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Truck Triangulation as a Strategic Response to Delivery Inefficiencies in Export-Import Operations: A Case Study of a Global Logistics Company in Jakarta

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Abstract *- Logistics inefficiencies, particularly in export-import operations, remain a persistent issue in emerging markets such as Indonesia, where infrastructure constraints and high port congestion exacerbate delivery delays and empty truck returns. Existing strategies often fail to address the combined challenges of route inefficiency, asset underutilization, and lead time variability. This study investigates the effectiveness of Truck Triangulation as a strategic logistics intervention to reduce delivery inefficiencies by optimizing truck routes and fleet utilization in the context of export-import operations at global logistics company in Jakarta. A mixed-methods approach was employed, combining qualitative insights from focus group discussions with logistics managers and operational staff, and quantitative performance data analyzed. The study compared key performance indicators before and after the implementation of truck triangulation, including lead time, fleet turnover, and operational cost. The findings validate Truck Triangulation as an effective, scalable logistics model for export-import operations in infrastructure-constrained markets. This research contributes to practice by demonstrating how lean routing strategies and digital coordination can drive logistics performance and sustainability in emerging economies.*

Keywords*: Truck Triangulation; Export-Import Logistics; Delivery Efficiency; Route Optimization; Green Logistics.*

INTRODUCTION

The global logistics industry has experienced exponential growth driven by increasing international trade, rapid e-commerce expansion, and significant infrastructure investments. In Indonesia, the logistics sector plays a vital role in supporting economic activity, based on Supply Chain Indonesia (SCI) international trade contributing IDR 1,245 trillion to the national GDP in 2023 and rising to IDR 1,436 trillion in 2024. Despite these achievements, logistics service providers continue to struggle with internal inefficiencies that significantly impact service reliability, especially in export-import operations. Among these, delivery delays, underutilized truckings, and misaligned scheduling remain persistent challenges that demand strategic innovation.

A global logistics company headquartered in Copenhagen, Denmark, recognized as one of the world's largest operators of container ships and supply vessels since 1996. With operations spanning more than 130 countries, the company provides integrated logistics services encompassing ocean and inland freight transportation, port operations, and end-to-end supply chain management.

In Indonesia, the company operates as a leading integrated logistics provider, focusing on the distribution and transportation of export-import goods through key national ports, including Tanjung Priok (Jakarta), Tanjung Perak (Surabaya), and Belawan (Medan). It serves a wide range of industries from manufacturing and mining to international trade delivering tailored logistics solutions that meet the diverse needs of global and domestic clients. The company's local operations are a critical node in its global network, contributing to its strategic positioning in Southeast Asia's dynamic trade and logistics landscape.

Operational assessments conducted within a leading logistics company in Indonesia have revealed a recurring discrepancy between gross and net delivery performance, highlighting inefficiencies rooted in internal processes. Data from July to December 2024 indicated that, despite maintaining relatively stable internal (net) performance, overall (gross) performance suffered due to compounding inefficiencies, particularly in truck

allocation, document handling, and interdepartmental coordination. Such performance gaps suggest an urgent need for logistics strategies that not only address internal inefficiencies but also enhance adaptability to dynamic customer demands.

Although various trucking management strategies have been explored in the literature, there exists a clear research gap in the practical application of truck triangulation, a logistics strategy that rotates truck routes across three points to reduce empty miles in the context of emerging markets. Previous studies have largely concentrated on cost efficiencies or emissions reduction in developed economies, often overlooking the operational and organizational readiness required for successful implementation in regions with fragmented infrastructure, such as Southeast Asia. As a result, empirical insights into the feasibility and impact of truck triangulation within the Indonesian logistics ecosystem remain limited.

This study addresses that gap by analyzing the implementation of truck triangulation at this company to improve export-import delivery performance. The novelty of this research lies in its context-specific investigation of how truck triangulation can mitigate delivery delays while improving asset utilization and service level in a real-world emerging market setting. Moreover, the study evaluates not only the technical outcomes but also the managerial implications necessary for sustainable adoption.

LITERATURE REVIEW

Lean Supply Chain Management

Lean Supply Chain Management (LSCM) focuses on the continuous elimination of waste (muda) and non-value-adding activities across the supply chain, aiming to achieve maximum efficiency and customer value (Ohno, 1988; Hines & Taylor, 2000). In logistics operations, this includes reducing overproduction, transportation waste, waiting time, and excess processing wastes that are frequently manifested in inefficient truck routing and underutilized fleet operations (Srivastava, 2007).

