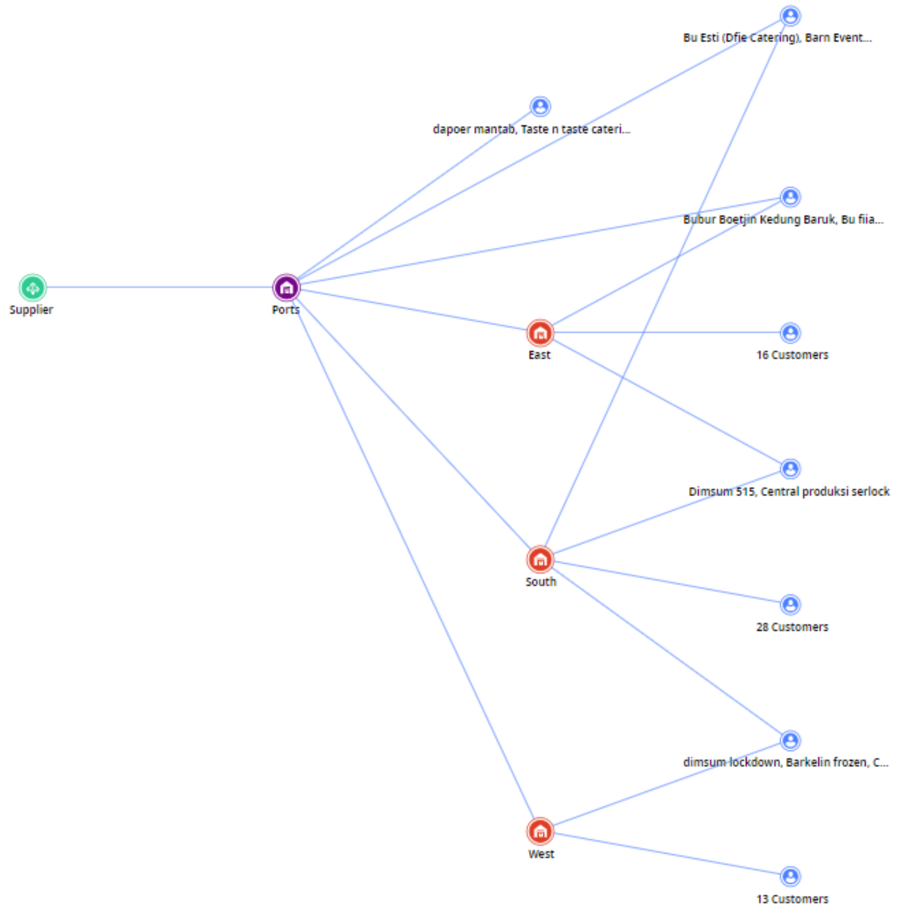


Figure 3. Network Structure

In the above **Figure 3** Network Structure, from DCs Berbek Industri, DCs Diponegoro, DCs Wonosalam, and Port of Tanjung Perak Surabaya to the 84 customers receiving chicken, fruit, beef, and fish products, can be displayed in the structure view above. This structural view depicts the logic of scenarios and the key elements of the supply chain, namely customers, DCs, factories, and suppliers, along with the connections between them. Through this structural view, it is possible to rearrange and filter these elements within their layout, making the entire concept of the supply chain more clearly visible.

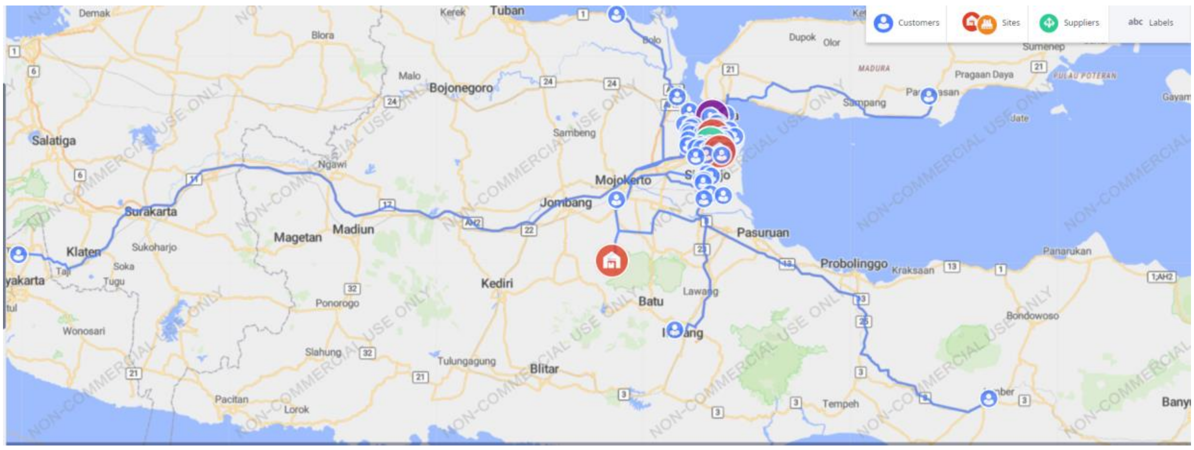


Figure 4. Object Visibility Distribution in East Java and Central Java from a far

