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Analysis of on-time delivery performance from inbound logistics, operations, and outbound logistics

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Abstract: This research aims to study the logistics and transportation management of Sattel (Thailand) Co., Ltd., a company engaged in domestic freight transport. A mixed methods research approach was employed, combining both qualitative and quantitative analyses. The qualitative research involved in-depth interviews and field observations, while the quantitative component utilized data from ERP and distribution requirements planning (DRP) systems, as well as vehicle routing problem (VRP) techniques for route optimization. The findings indicate that key factors influencing transportation performance include route planning, vehicle resource management, real-time shipment tracking, and communication among relevant departments. The main challenges identified were suboptimal route planning, leading to delivery delays, workforce shortages during peak periods, and ineffective coordination across inbound logistics, operations, and outbound logistics. To enhance transportation efficiency, the study proposes several strategies: implementing systematic transport route planning using appropriate route optimization technologies; improving the flexibility of vehicle resource allocation; adopting comprehensive real-time shipment tracking systems; and strengthening coordination processes among all involved parties. These improvements are expected to increase delivery punctuality, reduce delays, and elevate the overall performance of the logistics system.
Keywords: *Distribution requirements planning, Inbound logistics, Operations, Outbound logistics, Vehicle routing problems.*

1. Introduction

1.1. Background and Importance of the Problem

In recent years, the logistics sector worldwide has faced significant changes, especially due to the rapid growth of e-commerce, changing consumer behaviors, and technological advancements. According to Santos, et al. [1] the global logistics market was valued at approximately 345.13 billion USD in 2023 and is projected to expand to 536.88 billion USD by 2030, with a compound annual growth rate (CAGR) of 9.6%. This growth is driven by key factors such as the expansion of e-commerce, retail, and healthcare sectors, creating increased demand for faster, more flexible, and accurate distribution systems. Regionally, many countries are accelerating the development of infrastructure and smart systems, such as the European Union's "Smart Logistics" that utilizes Big Data and AI to improve route accuracy and resource management efficiency. Meanwhile, countries in the Asia-Pacific region, such as China, Japan, and South Korea, are investing in container tracking systems using IoT and blockchain technology, reducing errors in data exchange and increasing transparency in the supply chain.

For Thailand, as the economic hub of ASEAN, it faces challenges and pressures from these global changes. According to the Montoya-Torres, et al. [2] the value-added logistics sector in Thailand is 525.1 billion THB, or 3.0% of GDP, while the total logistics cost reaches 2,527.4 billion THB, or 14.1% of GDP, with transportation costs accounting for 6.7%, inventory costs for 6.4%, and management costs for 1.0%. These figures reflect both opportunities and cost burdens for businesses, and without

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significant system improvements, they directly impact the organization's competitiveness. Additionally, Thailand's logistics sector faces issues such as incomplete infrastructure, lack of integration between transport modes (road-rail-sea), fluctuating fuel prices, and increasing labor shortages, highlighting the urgent need to adopt technologies like Vehicle Routing Problem (VRP), Distribution Requirements Planning (DRP), and ERP/WMS systems that can enhance accuracy, reduce costs, and meet delivery deadlines.

In the case of Sattel (Thailand) Co., Ltd., a leading importer and distributor of electrical cables for industrial and large building sectors, the company faces specific challenges such as demand uncertainty, reliance on imports with risks in cost and lead time, and issues in warehouse management and on-time delivery planning. Despite financial stability and a warehouse located in Bangkok, the company faces challenges with customer expectations for accurate and fast deliveries. Relying solely on experiential data for decision-making may not suffice for strategic decisions and sustainable logistics system improvements. Key issues the company faces include delivery delays due to poor route planning, failure to prepare products on time due to lack of internal coordination, absence of real-time data connectivity between departments, and inaccurate data analysis, making it difficult to forecast product demand efficiently.

In this context, this research is crucial in presenting a systematic solution by utilizing qualitative data from actual operators and quantitative data from ERP and DRP systems to assess performance and simulate routing and resource management alternatives. This data will be analyzed with theoretical concepts such as the Vehicle Routing Problem (VRP) model and Smart Logistics concepts to propose an integrated logistics system planning approach. This research aims to provide a deep understanding of the issues and support systematic internal process improvements, with the goal of enhancing efficiency, reducing costs, and increasing long-term competitiveness, in line with the ongoing growth trends in the global and regional logistics sectors.

1.2. Research Question

Based on the analysis of the problem characteristics, causes, and solutions in logistics operations, the research questions are as follows:

1) What are the factors affecting on-time delivery performance in each stage of the logistics process, including Inbound Logistics, Operations, and Outbound Logistics?

