

RAW SUGAR SUPPLY CHAIN INTEGRATION IN INDONESIA: INSIGHTS FROM PT PELINDO'S NON-CONTAINER TERMINALS

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Abstract

Indonesia is a key player in the global raw sugar market, yet inefficiencies in its supply chain hinder competitiveness. This study examines the challenges faced by PT Pelindo's non-container terminals, managed under its Subholding Pelindo Multi Terminal (SPMT), focusing on Belawan Port as the case study. The research aims to identify operational bottlenecks and propose actionable solutions to enhance supply chain integration for raw sugar. Using qualitative methods, data were collected from operational reports, literature, and secondary sources. Root cause analysis, visualized through a fishbone diagram, highlights critical issues such as limited system integration, inadequate multimodal connectivity, and aging infrastructure. Results suggest that upgrading terminal facilities, adopting digital technologies, and fostering strategic partnerships are essential for improving efficiency and competitiveness. The study emphasizes the need for better infrastructure, enhanced transport integration, and real-time digital tools to streamline raw sugar logistics. These improvements not only strengthen Indonesia's position in the global raw sugar trade but also create economic opportunities across regions, contributing to more balanced development.

Keywords: Infrastructure, Logistic, PELINDO, Raw sugar, Supply chain.

INTRODUCTION

Indonesia is a key player in the global raw sugar market, with sugar being a strategic commodity for the country. Despite its importance, domestic production has declined in recent decades, while demand continues to rise, making Indonesia a major sugar importer (Abdullah et al., 2023). In response, the government has launched a program targeting sugar self-sufficiency by 2028 (Kementerian Perekonomian, 2024). However, the country faces significant challenges in managing its supply chain, particularly in the handling and transportation of raw sugar. These issues undermine operational efficiency and hinder Indonesia's competitiveness in global markets.

PT Pelindo, through its Subholding Pelindo Multi Terminal (SPMT), manages non-container terminals that focus on bulk cargo, including raw sugar. Among these, Belawan Port is a significant hub for the distribution of raw sugar. Despite its strategic role, the port encounters several operational difficulties, including outdated infrastructure, weak system integration, and limited multimodal connectivity. These problems lead to higher costs and delays, limiting the potential of Indonesia's raw sugar industry.

Previous studies on supply chain integration emphasize the importance of robust infrastructure, effective multimodal networks, and digital tools for optimizing logistics. However, many have not focused on the specific requirements and challenges of bulk commodities like raw sugar. This study aims to bridge this gap by providing actionable recommendations tailored to the unique operational context of SPMT's Belawan Port.

This article seeks to analyze the bottlenecks in Indonesia's raw sugar supply chain at Belawan Port and proposes strategies to enhance operational efficiency, strengthen global competitiveness, and contribute to balanced economic growth across regions.

LITERATURE REVIEW

Supply Chain Integration

Supply chain integration (SCI) involves the strategic collaboration and coordination of processes within and across organizations to fulfill customer demands. It includes internal integration, which focuses on aligning internal functions and processes to effectively meet customer needs, and external integration, which emphasizes collaboration with external partners like suppliers and distributors. By sharing information and fostering coordination, SCI aims to streamline operations, enhance responsiveness, and improve overall supply chain performance (Hendijani & Saeidi Saei, 2020).

Challenges in Bulk Cargo Logistics

Handling bulk cargo, such as raw sugar and other dry commodities, requires specialized infrastructure, advanced technology, and efficient operational systems. Common challenges at discharging ports include damages during loading and unloading, unclean holds, improper use of equipment, and insufficient safety measures for handling facilities. Operational bottlenecks like berth restrictions, port congestion, and limited storage capacity further exacerbate delays, often forcing ships to wait for adequate berth availability. As demand in the logistics sector grows, these challenges highlight the need for advanced handling techniques and enhanced infrastructure (Vasanth, 2018). Terminals dedicated to dry bulk cargo, such as those managed by PT Pelindo Multi Terminal at Belawan, Dumai, and Tanjung Intan, are equipped with specialized facilities for handling commodities like coal, soybeans, fertilizer, and raw sugar, but continuous improvements are necessary to meet the growing demands of the industry (Pelindo, 2023a).