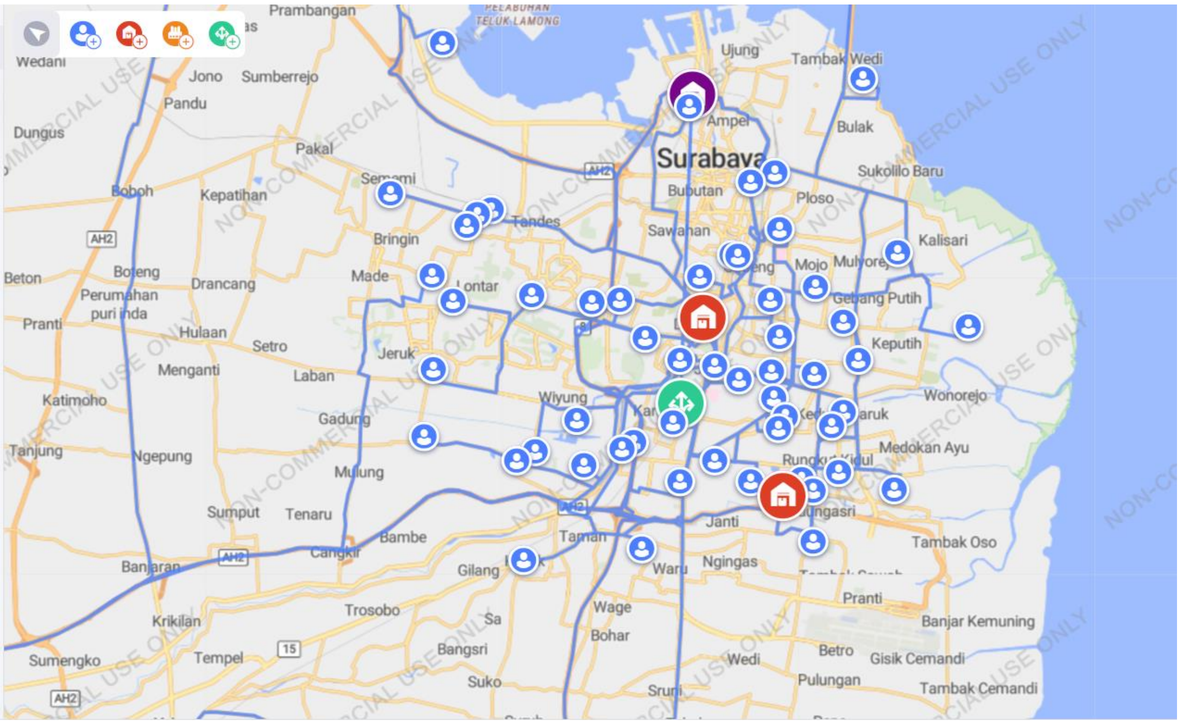


Figure 5. Object Visibility Ditribution in Surabaya from up close

The visualization of objects on the route map or delivery path from various Distribution Centers (DCs) and ports to 84 customers scattered across East Java (Jatim) and Central Java (Jateng) regions can be observed in the illustration provided in **Figure 4**. This illustration allows us to graphically depict the routes taken in the delivery process. With the capability of this visualization, we can more easily understand and analyze the paths taken by goods from each source of shipment (DCs and ports) to reach each end customer. The presence of this object visualization capability also offers benefits in conducting route efficiency analysis, thereby ensuring that all customers receive delivery services with optimal coverage. Through **Figure 5**, we can clearly observe the distribution network in the city of Surabaya involving complex routes, including the journey from suppliers to the port, from the port to the distribution center, and from the distribution center ultimately to the customers.

COMPARATIVE ANALYSIS OF RESULTS FROM 2 SCENARIOS

PROFIT AND LOSS STATEMENT

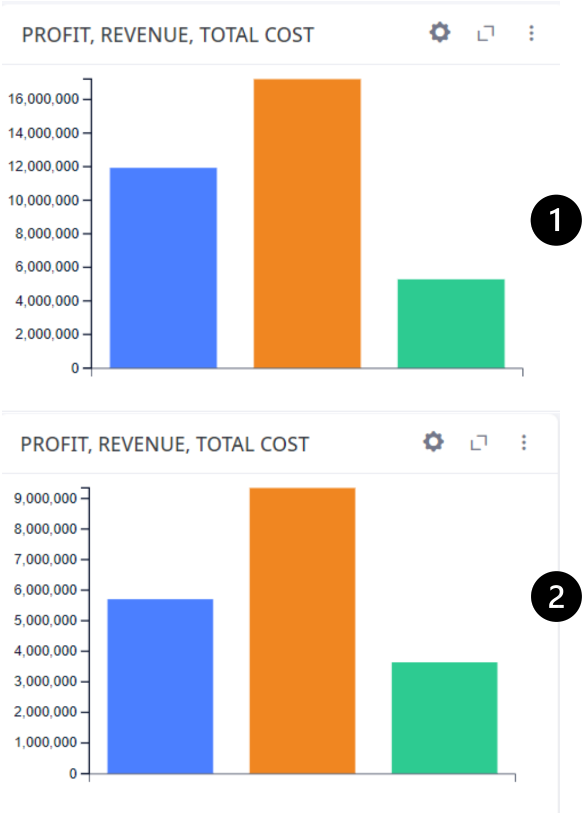


Figure 6. Profit and Loss Statement for Scenario 1 with ELT 2 and Scenario 2 with ELT 3