2) How effective is the organization's logistics management system in supporting on-time delivery?

3) What strategies can be implemented to improve the overall logistics process to enhance on-time delivery and reduce delays?

1.3. Research Objective

The study on the analysis of on-time delivery performance across inbound logistics, operations, and outbound logistics aims to achieve the following research objectives:

1) To analyze the key factors influencing on-time delivery performance at each stage of the logistics process, namely Inbound Logistics, internal Operations, and Outbound Logistics.

2) To evaluate the effectiveness of the logistics management system in supporting on-time delivery, using quantitative indicators such as customer waiting time, frequency of delivery delays, and delay-related costs.

3) To propose strategies for improving the overall logistics management system by integrating information across the supply chain, from upstream to downstream, through approaches such as Distribution Requirements Planning (DRP) and solutions to Vehicle Routing Problems (VRP), in order to reduce delays, enhance operational efficiency, and sustainably increase customer satisfaction.

2. Literature Review

2.1. Related Concepts and Theories

2.1.1. Inbound Delivery

The process of outbound delivery, from warehouses or distribution centers to customers or designated destinations, encompasses timely delivery planning, proper packaging, preparation of transportation documents, vehicle loading, and continuous tracking of delivery status. These activities ensure the smooth, accurate, and efficient flow of goods while minimizing potential losses. This study applies conceptual frameworks from McHugh [3]; Houghton [4]; Kwan [5]; Lee, et al. [6]; Wargo [7]; Meyer [8]; Wong [9] and Lee [10] to analyze the outbound delivery process, focusing on enhancing delivery efficiency, reducing transportation costs, and improving customer satisfaction. These concepts align with modern logistics management principles, which emphasize speed, accuracy, and efficient resource utilization.

2.1.2. Milk Runs Design

Milk Run is a transportation route design strategy that consolidates the collection of goods or raw materials from multiple points into a single trip. The objective is to minimize the number of vehicle trips and operational time. This approach enhances truck utilization efficiency, reduces fuel costs, and improves the accuracy of raw material deliveries to warehouses or production lines. The researcher adopted conceptual frameworks from McHugh [3]; Houghton [4]; Kwan [5]; Lee, et al. [6]; Wargo [7]; Meyer [8]; Wong [9] and Lee [10]to synthesize and design a Milk Run system that aligns with real-world industrial conditions. This includes scheduling, defining pick-up and drop-off points, and applying dynamic route adjustments to ensure a continuous, fast, and cost-effective material flow.

2.1.3. Vehicle Routing Problems

Vehicle routing design aims to maximize delivery efficiency by minimizing travel distance and operational costs through the application of algorithms, computational strategies, and mathematical models. In this study, key factors are considered, including travel distance and time to ensure the fastest possible delivery; vehicle load capacity constraints to ensure compliance with technical specifications; and route conditions such as the number of stops, sequence of visits, and time window restrictions at each location. The researcher adopts conceptual frameworks from McHugh [3]; Houghton [4]; Kwan [5]; Lee, et al. [6]; Wargo [7]; Meyer [8]; Wong [9] and Lee [10] as the foundation for synthesizing and designing a VRP solution approach tailored to the context of Thailand's logistics system. The goal is to generate cost-effective routing plans that genuinely meet the needs of logistics service providers.

2.1.4. Distribution Terminal

Distribution Terminal Management encompasses processes ranging from inbound receipt, systematic storage, and order picking for outbound delivery, to the final dispatch of goods to their destinations. Each step requires precise planning of storage space, personnel allocation, and equipment utilization to ensure continuity within the supply chain, enhance operational efficiency, reduce costs, and flexibly accommodate increasing order volumes. This study applies conceptual frameworks from McHugh [3]; Houghton [4]; Kwan [5]; Lee, et al. [6]; Wargo [7]; Meyer [8]; Wong [9] and Lee [10] to synthesize a management approach for distribution terminals suited to the Thai context. This includes warehouse layout design, sequencing of order picking, delivery route planning, and the use of information technology to support strategic decision-making. The aim is to enable distribution centers to respond rapidly, flexibly, and sustainably to market demands.