The Role of Digital Transformation

Digital transformation is redefining logistics and port operations with technologies like automation, IoT, and big data analytics. These innovations enable real-time tracking, optimize processes, and enhance decision-making. Tools such as simulation and VR further support operations by modeling scenarios and improving staff training, driving efficiency and responsiveness in supply chains (Notteboom *et al.*, 2021).

In Indonesia, PT Pelindo's merger has accelerated digital integration across its operations. The adoption of standardized processes, integrated IT systems, and optimized resource allocation has improved service delivery and operational efficiency. These efforts not only address logistical challenges but also contribute to lowering national logistics costs and enhancing Indonesia's competitiveness (Pelindo, 2023b).

Case Study Approach

The case study method is an essential approach in qualitative research, allowing researchers to explore specific operational contexts in depth. It provides a detailed framework for identifying and understanding challenges while formulating tailored solutions. This method is particularly effective in complex systems, where real-world scenarios must be examined to derive actionable

recommendations (Priya, 2020). By focusing on actual situations, the case study methodology bridges theoretical concepts with practical applications. For this study, Belawan Port, managed by PT Pelindo's Subholding Pelindo Multi Terminal (SPMT), serves as the case study. As a critical node in Indonesia's raw sugar supply chain, the port's operational challenges offer valuable insights into the broader logistics framework. This approach ensures a comprehensive understanding of the unique dynamics influencing supply chain performance.

RESEARCH METHOD

Research Type

This research adopts a qualitative case study approach to investigate the specific operational issues faced by Belawan Port. The qualitative nature of the study enables a holistic exploration of the interconnected factors contributing to inefficiencies, including organizational, infrastructural, and environmental aspects. By focusing on a single case, the study ensures a deeper analysis of the factors influencing raw sugar logistics, aligning with the aim of uncovering actionable strategies to improve operational efficiency.

Data Collection

Data for the study were collected from secondary sources, including operational reports, academic literature, industry publications, and relevant policy documents. The operational reports provided detailed information about port activities, highlighting key inefficiencies and bottlenecks. Academic literature offered theoretical insights and comparative frameworks for analyzing supply chain integration. Industry publications shed light on best practices and benchmarks, while policy documents provided context regarding national and regional logistics standards. The triangulation of these diverse data sources ensured a robust foundation for analysis, minimizing bias and enhancing the validity of findings.

Data Analysis

The data collected were analyzed using a thematic approach to uncover recurring patterns and key themes related to operational challenges at Belawan Port. Thematic analysis is particularly effective in qualitative research as it allows researchers to systematically organize, categorize, and interpret qualitative data to identify meaningful insights. This method involves a step-by-step process of data coding, where the raw data are broken into smaller units of information and categorized based on shared characteristics or recurring issues. These coded data segments were then grouped into broader themes that represent the major challenges in the supply chain operations at Belawan Port.

To provide further clarity and structure, the themes were mapped onto a fishbone diagram, a widely recognized tool for root cause analysis. This visual framework helps to systematically explore and display the causes contributing to identified challenges, categorizing them into six primary areas aligned with Ishikawa's principles:

1. **Manpower:** Issues related to workforce skills, training, and capacity, including the availability of specialized personnel to handle bulk cargo like raw sugar.
2. **Methods:** Inefficiencies in logistics processes, such as a lack of standardized operating procedures and inadequate coordination between stakeholders.

3. Materials: Limitations in the raw sugar supply chain, such as seasonal variability and inadequate packaging practices that result in contamination or loss.
4. Machines: Outdated infrastructure and insufficient equipment, which hinder the efficient handling, storage, and transportation of raw sugar.
5. Management: Weaknesses in strategic oversight, including ineffective planning, limited use of advanced forecasting tools, and inadequate decision-making frameworks.
6. Environment: External factors like poor multimodal connectivity, port congestion, and inadequate integration of road, rail, and port infrastructure that lead to delays and increased costs.