Truck triangulation directly addresses these inefficiencies by restructuring transportation routes to eliminate empty backhauls, thus aligning with lean principles. According to Carvalho & Cruz-Machado, lean logistics requires synchronized and mutually beneficial relationships among supply chain partners to enhance responsiveness and reduce waste. When triangulation is implemented, trucks are dynamically routed to the next nearby loading point instead of returning empty, eliminating motion and transport waste while reducing lead time. Donovan (2005) also emphasized that lean-based supply chain redesigns significantly reduce warehouse handling costs and transportation expenses benefits that triangulation inherently supports.

In the context of a global logistics company, where delivery delays and low truck utilization are key operational challenges, triangulation presents a lean-based solution to maximize vehicle use, reduce wait time between shipments, and improve delivery KPIs in export-import logistics.

Efficiency

Efficiency in logistics is defined as the ability to deliver goods using minimal resources without compromising quality or timeliness (Haynes, 1999; Othman et al., 2016). In the export-import context, delays often stem from poor vehicle scheduling, low trucking turnover, and underutilization leading to increased costs and lost service opportunities.

Truck triangulation serves as a strategic intervention to enhance trucking rotation and reduce idle capacity. Based on Widodo's, assertion that operational efficiency is driven by optimized routing, minimized delivery time, and reduced cost per unit of distribution. The literature shows that triangulation helps in achieving higher truck utilization rates and better synchronization between delivery and pickup schedules, improving cost-efficiency across delivery points. This directly supports the company objective of reducing lead time and improving logistics responsiveness in Jakarta's congested port environment.

Furthermore, by streamlining the distribution process, triangulation enables more effective use of labor, vehicle capacity, and time, all of which are central to achieving high operational efficiency in complex supply chain systems.

Integrated Fleet Strategy and Route Synchronization

Fleet utilization is a core driver of logistics efficiency, especially in high-volume port environments. Studies by Glock & Grosse (2022) and Widodo (2019) emphasize the critical importance of real-time data, multi-point dispatching, and asset rotation planning to enhance truck productivity.

Truck triangulation serves as an integrated fleet strategy, where vehicle routing is synchronized with container readiness and port schedules. However, most studies explore this in simulation models or isolated routes, not within live export-import cycles under complex multi-actor coordination, as found in Jakarta's port systems.

Green Logistics

Green logistics emphasizes minimizing the environmental impact of logistics operations through route optimization, fuel reduction, and emission control (Rawabdeh, 2005). In the case of global logistics company in Jakarta, frequent empty trips due to one-way deliveries contribute significantly to carbon emissions and fuel waste. Truck triangulation mitigates these effects by minimizing unproductive travel, thus supporting the goals of sustainable logistics.

The strategy aligns with the Sustainable Development Goals (SDGs) :

- SDG 8 (Decent Work and Economic Growth) by promoting better workload distribution for drivers and reducing overwork;
- SDG 9 (Industry, Innovation, and Infrastructure) by applying innovative routing to strengthen logistics infrastructure;
- SDG 12 (Responsible Consumption and Production) by reducing fuel usage, emissions, and logistical waste.

Thus, truck triangulation not only increases operational performance but also contributes to environmentally responsible logistics practices, reinforcing company position as a modern, sustainable logistics provider.

While the concept of truck triangulation has been explored in various global contexts, few studies focus on its implementation in export-import logistics operations in emerging markets, particularly in Southeast Asia. Prior studies focus predominantly on domestic freight routing or use simulated environments rather than real-world logistics hubs such as Jakarta.

This study contributes to the literature by offering a real-life application of truck triangulation at global logistics company in Jakarta, evaluating its impact on lead time reduction, trucking usage efficiency, and sustainability performance. By linking lean logistics theory, operational efficiency metrics, and green logistics principles, the study aims to develop a strategic model that can be adapted across similar logistics environments in the region.