2.1.5. Distribution Requirements Planning

Distribution Requirements Planning (DRP) is the process of planning and controlling the distribution of goods to distribution centers or regional areas based on demand forecasts in each region. The objective is to ensure product availability for continuous and timely market delivery. This process involves analyzing historical sales data, demand trends, and various external factors to determine appropriate stock levels and replenishment timing. The study applies conceptual frameworks from leading scholars, McHugh [3]; Houghton [4]; Kwan [5]; Lee, et al. [6]; Wargo [7]; Meyer [8]; Wong [9] and Lee [10] as a foundation for synthesizing empirical variables and developing a DRP model tailored to the specific context and challenges of the logistics sector.

2.1.6. Outbound Delivery

The process of outbound delivery, from warehouses or distribution centers to customers or designated destinations, encompasses timely delivery planning, proper packaging, preparation of transportation documents, vehicle loading, and continuous tracking of delivery status. These activities ensure the smooth, accurate, and efficient flow of goods while minimizing potential losses. This study applies conceptual frameworks from McHugh [3]; Houghton [4]; Kwan [5]; Lee, et al. [6]; Wargo [7]; Meyer [8]; Wong [9] and Lee [10] to analyze the outbound delivery process, focusing on enhancing delivery efficiency, reducing transportation costs, and improving customer satisfaction. These concepts align with modern logistics management principles, which emphasize speed, accuracy, and efficient resource utilization.

2.2. Literature Surveys

2.2.1. Inbound Logistics

Puspitasari and Kurniawan [11] developed a VRP model considering capacity and time constraints, using CPLEX to obtain solutions. Their results showed an 18% reduction in total travel distance and a 10% decrease in the number of vehicles used compared to the original plan, significantly reducing fuel costs and delivery time.

Sabet and Farooq [12] reviewed studies on Green VRP (G-VRP), integrating environmental factors such as CO_2 emissions and energy usage. They categorized existing solution approaches and highlighted research gaps, including the management of uncertainty and the application of IoT/Big Data in green logistics systems.

Santos, et al. [1] developed a VRP model that integrates delivery, returns, and reverse logistics into a single system. They used Mixed-Integer Linear Programming and Adaptive Large Neighborhood Search (ALNS) to solve the problem. The results showed a 10–15% reduction in both distance and cost compared to traditional models.

2.2.2. Operations

Lee [13] proposed Cyber-Physical Systems (CPS) that integrate IoT, Big Data, and Edge/Cloud Computing with MES to enhance real-time production tracking capabilities. Their system includes Predictive Maintenance using Machine Learning, improving OEE by over 20% and reducing maintenance costs by 25%.

Montoya-Torres, et al. [2] reviewed solutions to Multi-Depot VRP (MDVRP) using Exact, Heuristic, and Metaheuristic techniques. They proposed the integration of ERP/WMS data to improve route planning accuracy and identified gaps in the development of Dynamic MDVRP and sustainable future routing solutions.

Tao, et al. [14] developed a Digital Twin Architecture consisting of IoT, production line simulation systems, and AI to analyze data. This system improved flexibility and reduced issues in factories, resulting in a 20% reduction in emergency repairs and a 15% increase in throughput within the first quarter.

2.2.3. Outbound Logistics

González-Feliu and Morana [15] used a VRP model combined with Clustering techniques and real-time traffic data to reduce delivery distances and improve routing flexibility. The results showed an

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~18% reduction in distance and an increase in Service Level to 95%. They also experimented with integrating Crowdsourced Delivery to reduce costs and pollution in low-density areas.

Cattaruzza, et al. [16] developed a Cross-Docking VRP model that minimizes intermediate stockholding. The results demonstrated a 22% reduction in Dwell Time, a 24% decrease in total distance, and a 12% increase in cargo space utilization, using LNS + VND algorithms to efficiently solve large-scale problems.

Boysen and Schwerdfeger [17] reviewed integrated Last-Mile Logistics approaches (VRP, CrowdShipping, Drones) and found that using multiple transport modes + dynamic Metaheuristics could reduce costs and time by more than 15% in urban areas. They recommended integrating real-time data from IoT and developing automated systems to accommodate operational order changes.

2.2.4. Wholesale

Disney and Towill [18] developed a VMI model that significantly reduces the Bullwhip Effect and stock variance using dynamic models and Monte Carlo simulation. They found that this approach helped reduce inventory holding costs by 20% and overall logistics costs by 15%, while also increasing flexibility in adjusting plans according to actual demand.

Richey and Davis-Sramek [19] reviewed 150 pieces of literature on Inventory Management, highlighting a gap in integrating modern technologies such as IoT, AI, and Blockchain to support Omni-channel, Sustainability, and Resilience. They propose developing a Real-Time Inventory System using Deep Learning and Big Data.