This structured approach not only identified the underlying causes of inefficiencies but also provided a clear foundation for developing actionable strategies to address them. The thematic analysis facilitated a deep understanding of the interrelated nature of these challenges, enabling the formulation of targeted solutions.

The integration of thematic analysis with a fishbone diagram further enhanced the depth of the study by visually organizing complex, multifaceted issues into a comprehensible framework. This method not only ensured a systematic identification of critical areas for improvement but also emphasized the interconnectedness of the challenges. By addressing these root causes through a combination of strategic interventions, the study provides practical recommendations to streamline the raw sugar supply chain at Belawan Port and beyond.

RESULTS AND DISCUSSION

Results

The analysis revealed significant barriers to the efficient operation of the raw sugar supply chain at Belawan Port, highlighting several interconnected issues that contribute to inefficiencies. These challenges reflect systemic shortcomings across infrastructure, processes, and connectivity that limit the port's ability to handle and distribute raw sugar effectively. Addressing these issues is critical not only to improving operational efficiency but also to strengthening Indonesia's competitiveness in the global raw sugar market. Specifically, the analysis identified three major challenges:

1. Limited System Integration:

Inadequate data synchronization across terminals disrupts logistics planning and decision-making, leading to inefficiencies in cargo handling and scheduling. The absence of integrated systems results in fragmented operations, delays, and increased administrative burdens for stakeholders.

2. Inadequate Multimodal Connectivity:

Weak integration between ports, railways, and road networks results in increased transit times and higher logistics costs. The lack of seamless connectivity between these modes of transport creates bottlenecks, reducing the efficiency of supply chain operations and limiting the port's ability to meet demand.

3. Outdated Infrastructure:

Aging equipment and insufficient terminal capacity hinder the efficient handling and storage of raw sugar, leading to delays and operational inefficiencies. The reliance on outdated machinery and limited storage facilities also increases costs and reduces the overall throughput capacity of the port.

Root Cause Analysis

The fishbone diagram (Figure 1) provides a detailed visualization of the root causes contributing to these challenges. The primary causes, based on Ishikawa's methodology, are categorized as follows:

1. Machines (Infrastructure): Outdated equipment and limited terminal capacity reduce operational throughput.
2. Methods (Processes): Lack of standardized procedures and real-time tracking systems undermine process efficiency.
3. Environment (Multimodal Connectivity): Poor integration of port-rail-road links and high transit costs delay shipments.
4. People (Stakeholders): Weak collaboration with producers and misaligned supply schedules disrupt the supply chain.
5. Materials (Raw Sugar Supply): Seasonal variability in supply and inadequate packaging solutions lead to inefficiencies in handling and transport.
6. Management (Strategy and Oversight): Ineffective planning and lack of advanced forecasting tools limit operational optimization.