The comparative analysis between ELT 2 with a 3-day Order Interval and ELT 3 with a 5-day Order Interval in Figure 6 reveals the following outcomes. In the case of ELT 2 with a 3-day Order Interval, a profit of 5,286,977,022; is observed, with a total revenue of 17,215,056.04; and a total cost of 11,928,079.018. Conversely, for ELT 3 with a 5-day Order Interval, the generated profit amounts to 3,639,383,149; with revenue totaling 9,342,842.38; and a total cost of 5,703,459.231. These findings suggest that despite ELT 3 having lower total costs, the profitability attained through ELT 2 is significantly higher. Thus, considering the aspect of profitability, the strategy of utilizing ELT 2 with a 3-day Order Interval is favored over ELT 3 with a 5-day Order Interval.

SERVICE LEVEL BY SOURCE AND SERVICE LEVEL BY PRODUCT

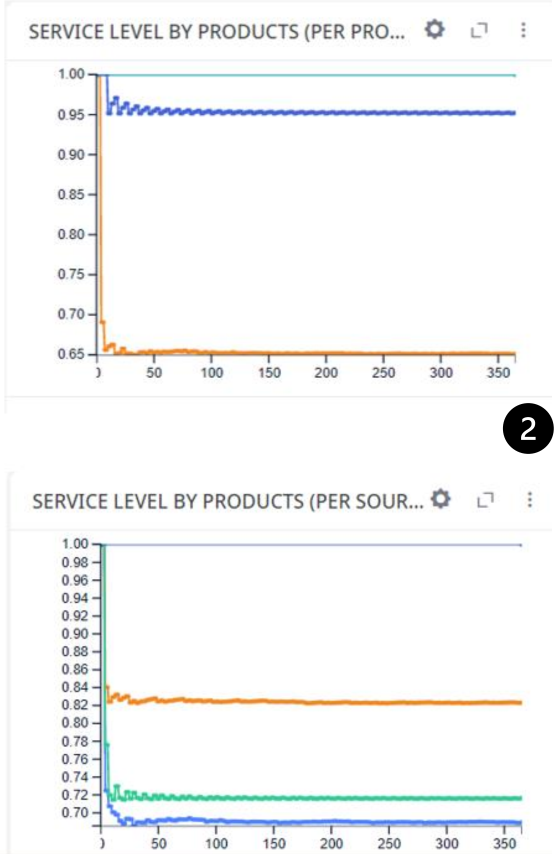


Figure 7. Service Level by Product and Service Level by Source for ELT 2 (Scenario 1) & ELT 3 (Scenario 2)

Legend: Light Blue: Fruit, Orange: Chicken, Green: Fish, Dark Blue: Beef.

From the analysis of the Service Level by Source graph (Scenario 1) in **Figure 7**, it can be observed that utilizing the main delivery source from DCs Diponegoro has a positive impact on achieving a more optimal service level compared to other sources. The service level line above the target indicates a significant contribution from using the port as the primary delivery source. In the analysis of the Service Level by Product, it is evident that the fruit products exhibit a stable service level, while the meat products experience fluctuations. In the alternate scenario (Scenario 2), uncertainties are noticeable in both source and product service levels. In conclusion, understanding these patterns enables the company to identify and rectify areas influencing the service level, supporting an overall enhancement in inventory and distribution management to meet customer satisfaction.