2.2.5. Retail

Verhoef, et al. [20] describe the transition from Multi-channel to Omni-channel, emphasizing seamless integration of both technology systems and fulfillment processes, as well as returns management. They highlight the importance of real-time Inventory Visibility to manage centralized stock (Inventory Pooling), reduce Lead Time, and increase Fill Rate.

Ailawadi and Farris [21] propose a framework for evaluating distribution channels through indicators such as Customer Order Fill Rate and Channel Margin Contribution. They found that integrating data through a unified CRM/WMS system improves Fill Rate and channel returns, while recommending strategies like Price Fences, Omni-promotions, and AI-driven Forecasting to reduce conflicts and increase stock management accuracy.

Bell, et al. [22] analyze Showrooming and Webrooming in the Omni-channel context through an economic model, finding that seamless integration of online and offline experiences increases CLV by about 12%, boosts Conversion by 8–10%, and reduces returns by 15%. They recommend investing in centralized IT systems and enhancing employee skills to effectively manage all Touchpoints.

2.3. Conceptual Framework (Action Research)

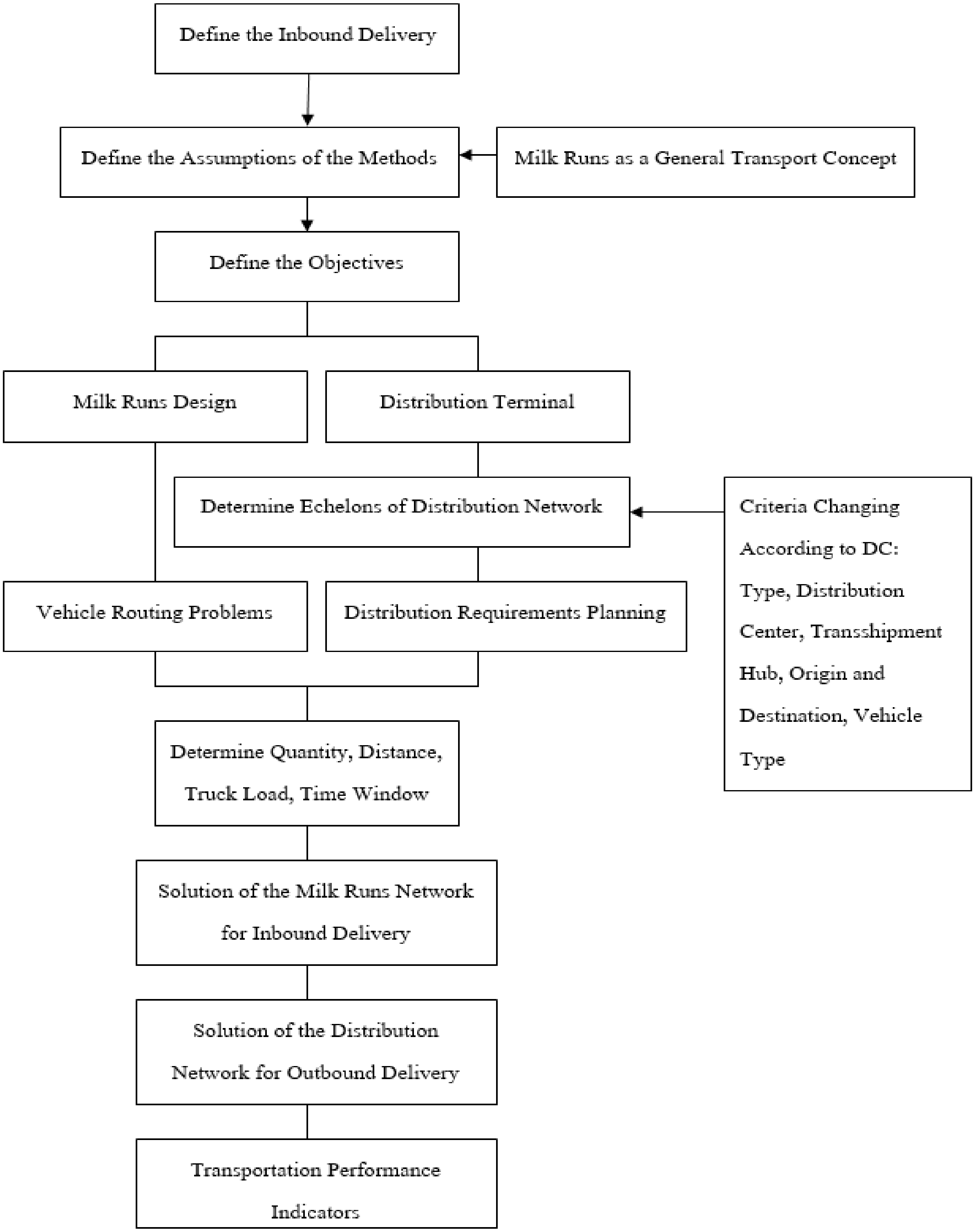

Figure 1.
Action Research Framework.