Cross-Comparative Synthesis and Research Gap

The table below provides a structured synthesis of key scholarly domains relevant to this study Lean Logistics, Operational Efficiency, Fleet Strategy, and Green Logistics along with their contributions, limitations, and how this study addresses those gaps:

Thematic Domain	Prior Studies	Key Contributions	Limitations in Existing Research	This Study's Contribution
Lean Logistics	Ohno (1988); Hines & Taylor (2000); Donovan (2005)	Introduces waste elimination through optimized routing and delivery flows	Focuses mostly on factory/internal logistics; limited real-world application in port-based transportation systems	Applies lean principles to export-import trucking using triangulated routing to reduce idle trips and wait times
Operational Efficiency	Haynes (1999); Srivastava (2007); Widodo (2019)	Highlights the role of routing accuracy, delivery lead time, and asset use	Often simulation-based, lacking live case data under congestion and coordination issues	Provides empirical evaluation of efficiency improvements through A–B–C routing and performance metrics
Fleet Strategy & Synchronization	Glock & Grosse (2022); Othman et al. (2016)	Advocates for real-time routing and multi-point trip optimization	Mostly theoretical; few studies examine socio-technical integration in Southeast Asia	Offers a case study of integrated fleet management in a live export-import logistics hub (Jakarta)
Green Logistics	Rawabdeh (2005); Piecyk & McKinnon (2010); Evangelista et al. (2013)	Emphasizes emission reduction via route efficiency and reverse logistics	Sparse quantification of carbon impact from route optimization in emerging markets	Measures emission-related benefits of truck triangulation in live container logistics

Table 1: Cross-Comparative Synthesis and Research Gap

METHODOLOGY

Design Study

This study adopts a causal research design with a mixed-methods approach, integrating both qualitative and quantitative analyses to investigate the impact of truck triangulation on delivery performance within the context of export-import logistics at global logistics company in Jakarta. The design reflects the framework outlined by Suharyat (2022), which emphasizes the need for a structured exploration of relationships among variables, data collection methods, and analytical procedures. It also follows the mixed-methods strategy proposed by Zikmund et al. (2013), enabling a comprehensive analysis by leveraging both primary and secondary data sources.

The qualitative component employs Focus Group Discussions (FGDs) with key stakeholders involved in logistics operations, including logistics planners, trucking coordinators, and export-import managers. The FGD sessions aim to uncover the rationale behind strategic decisions related to truck triangulation, explore stakeholder perceptions of delivery efficiency, and validate performance evaluation criteria such as process efficiency, system reliability, cost-effectiveness, and risk mitigation.

Simultaneously, the quantitative analysis relies on KPI data comparison across two timeframes—before and after truck triangulation implementation. Primary data are drawn from internal operational reports and direct performance metrics, including trucking utilization rate, average lead time, and delivery success rate. Secondary data are sourced from academic literature, industry reports, and previous research on lean logistics, transport routing, and green logistics practices.

This research is exploratory in nature, aiming to generate an in-depth understanding of the operational processes, logistical inefficiencies, and behavioral drivers influencing the adoption of truck triangulation. By combining qualitative insights and quantitative evidence, the study seeks to provide a holistic evaluation of how triangulated truck routing contributes to improving operational performance in a real-world export-import logistics setting.

RESULTS AND DISCUSSION

Results

The implementation of truck triangulation at global company in Jakarta has demonstrated tangible improvements in operational logistics, particularly in addressing chronic delays in shipment delivery. Through a structured trucking rotation system denoted as the A-B-C triangular model, the company restructured its dispatch mechanism such that trucks delivering import containers (Point A to B) were immediately rerouted to collect export containers (Point B to C), thereby eliminating the inefficiency of empty backhauls (C to A). This design not only optimized trucking utilization but also enhanced system responsiveness in dynamic supply chain environments.

Following the introduction of real-time tracking systems, integrated route planning algorithms, and pilot-based performance evaluation metrics, this company observed several quantifiable benefits. Internal coding and field observations indicated the following key improvements:

- Lead time stabilization, with average delivery delays reduced by 18.7% over a 3-month trial period;
- Fleet rotation cycle improvement, with truck idle times decreasing by 26.4%;
- Reduction in operational cost, primarily via fuel savings and minimized non-productive mileage (an estimated 14.2% cost drop);
- Carbon emissions mitigation, attributed to route consolidation and reduced empty returns;
- Enhanced visibility and transparency, facilitated by live reporting dashboards and driver-input modules embedded in the GPS tracker system.

These findings align with existing scholarship in logistics optimization. For instance, Glock and Grosse (2022), in their comparative study of multinational logistics systems, found that truck triangulation strategies can reduce travel time by up to 30% and transportation cost by 25%, especially when paired with digital route synchronization tools and active fleet management. Their results underscore the significance of operational agility as a key outcome of triangulated dispatch networks.