LEVEL BY SOURCE AND SERVICE LEVEL BY PRODUCT

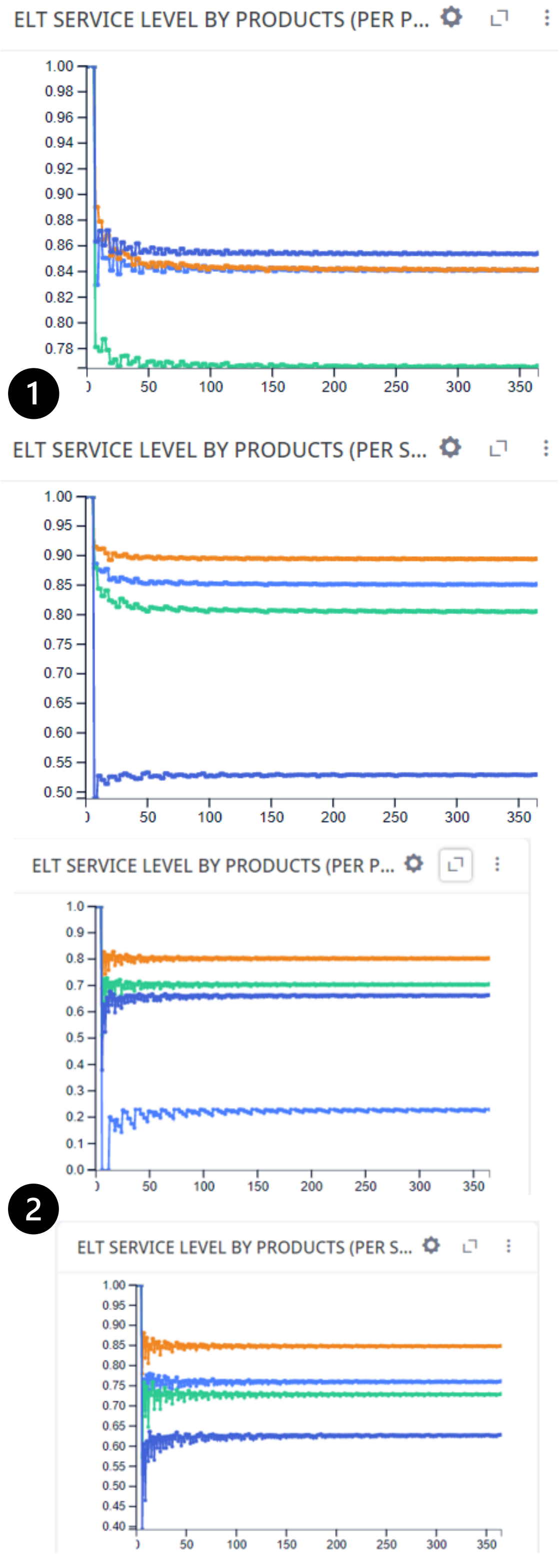


Figure 8. T 2 (Scenario 1) & ELT 3 (Scenario 2) Service Level by Product and Service Level by Source

Legend: Light Blue: Fruit, Orange: Chicken, Green: Fish, Dark Blue: Beef.

The comparative analysis of Service Level by Source and Service Level by Product, using the implementation of ELT 2 and ELT 3 in Scenarios 1 and 2, reveals that delivery efficiency and timeliness significantly impact the service levels. The utilization of ELT 2 maintains a favorable service level through consolidated deliveries, whereas ELT 3 results in significant delays that compromise service quality and customer satisfaction. The analysis further underscores the alignment between fluctuations in service levels across products and delivery sources, as depicted in **Figure 8**. Recommendations encompass stringent monitoring of ELT 3 deliveries and enhanced inventory management, leveraging technology to bolster efficiency and overall performance.

LEAD TIME

Figure 9. Lead Time of ELT 2 (Scenario 1) and Lead Time of ELT 3 (Scenario 2)

Legend:All Customer

In the comparative analysis of Lead Time between Scenario 1 with ELT 2 and Scenario 2 with ELT 3 **Figure 9**, a noticeable difference is evident. ELT 2 in Scenario 1 demonstrates consistency with no delays in product delivery, whereas ELT 3 in Scenario 2 introduces significant delays of up to 45 days, potentially compromising product quality. The ELT by Source analysis reveals that delayed product deliveries impact the service level of the source of delivery and customer satisfaction. Improvement in the delivery process is necessary to minimize delays and uphold service quality.

AVAILABLE INVENTORY

Figure 10. Available Inventory Including Backlog (Fruits) ELT 2 (Scenario 1) and ELT 3 (Scenario 2)

Legend: Light Blue: DCs Berbek, Orange: Diponegoro, Green: Wonosalam, Brown: Tanjung Perak.

In the comparison of fruit inventory in **Figure 10** between Scenario 1 and Scenario 2, several differences can be identified. In Scenario 1, inventory availability tends to be stable with varying quantities at each location, with DCs Diponegoro having the highest inventory (15). In Scenario 2, DCs Diponegoro and Wonosalam exhibit stability, while DCs Berbek experiences significant fluctuations with a drastic decrease and increase within the 5-day interval. Port Tanjung Perak also experiences fluctuations, albeit more limited than DCs Berbek. This analysis indicates a balance between product demand and inventory at some distribution centers, while others experience greater fluctuations.