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3. Research Methodology

3.1. Research Design

This research employs a mixed-methods approach, combining both qualitative and quantitative data to provide a comprehensive understanding of the logistics process of Sattel (Thailand) Co., Ltd. The qualitative data collection includes interviews, observations, and focus group discussions, while the quantitative data is sourced from ERP, DRP, and GPS systems for accurate analysis and decision-making.

3.2. Population and Sample

1) Population and Sample: The population and sample consist of employees from the procurement, warehouse, planning, and delivery departments of the company.

2 Sample Size: The qualitative sample includes 5 individuals from 4 departments, selected purposively, all with at least 2 years of experience and usage of the ERP/DRP systems. For the quantitative data, information was collected from the actual system over a 12-week period, covering purchase orders, delivery trips, costs, distances, etc.

3.3. Research Procedure

The research procedure begins with a literature review, followed by tool design, obtaining permissions, and scheduling. Data collection for both qualitative and quantitative aspects is then carried out. Finally, the data is analyzed, and scenarios are simulated using VRP and DRP models to propose improvement strategies.

3.4. Research Instruments

1) Semi-structured interview guides and observation forms for qualitative data collection.
2) ERP/DRP data forms, along with software tools like Excel, VRP Solver, and GIS, for quantitative data collection.

3.5. Research Instrument Quality Validation

A pilot study was conducted with selected employees, and data consistency was verified by comparing ERP data with operational reports.

3.6. Data Collection

1) Qualitative: Interviews with 15 employees, along with direct observations.
2) Quantitative: Data from ERP, DRP, and GPS systems, including purchase orders, delivery trips, product weights, distances, costs, etc.

3.7. Data Analysis

Qualitative data was analyzed through categorization and interpretation (Content Analysis), while quantitative data was analyzed using descriptive statistics and scenario simulations with VRP and DRP models to evaluate the effectiveness of product distribution and inventory planning.

4. Data Analysis and Findings

4.1. Introduction

This chapter presents the results of the data analysis obtained from the study, divided into two main parts to provide both in-depth and quantitative analysis. These analyses will support the planning of product distribution demand and vehicle routing efficiency. Both types of data analysis are crucial for decision-making and strategy formulation within the context of logistics and supply chain businesses.

4.2. Data Analysis of the Qualitative Data

The qualitative data analysis focuses on collecting and understanding information from the experiences, opinions, and perspectives of stakeholders in the logistics process, such as warehouse staff, delivery personnel, route planning departments, and management. This data is gathered from interviews, observations of work behavior, and brainstorming sessions, which helps understand the factors and conditions affecting system performance.

4.2.1. Internal and External Factors Affecting Product Distribution

The analysis of qualitative data highlights both internal and external factors affecting product distribution:

1) Internal Factors: Organizational management structure, the skills and experience of personnel, resource allocation (e.g., vehicles, delivery staff, warehouse information systems).

2) External Factors: Traffic conditions, fluctuations in product demand, policy-related factors (e.g., road usage regulations, weight limits for transport vehicles, import taxes).

4.2.2. Problems and Obstacles in Operations

Qualitative data analysis also helps identify issues and obstacles encountered in actual operations, which may not be evident in reports or statistical data. Examples include issues such as broken transport vehicles, delayed deliveries due to rain, improper product arrangement, or confusion in using software systems.

4.2.3. Feedback and Suggestions from Interviews

In-depth interviews with stakeholders in the logistics process provided valuable insights for improving the system. The respondents shared their opinions and suggestions on several issues, such as:

1) The key components of the inbound logistics process that affect timely delivery.
2) Approaches to managing suppliers to prevent delays.
3) Steps within the warehouse that often lead to delays and ways to address them.
4) The use of technology for tracking and controlling time at each step.
5) Methods for evaluating and measuring on-time delivery performance.
6) Factors directly affecting on-time delivery to customers in the outbound logistics process.
7) Approaches to handling external factors that affect product delivery.
8) The effectiveness of coordination between different departments within the organization.
9) The biggest challenges in maintaining on-time delivery performance.
10) Suggestions or policies that can improve the efficiency of the logistics system.
11) Factors affecting product distribution and route planning.