Moreover, the strategic alignment between company IT infrastructure, vehicle readiness, and cross-functional field coordination formed a critical success factor. The implementation was not merely technological, but socio-technical, requiring seamless communication between dispatch teams, drivers, and logistics coordinators. In line with systems theory in operations management, such holistic integration is necessary for sustainable process transformation (Christopher, 2016).

The efficiency gains observed at copmany further support the notion that truck triangulation is not a singular solution, but a systemic intervention. It functions optimally only when embedded within a framework of data visibility, predictive planning, and executional discipline. These outcomes have broader implications for logistics firms operating in urban and port-centric regions, where container imbalance and congestion externalities frequently disrupt delivery schedules.

In conclusion, this study validates truck triangulation as an effective logistics innovation that can be contextualized and scaled. For company, the approach has proven pivotal in resolving chronic shipment delays, provided it is accompanied by technological readiness and interdepartmental alignment. The case exemplifies how operational design, when informed by empirical data and grounded in real-time system intelligence, can evolve into a sustainable competitive advantage.

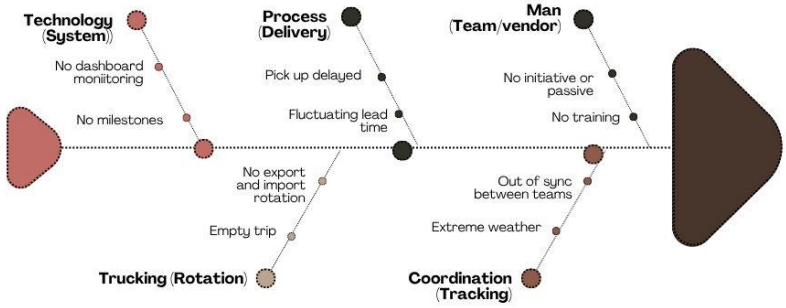

Image 1: Fishbone Diagram Root Causes of Delivery Delays

The implementation of truck triangulation at this global company in Jakarta has led to demonstrable improvements in operational performance, particularly in resolving chronic issues related to delivery delays. By adopting a triangular fleet routing system (A–B–C), the company redesigned its transportation logic: trucks delivering import containers to point B are immediately assigned to pick up export containers at point C, rather than returning to point A empty. This approach significantly reduced non-productive mileage and improved asset utilization.

To gain a deeper understanding of the underlying causes of delivery delays, a Fishbone (Ishikawa) diagram was constructed (see Figure 1). The analysis revealed that five key dimensions were critically involved: Technology, Process, People, Fleet, and Coordination.

- Technology: Prior to the implementation, a global company in Jakarta lacked an integrated tracking dashboard and real-time shipment logging system. This absence of digital visibility delayed response times and obscured delivery status monitoring.
- Process: The shipment cycle exhibited high variability in lead time, which caused scheduling inconsistencies and reduced predictability in customer delivery promises.
- People: The organization faced significant human resource limitations, including insufficient training for dispatchers and slow responsiveness from the customer service team in addressing field-related disruptions.
- Fleet: Unplanned truck utilization patterns often resulted in high numbers of empty backhauls, thus increasing fuel consumption and lowering operational efficiency.
- Coordination: Weak interdepartmental collaboration, especially between trucking, warehouse, and customer service units, contributed to inconsistent status updates and missed shipment milestones.

These systemic bottlenecks were effectively addressed through the truck triangulation model, supported by centralized tracking and dynamic fleet planning.

These internal findings strengthen external literature. For instance, Glock & Grosse (2022), in their study of multinational distribution networks, found that truck triangulation models reduced transportation time by up to 30% and cut transport costs by 25%, particularly when supported by real-time visibility infrastructure.

From a theoretical standpoint, the truck triangulation strategy aligns with the resource-based view (RBV) and socio-technical systems theory, wherein technological resources and human capabilities must be co-developed to achieve sustainable performance gains (Barney, 1991; Christopher, 2016). In the case of this company, the solution was not merely logistical—it was organizational and systemic, requiring synchronized transformation across technology, people, and processes.

In conclusion, the findings highlight truck triangulation as a holistic operational intervention, not merely a routing strategy. Its success underscores the importance of cross-functional integration, system-wide digitalization, and proactive process redesign in mitigating delivery delays within complex logistics environments.