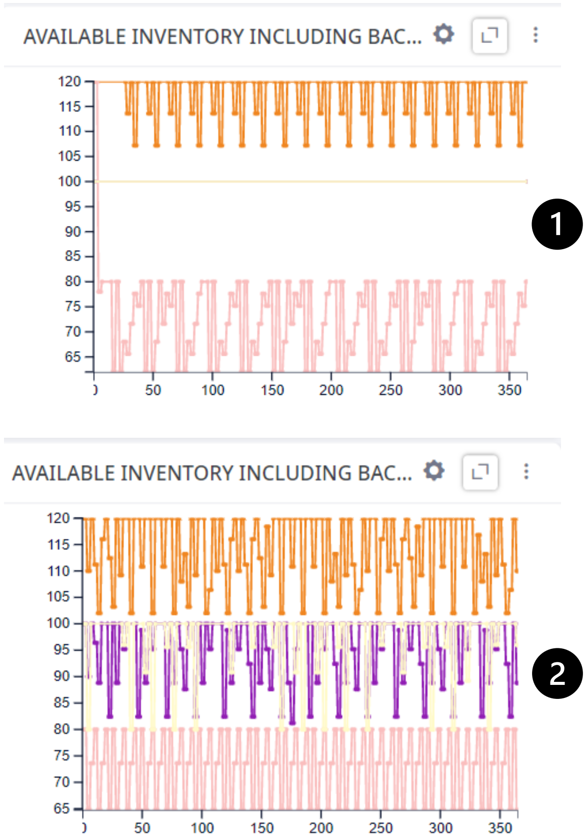


Figure 11. Available Inventory Including Backlog (Chicken Meat) ELT 2 (Scenario 1) and ELT 3 (Scenario 2)

Legend: Orange: DCs Berbek, Purple: Diponegoro, Pink: Wonosalam, Cream: Tanjung Perak.

In the analysis of chicken meat inventory in **Figure 11**, the differences and similarities between Scenarios 1 and 2 are evident. In Scenario 1, DCs Wonosalam and DCs Berbek Industri experience fluctuations, with DCs Wonosalam undergoing periodic fluctuations and DCs Berbek Industri showing stable fluctuations with higher inventory. DCs Diponegoro and Port Tanjung Perak remain stable. In Scenario 2, all DCs experience similar fluctuations in stock levels, but DCs Berbek Industri has a higher inventory, while DCs Diponegoro and Port Tanjung Perak fall between DCs Wonosalam and DCs Berbek Industri. This analysis identifies DCs Berbek

Industri as a distribution center with stable inventory and high stock levels, while other DCs have distinct roles in chicken meat supply.

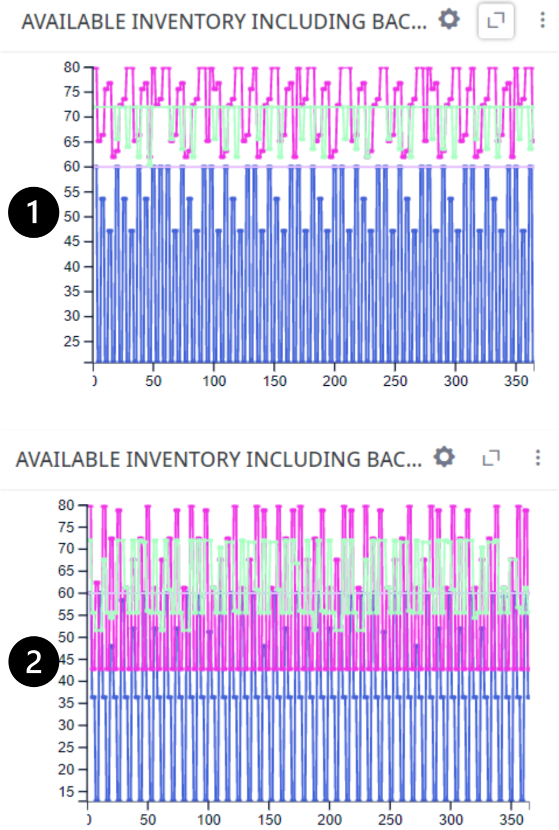


Figure 12. Available Inventory Including Backlog (Beef) for ELT 2 (Scenario 1) and ELT 3 (Scenario 2)

Legend: Dark Blue: DCs Berbek, Pink: Diponegoro, Gray: Wonosalam, Green: Tanjung Perak.

The comparison analysis of beef inventory in **Figure 11** reveals differences and similarities. In Scenario 1, DCs Wonosalam demonstrates stability without significant fluctuations, while DCs Berbek, DCs Diponegoro, and Port Tanjung Perak experience periodic fluctuations. DCs Berbek exhibits sharp fluctuations with the potential risk of stock shortages if replenishment is not timely, whereas DCs Diponegoro shows more controlled fluctuations and ample stock reserves. In Scenario 2, DCs Berbek experiences sharp fluctuations with the risk of stock shortages, while DCs Diponegoro maintains more stable fluctuations and sufficient stock reserves. DCs Wonosalam remains stable, and Port Tanjung Perak remains stable in relation to DCs Diponegoro. This analysis highlights the inventory management capabilities of each distribution center and the significant impact of large fluctuations on the risk of stock shortages.