The qualitative data analysis also helped to understand the factors affecting product distribution and route planning, which are complex and interrelated. These factors include:

1) Vehicle and Personnel Readiness: The adequacy and operational condition of transportation vehicles, as well as the experience and expertise of drivers.

2) Planning and Scheduling Capability: The use of accurate and up-to-date information, GPS systems, and route planning software.

3) Road and Environmental Issues: Traffic conditions, weather, and accidents.

4) Customer-Specific Demands: The diversity of customer needs and the urgency of deliveries.

4.3. Data Analysis of the Quantitative Data

4.3.1. Inbound Logistics

In the Inbound Logistics process, data was collected regarding the number of suppliers, their locations, the distance from the warehouse, order quantities per shipment, and the types of raw materials used in the production process. This data forms a crucial foundation for route planning, purchase cycle determination, and forecasting the amount of raw materials to be stocked in advance.

Additionally, factors such as transportation costs, delivery time, and potential risks, including delivery delays, raw material shortages, or quality issues, must be considered. The numerical data from Inbound Logistics can also be analyzed in conjunction with resource constraints, such as the capacity of vehicles used for transportation, the number of trips a vehicle can make per day, and geographical data like the routes used and traffic conditions. All this information will be used to design the most efficient transportation plan. The next section will present a detailed analysis using a VRP model to assess the minimum number of trips required and the optimal route sequence to reduce costs and travel distance.

4.3.2. Operations

For the Warehouse Operations process, quantitative data related to the efficiency of each step in the process was analyzed. This includes the time taken for receiving goods, the time used for storage, the average time spent on quality inspection, and the accuracy of receiving and storing goods. The analysis focused on error rates, storage density, and the frequency of item picking, aiming to identify factors affecting efficiency and find potential bottlenecks that may hinder the flow of goods. Additionally, there was an analysis of human resources data, such as the number of warehouse staff used per shift, average work rate per person, and the correlation between workload and work efficiency. Information regarding the technology used, such as barcode systems, RFID, and Warehouse Management Systems (WMS), was also analyzed to assess the alignment between recorded data and actual stock in the warehouse.

4.3.3. Outbound Logistics

In the Outbound Logistics section, data from customer orders across different time periods, order frequency, order quantities, and peak order times were analyzed. This data was used in conjunction with the concept of Distribution Requirements Planning (DRP) to forecast market demand, schedule delivery rounds, and plan inventory to ensure flexibility and sufficiency at all times. The quantitative analysis in this section also covers metrics such as On-Time Delivery Rate, cost per delivery, and return rate, which reflect the efficiency of service and customer satisfaction. In summary, the analysis of quantitative data across the Inbound, Operations, and Outbound processes plays a crucial role in enabling the organization to clearly assess the current state of the logistics system and lay the foundation for long-term process improvements. Particularly when the data is integrated with mathematical models, it allows for scenario simulations, reduces decision-making risks, and enhances the organization's long-term competitive capabilities.

4.3.4. Analysis of Delivery Performance

4.3.4.1. Delivery Performance to Branch Warehouses

The analysis of delivery performance to the branch warehouses of Sattel (Thailand) Co., Ltd. covers four key dimensions:

- Cost per Unit: The company uses the Full Truck Load (FTL) approach to reduce costs. The cost per unit varies by warehouse, depending on the distance and the quantity of goods.
- Delivery Time: Delivery time varies by distance, with warehouses located closer (e.g., Rayong) taking less time than those farther away (e.g., Songkhla). External factors such as traffic and weather conditions affect delivery time.
- On-time Delivery: The average on-time delivery rate is 96.25%, which is considered good. Warehouses that are closer have higher on-time delivery rates.
- Comparison Before and After Using DRP: The use of DRP (Distribution Requirements Planning) has helped reduce the cost per unit, decrease the number of delivery trips, and minimize inventory overflow. A case study at the Songkhla warehouse shows that DRP effectively reduced inventory backlogs.

4.3.4.2. Logistics Performance Indicators

4.3.4.2.1. Inventory Management Performance

Sattel (Thailand) Co., Ltd. has an efficient inventory control system, with the Inventory Accuracy at 96%, which indicates the reliability of the inventory data. The Damaged Inventory rate is at 0.8%, which is a low level. The Days on Hand is at 26.7 days, which is appropriate and does not lead to excess holding costs. The Storage Utilization is at 78%, showing the effective use of warehouse space. The Dock-to-Stock Time is at 3.8. hours, indicating fast processing, and the Inventory Visibility is at 2 hours, which can be further improved, as shown in Table 1. ประสิทธิภาพการจัดการสินค้าคงคลัง (Inventory Management Performance)

Table 1.
Inventory Management Performance.