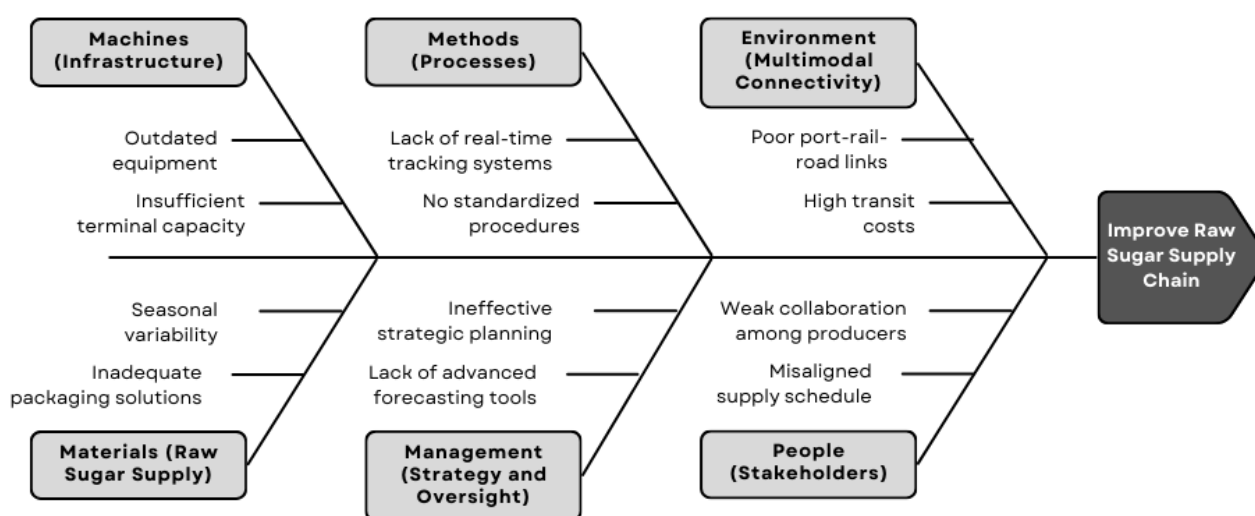


Figure 1: Fishbone diagram of raw sugar supply chain challenges

Discussion

Addressing the challenges identified in the analysis requires a comprehensive and targeted approach to improve the efficiency and effectiveness of the raw sugar supply chain. These challenges—ranging from limited system integration to inadequate multimodal connectivity and outdated infrastructure—reflect deep-rooted issues that need strategic interventions. Without immediate and coordinated efforts, these inefficiencies may continue to disrupt operations, increase costs, and hinder the competitiveness of Indonesia's logistics network, particularly at Belawan Port. By tackling the root causes systematically, it is possible to not only resolve these challenges but also create a more resilient and robust supply chain that can support the demands of the global raw sugar market.

To achieve these goals, the following strategic interventions are proposed:

1. Infrastructure Development:
 - Expand terminal capacity to accommodate higher volumes of raw sugar and other bulk commodities.
 - Modernize handling equipment, such as automated cranes and conveyor systems, to enhance efficiency and reduce operational delays.
2. Digital Transformation:
 - Implement real-time tracking systems, such as the Pelindo Terminal Operating System (PTOS), to improve data synchronization and operational transparency.
 - Leverage digital tools for accurate inventory management and forecasting.
3. Multimodal Connectivity:
 - Strengthen physical and operational linkages between ports, railways, and road networks to reduce transit costs and improve delivery times.
 - Develop dedicated freight corridors to ensure seamless cargo movement.
4. Stakeholder Collaboration:
 - Foster stronger partnerships with sugar producers and logistics providers to align supply schedules with port operations.
 - Conduct regular stakeholder meetings to optimize planning and streamline coordination across the supply chain.

These measures are designed to address the root causes of inefficiencies, enhance the operational capacity of Belawan Port, and streamline logistics for raw sugar. By implementing these strategies, Indonesia can reduce logistics costs, improve global competitiveness, and ensure a more resilient and efficient supply chain network.

CONCLUSION

This study highlights the critical challenges facing the raw sugar supply chain at Belawan Port, managed by PT Pelindo's Subholding Pelindo Multi Terminal (SPMT). The identified issues, including limited system integration, inadequate multimodal connectivity, and outdated infrastructure, reflect systemic barriers that hinder operational efficiency and reduce Indonesia's competitiveness in the global raw sugar market.

Through root cause analysis using Ishikawa's framework, these challenges were traced to deficiencies in infrastructure, processes, connectivity, collaboration, supply chain management, and strategic oversight. To address these issues, this study proposes strategic interventions focusing on infrastructure development, digital transformation, multimodal connectivity, and enhanced stakeholder collaboration.

By expanding terminal capacity, modernizing equipment, implementing real-time tracking systems, strengthening transport linkages, and fostering stronger partnerships, Indonesia can streamline its raw sugar supply chain operations. These efforts are expected to reduce logistics costs, improve operational efficiency, and position Indonesia as a more competitive player in the global market.

Ultimately, these strategies not only resolve the immediate operational inefficiencies but also lay the foundation for a resilient and robust logistics network that supports economic growth and regional development. Future research could explore the implementation of these strategies in other commodities or regions to further enhance Indonesia's logistics capabilities.

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