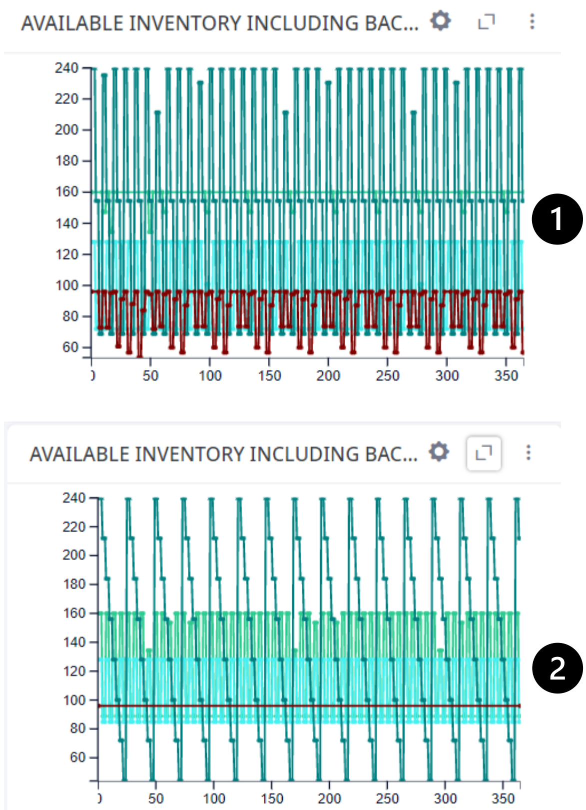


Figure 13. Available Inventory Including Backlog (Fish) ELT 2 (Scenario 1) and ELT 3 (Scenario 2)

Legend: Green: DCs Berbek, Light Blue: Diponegoro, Dark Green: Wonosalam, Brown: Tanjung Perak.

From the comparison analysis of fish inventory in **Figure 13**, a high fluctuation is evident in DCs Wonosalam, while DCs Berbek demonstrates stability and effective inventory management. DCs Diponegoro exhibits localized fluctuations, supported by a focus on deliveries in specific areas. Port Tanjung Perak experiences lower fluctuations compared to DCs Wonosalam, possibly due to strong connectivity with DCs Diponegoro. In conclusion, inventory stability contributes to sufficient product availability and reduction of delivery delay risks.

PEAK CAPACITY

PEAK CAPACITY

#	Statistics	Object	Value
1	Peak Capacity	DC Berbek Industri	699.6
2	Peak Capacity	DC Diponegoro	456.6
3	Peak Capacity	DC Wonosalam	546.8
4	Peak Capacity	Port of Tanjung Pera...	1,702

PEAK CAPACITY

2

#	Statistics	Object	Value
	filter	filter	filter
1	Peak Capacity	DC Berbek Industri	699.6
2	Peak Capacity	DC Diponegoro	456.6
3	Peak Capacity	DC Wonosalam	546.8
4	Peak Capacity	Port of Tanjung Pera...	1,702

Figure 14. Peak Capacity ELT 2 (Scenario 1) and ELT 3 (Scenario 2)

In the comparison analysis of peak capacity in **Figure 14**, differences in the processed data results between the two scenarios are evident. DCs Port Tanjung Perak has the highest peak capacity in both analyses, followed by DCs Berbek Industri, DCs Diponegoro, and DCs Wonosalam. However, there is a disparity in the peak capacity figures between the two scenarios. This change could be attributed to factors such as policy adjustments or capacity modifications between different analysis periods. This disparity highlights the importance of further evaluation to comprehend the influencing factors behind peak capacity changes and to optimize capacity utilization within the supply chain.

FULFILLMENT

DEMAND PLACED, FULFILLMENT RECEIVED (ACCUMULATIVE)

1

#	Statistics	Product	Value
	filter	filter	filter
1	Demand Placed (Products) by Customer	Daging Ayam	81,118.4
2	Fulfillment Received (Products) by Customer	Daging Ayam	80,985.6
3	Fulfillment Received (Products On-time)	Daging Ayam	68,172
4	Demand Placed (Products) by Customer	Daging Ikan	48,303.2
5	Fulfillment Received (Products) by Customer	Daging Ikan	48,171.2
6	Fulfillment Received (Products On-time)	Daging Ikan	36,923.2
7	Demand Placed (Products) by Customer	Daging Sapi	15,294.4
8	Fulfillment Received (Products) by Customer	Daging Sapi	15,261.6
9	Fulfillment Received (Products On-time)	Daging Sapi	13,037.6
10	Fulfillment (Late Products)	Daging Ayam	12,813.6
11	Fulfillment (Late Products)	Daging Ikan	11,248
12	Fulfillment (Late Products)	Daging Sapi	2,224
13	Demand Placed (Products) by Customer	Buah	1,089
14	Fulfillment Received (Products) by Customer	Buah	1,086

DEMAND PLACED, FULFILLMENT RECEIVED (ACCUMULATIVE)