Metric	Calculation	Results	Remarks
Inventory Accuracy	Actual Quantity per SKU (960) / Quantity in System (1,000)	96%	Minor discrepancy reflects the accuracy of the system
Damaged Inventory	Value of Damaged Goods (8,000) / Total Goods Value (1,000,000)	0.8%	Most goods have been well cared for
Days on Hand	Average Inventory Value per Month (2,400) / Average Daily Sales (90)	26.7 days	Inventory is at a safe level and rotates efficiently
Storage Utilization	Actual Used Space (7,800) / Total Warehouse Space (10,000)	78%	Storage space is used efficiently
Dock-to-Stock Time	Total Time from Receiving to Storage (190) / Number of Receiving Cycles (50)	3.8 hours	Average time from receiving goods to storage in system
Inventory Visibility	System Time 11:00 – Actual Receiving Time 9:00	2 hours	Delay due to manual recording

4.3.4.2.2. Warehouse Productivity

The company's warehouses manage orders efficiently, with an Orders per Hour rate of 8 orders per hour. Internal warehouse processes are effective, capable of handling large volumes of orders (Lines per Hour: 25 lines, Items per Hour: 160 units). The Cost per Order is at a manageable level (180 THB). The warehouse cost as a percentage of total sales (Cost as % of Sales) is 6.2%, indicating that the warehouse operations are cost-effective. Overall, the warehouse manages labor and space well, with good coordination and the ability to meet inventory targets. This is shown in Table 2.

Table 2.
Warehouse Productivity.

Metric	Calculation	Results	Remarks
Orders per Hour	Orders Delivered (400) / Warehouse Labor Hours (50)	8 Orders/Hour	Large warehouse operates efficiently
Lines per Hour	Product Lines (1,250) / Warehouse Labor Hours (50)	25 Lines/Hour	Simple tasks allow quick organization
Items per Hour	Total Items (8,000) / Warehouse Labor Hours (50)	160 Items/Hour	Efficient labor use, meeting warehouse standards
Cost per Order	Total Warehouse Cost (72,000) / Orders Delivered (400)	180 THB/Order	Includes labor, equipment, and utilities costs
Warehouse Cost as % of Sales	Warehouse Cost (72,000) / Total Revenue (1,150,000)	6.2%	Warehouse cost under 10% is considered reasonable

4.3.4.2.3. Transportation Performance

The company has an On-Time Delivery Rate of 96.25%, reflecting good planning and the ability to deliver on time. The Damage Rate is 1.2%, indicating safe transportation. There are no Demurrage Costs. The company incurs additional charges from Accessorial Charges, which account for 3% of the transportation costs. The Missed Appointments rate is 4%, which still has room for improvement. The Freight Bill Accuracy is 99.5%, demonstrating the accuracy of the accounting system. Overall, the company operates an efficient transportation system, but there are opportunities for further development, such as reducing damages and improving appointment accuracy, as shown in Table 3.

Table 3.
Transportation Performance.

Metric	Calculation	Results	Remarks
On-Time Delivery Rate	Number of On-Time Deliveries (77) / Total Deliveries (80)	96.25%	The delivery system is aligned with the DRP plan
Damage During Transport	Value of Damages (12,000) / Total Delivery Value (1,000,000)	1.2%	Damages occurred due to occasional incorrect loading
Demurrage/Waiting Charges	Demurrage Charges (0) / Total Transportation Costs (210,000)	0%	No demurrage charges due to prior planning
Accessorial Charges	Additional Charges (6,300) / Total Transportation Costs (210,000)	3%	Extra charges for special services, e.g., expedited delivery
Missed Appointments	Missed Appointments (2) / Total Appointments (50)	4%	Some warehouses received deliveries late
Freight Bill Accuracy	Billing Errors (1,050) / Total Transportation Costs (210,000)	0.5%	Errors due to occasional invoice printing mistakes

4.4. Summary of the Results

Sattel (Thailand) Co., Ltd. operates five strategically located warehouses, enabling the company to effectively respond to regional demand. However, this network also presents challenges in planning and cost control. The implementation of a Distribution Requirements Planning (DRP) system has shifted the company's logistics approach from reactive to proactive planning, resulting in more efficient deliveries. The DRP system helps reduce unnecessary transport trips, improves satisfaction at destination warehouses, and minimizes excess inventory. Although the company has a multi-level product inspection system in place, delays in real-time data updates remain an issue, along with an overreliance on manual checks. Sattel (Thailand) Co., Ltd. demonstrates flexibility in expediting shipments during emergencies, particularly for warehouses located nearby. However, remote warehouses still lack agility in responding to unforeseen situations. The average transportation cost is approximately 106 THB per roll, with nearby warehouses incurring lower costs than those farther away. Looking forward, the company has proposed strategic initiatives such as developing a real-time logistics dashboard, implementing GPS tracking, conducting transport route analysis, utilizing AI for demand forecasting, and planning warehouse infrastructure to cover emerging growth areas.