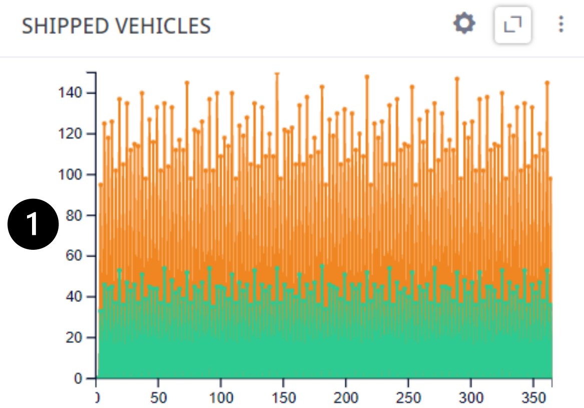
2

#	Statistics	Product	Value
	filter	filter	filter
1	Demand Placed (Products) by Customer	Daging Ayam	57,402.4
2	Fulfillment Received (Products) by Customer	Daging Ayam	57,241.6
3	Fulfillment Received (Products On-time)	Daging Ayam	45,973.2
4	Demand Placed (Products) by Customer	Daging Ikan	24,006.4
5	Fulfillment Received (Products) by Customer	Daging Ikan	23,909.6
6	Fulfillment Received (Products On-time)	Daging Ikan	16,845.6
7	Fulfillment (Late Products)	Daging Ayam	11,278
8	Demand Placed (Products) by Customer	Daging Sapi	9,341.2
9	Fulfillment Received (Products) by Customer	Daging Sapi	9,296.8
10	Fulfillment (Late Products)	Daging Ikan	7,064
11	Fulfillment Received (Products On-time)	Daging Sapi	6,164.8
12	Fulfillment (Late Products)	Daging Sapi	3,132
13	Demand Placed (Products) by Customer	Buah	145.2
14	Fulfillment Received (Products) by Customer	Buah	144

Figure 15. Fulfillment ELT 2 (Scenario 1) and ELT 3 (Scenario 2)

In the comparison analysis of Fulfillment in **Figure 15**, a significant difference is evident between the cases of ELT 2 (Scenario 1) with a delay of 26%, which remains relatively acceptable within the context of a large total order volume, and the case of ELT 3 (Scenario 2) with a delay of 37%, indicating a serious issue in the delivery process. In the case of ELT 3, the high delay with a range of up to 45 days can have a negative impact on customer satisfaction and business potential. Therefore, more aggressive improvement measures are required to enhance the efficiency and reliability of the delivery process, whereas the ELT 2 case demonstrates a more tolerable delay with a lower scale comparison. Ongoing evaluation is crucial to ensure the quality of order fulfillment and timely delivery.

USED VEHICLE



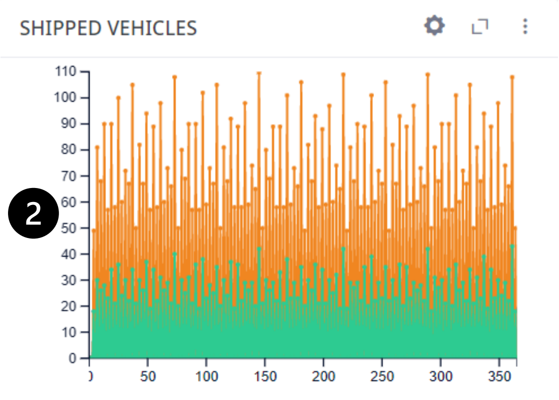


Figure 16. Used Vehicle ELT 2 (Scenario 1) and ELT 3 (Scenario 2)

Legend: Light Blue: Container, Orange: Lorry, Green: Pick-up.

In **Figure 16** of Scenario 1, the distribution relies more on thermo trucks (lorries) compared to pickup trucks, with a higher number of lorries (139) than pickups (58), indicating the need for larger-capacity vehicles for large-scale deliveries to distribution centers (DCs). However, Scenario 2 reveals an imbalance between the supply of products from containers to the port and pickup deliveries. In this case, the company needs to optimize vehicle allocation to address this imbalance, such as reinforcing the supply from containers to the port and enhancing the delivery capacity of pickups, to reduce inventory buildup at DCs and improve distribution efficiency to customers.