5. Conclusion, Discussion, and Recommendation

5.1. Conclusion

This study aims to investigate the factors influencing on-time delivery performance in organizational logistics processes, evaluate the effectiveness of current logistics management systems, and propose improvements to better meet customer demands efficiently and sustainably. A mixed methodology approach was employed, combining qualitative methods (in-depth interviews) and quantitative analysis (logistics performance data analysis). The research findings reveal the following:

1) Inbound Logistics: Key factors contributing to delays include inaccurate procurement planning, unreliable suppliers, the absence of real-time tracking systems, and incomplete import documentation.

2) Operations: Internal challenges include unstructured inventory storage, lack of coordination between departments, and the absence of an automated Warehouse Management System (WMS).

3) Outbound Logistics: Delays are often caused by inflexible route planning, lack of real-time data, unavailability of vehicles, and external factors such as traffic and weather conditions.

The application of Vehicle Routing Problem (VRP) and Distribution Requirements Planning (DRP) models demonstrated a potential to reduce transportation trips by up to 25% and significantly lower overall delivery costs. These improvements positively impact both operational expenses and customer satisfaction rates.

5.2. Discussion

The research findings are consistent with existing theories and prior studies and can be discussed in the following dimensions:

5.2.1. Inbound Logistics

Efficient inbound logistics management requires accurate planning, reliable supplier sourcing, and real-time tracking systems. The results support the concepts of Cattaruzza, et al. [16] who emphasized the importance of visibility throughout the supply and Wargo [7] who pointed out that close supplier relationship management helps mitigate risks associated with delays.

5.2.2. Operations

The absence of structured warehouse management systems, such as WMS and ERP, was found to negatively affect coordination and the speed of order preparation. This aligns with Wong [9] who stated that warehouses lacking such systems are more prone to picking and delivery errors. The integration of technology with clearly defined internal coordination structures is a key solution.

5.2.3. Outbound Logistics

In outbound logistics, factors such as route flexibility, effective delivery scheduling, and proactive customer notifications were found to have a direct impact on delivery timeliness. These findings are consistent with Disney and Towill [18] who proposed that DRP helps reduce the Bullwhip Effect, and with Tao, et al. [14] who advocated for "Customer-centric logistics" to enhance satisfaction and minimize delays.

5.3. Recommendation

5.3.1. Recommendations for the Application of Research Findings

To enhance the efficiency of the logistics system, organizations can adopt the following recommendations:

1) Develop and integrate information systems such as ERP, WMS, GPS, and RFID to link planning, inventory control, and real-time delivery tracking, enabling accurate decision-making at every stage.

2) Improve route planning processes by applying VRP and DRP models in conjunction with real-time traffic data and actual order information. This allows for scenario simulation and analysis before execution, helping to reduce costs and increase on-time delivery rates.

3) Promote internal collaboration by establishing clear Service Level Agreements (SLAs) among planning, warehousing, and transportation departments, supported by dashboards and automated alert systems.

4) Develop personnel capabilities to effectively utilize technology through training programs, including the use of DRP systems, GPS tracking, and dashboard-based data analysis, in order to reduce errors and enhance quality control.

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5.3.2. Recommendations for Future Research

Although this research covers multiple dimensions, there are still limitations that present opportunities for further development, as follows:

1) Expand the sample group to include more diverse sectors, such as food, pharmaceuticals, e-commerce, and various organizational sizes, in order to enhance the applicability of the research findings across different contexts.

2) Investigate statistical relationships between key variables, such as the accuracy of DRP plans and on-time delivery rates, or the frequency of data updates and customer satisfaction.

3) Utilize advanced data analytics technologies, such as AI and Machine Learning, to analyze order trends or detect anomalies in processes, and to develop early warning systems (Predictive Logistics).

4) Examine external factors affecting logistics systems, including government policies, natural disasters, and climate conditions, to propose sustainable strategic-level contingency plans.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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