Table 2 Summary of Comparative Analysis Results

Metric	Type	Scenario 1	Scenario 2	Description
Profit and Loss Statement	Profit	$11.928,079.018	$5.703,459.231	Usage of ELT 2 is more optimal as it generates higher profit compared to ELT 3.
	Revenue	$17.215,056.04	$9.342,842.38	Usage of ELT 2 is more optimal as it generates higher revenue compared to ELT 3.
	Total Cost	$5.286,977.022	$3.639,383.149	Usage of ELT 2 is more optimal as it has lower total costs compared to ELT 3.
Service Level by Source	DCs Berbek	0.75	0.7	Service level for ELT 2 is 75%, while for ELT 3 it is 70%.
	DCs Diponegoro	0.90	0.84	Service level for ELT 2 is 90%, while for ELT 3 it is 84%.
	DCs Wonosalam	1	1	Service level for ELT 2 is 100%, while for ELT 3 it is 100%.
	Port of Tanjung Perak	1	1	Service level for ELT 2 is 100%, while for ELT 3 it is 100%.
Service Level by Product	Fruits	1	0.95	Service level for the product "Fruits" in ELT 2 is 100%, while in ELT 3 it is 95%.
	Chicken Meat	0.60	0.70	Service level for the product "Chciken Meat" in ELT 2 is 60%, while in ELT 3 it is 70%.
	Beef	1	0.95	Service level for the product "Beef" in ELT 2 is 100%, while in ELT 3 it is 95%.
	Fish	0.95	1	Service level for the product "Fish" in ELT 2 is 95%, while in ELT 3 it is 100%.
ELT Service by Source	DCs Berbek	1	0.60	ELT level for DCs Berbek in ELT 2 is 100%, while in ELT 3 it is 60%.
	DCs Diponegoro	0.95	0.85	ELT level for DCs Diponegoro in ELT 2 is 95%, while in ELT 3 it is 85%.
	DCs Wonosalam	0.90	0.75	ELT level for DCs Wonosalam in ELT 2 is 90%, while in ELT 3 it is 75%.
	Port of Tanjung Perak	1	1	ELT level for Port of Tanjung Perak in ELT 2 is 100%, while in ELT 3 it is 100%.
ELT Service by Product	Fruits	0.86	0.40	ELT level for the product "Fruits" in ELT 2 is 86%, while in ELT 3 it is 40%.
	Chicken Meat	0.90	0.80	ELT level for the product "Chicken Meat" in ELT 2 is 90%, while in ELT 3 it is 80%.
	Beef	1	1	ELT level for the product "Beef" in ELT 2 is 100%, while in ELT 3 it is 100%.
	Fish	0.88	0.75	ELT level for the product "Fish" in ELT 2 is 88%, while in ELT 3 it is 75%.
Lead Time		3-6 hari	5-45 hari	Usage of ELT 2 is more optimal due to its shorter and more stable delivery lead time compared to ELT 3, which experiences delays of up to 45 days. Therefore, the usage of ELT 2 is more optimal as it provides shorter and more stable

Metric	Type	Scenario 1	Scenario 2	Description
				delivery lead time, thus enhancing efficiency and customer satisfaction in the food supply chain.
Available Inventory	Fruits	Min: 6, Max: 15	Min: 3, Max: 15	ELT 2 is more optimal as it has a larger inventory compared to ELT 3.
	Chicken Meat	Min: 65 Max: 120	Min: 65, Max: 120	The fluctuation difference of ELT 2 is better than ELT 3 in inventory management.
	Beef	Min: 25, Max: 80	Min: 15, Max: 80	ELT 2 is more optimal as it has a higher initial inventory.
	Fish	Min: 75, Max: 240	Min: 60, Max: 240	ELT 2 is more optimal as it maintains a better inventory level compared to ELT 3.
Peak Capacity	DCs Berbek	699.6	768	In scenario 2, peak capacity at DCs Berbek Industri is higher.
	DCs Diponegoro	456.6	605	In scenario 1, peak capacity at DCs Diponegoro is lower.
	DCs Wonosalam	546.8	405.8	In scenario 1, peak capacity at DCs Wonosalam is higher.
	Port of Tanjung Perak	1,702	1,410.2	In scenario 1, peak capacity at Port Tanjung Perak is higher.
Fulfilllment	Delay Scale	26%	37%	ELT scenario 1 experiences fewer delays compared to scenario 2, making scenario 1 more optimal.
Used Vehicle	Container	41	30	ELT 2 utilizes more containers.
	Lorry	139	102	ELT 2 utilizes more thermo (lorry) vehicles.
	Pickup	58	25	ELT 2 utilizes more pick-up vehicles.

The analysis results conclude that overall, the usage of ELT 2 demonstrates a more optimal performance compared to ELT 3 in several aspects of the food supply chain. Firstly, in terms of profitability, the analysis of the Profit and Loss Metric indicates that ELT 2 generates higher profits, greater revenue, and lower total costs compared to ELT 3. Furthermore, in terms of service levels based on source and product, ELT 2 also achieves higher service levels than ELT 3. The source-based service level demonstrates that ELT 2 has higher percentages across all sources, while the product-based service level shows that ELT 2 has higher percentages across all product types. Additionally, ELT 2 also exhibits better lead times, more available inventory, optimal peak capacity, and more efficient vehicle utilization. From these analysis findings, it can be concluded that the overall usage of ELT 2 is more optimal in enhancing the performance and efficiency of the food supply chain compared to ELT 3.

CONCLUSION

Based on the simulation results using the DSCT method and the implementation of the AnyLogistix software in this study, it can be concluded that this approach provides innovative contributions to food supply chain management. The DSCT modeling integrates the unique characteristics of the food supply chain and enables accurate real-time modeling. Its application to the Ternakmart case demonstrates its effectiveness in analyzing performance, identifying risks, and optimizing solutions. Furthermore, the analysis results indicate optimal values in various performance aspects, underscoring the potential of the DSCT approach to enhance efficiency, reduce costs, and address challenges in the food industry. By employing simulation methods and digital twin analysis, this research not only offers deep insights into the dynamics of the supply chain but also guides the direction for potential future research in this field.

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