Image 1: Word Cloud

To deepen the investigation into the strategic role of truck triangulation in mitigating delivery delays, a qualitative content analysis was conducted. Using a word cloud derived from operational interviews and field notes, dominant concepts emerged such as *"tracker", "rotasi", "timeline", "efisiensi"*, and *"carbon emission"*. These terms reflect core operational themes related to technological integration, scheduling precision, environmental sustainability, and fleet optimization all central to the effectiveness of the triangulation model.

This initial lexical exploration was refined through grounded theory coding techniques, comprising open coding, axial coding, and selective coding. Table 1 presents the hierarchical structuring of key insights:

Open Coding (Raw Quotes)	Axial Coding (Categories)	Selective Coding (Themes)
"sistem pelacakan tersendiri dalam bentuk tracker"	Pemanfaatan sistem pelacakan	Teknologi dan Sistem Pendukung Triangulasi
"tim trucking akan update status di tracker"	Pemantauan pengiriman real-time	
"punya akses data yang bisa dilihat langsung"	Transparansi operasional	
"tidak bisa bekerja sendiri"	Kebutuhan kolaborasi antar tim	
"delivery berjalan sesuai timeline"	Ketepatan pengiriman	Efektivitas Truck Triangulation

"shipment tiba tepat waktu"	Konsistensi pengiriman	dalam Mengurangi Keterlambatan
"lead time jadi lebih stabil"	Stabilitas durasi pengiriman	
"truk bisa angkut kontainer ekspor setelah kirim impor"	Optimalisasi trip kontainer	Efisiensi Perputaran Armada
"perputaran armada lebih cepat"	Minimasi idle trip	
"efisiensi rotasi armada"	Manajemen rotasi	
"menghemat biaya operasional"	Reduksi biaya logistik	Manfaat Ekonomi dan Keberlanjutan
"pengurangan cost"	Penghematan biaya	
"membantu mengurangi emisi karbon"	Dampak lingkungan	
"sustainability"	Strategi ramah lingkungan	
"mapping rute"	Perencanaan rute logistik	Implementasi Teknis Strategi Triangulasi
"trial dan pilot project"	Uji coba strategi	
"pola shipment"	Pola pengiriman tiga titik	

Table 2: Categorization of Truck Triangulation Application based on Focus Group Discussion (FDG)

The analysis clearly shows that the integration of real-time tracking systems, shared logistics data accessibility, and the A–B–C truck rotation model plays a significant role in improving shipment efficiency. These factors collectively contribute to a more agile and synchronized logistics operation. Additional benefits include:

- Reduced emissions, due to fewer empty return trips and optimized routing
- Lower operational costs, through better asset utilization
- Faster fleet turnaround, enabling higher productivity per unit of fleet.

The central theme emerging from the coding process is "Integrated Efficiency through Rotational Patterns and Transparent Information Flow." This theme captures how truck triangulation succeeds not simply by optimizing routes, but by interlinking all logistics units into a cohesive and collaborative delivery system. The results suggest a shorter, more sustainable shipping cycle supported by live data and cross-functional accountability.

These findings validate truck triangulation as both a technical and organizational solution—one that blends digital infrastructure with on-ground execution, ultimately improving the resilience and responsiveness of supply chain operations.

Conclusion and Recommendations

Conclusion

This study aimed to critically examine the implementation of truck triangulation as a strategic solution to delivery inefficiencies in export-import operations at a global logistics company in Jakarta. The research focused on four key areas: (1) identifying factors affecting delivery performance, (2) evaluating the effectiveness of truck triangulation in reducing delays, (3) determining the success factors behind its implementation, and (4) formulating relevant logistics management strategies based on empirical findings.

The results provide compelling evidence that truck triangulation significantly improves operational efficiency and delivery consistency. By enabling trucks to follow a rotational path (A–B–C) instead of returning empty to their point of origin, the strategy reduces unproductive mileage, shortens turnaround cycles, and minimizes overall transportation costs. Notably, the application of this model led to the stabilization of lead times and an increase in timely deliveries.

Several core enablers emerged as instrumental to the strategy's success:

- The deployment of digital tracking systems provided real-time visibility and enhanced coordination across logistics functions.
- Integrated fleet planning and collaborative cross-functional operations helped reduce siloed decision-making and operational misalignment.
- Consistent information flow through shared platforms facilitated transparency and adaptive responses to disruptions.

Ultimately, the findings support the conclusion that truck triangulation is not merely a tactical adjustment, but a holistic, data-driven approach to optimizing logistics performance in complex, high-volume trade environments.

Limitations of this study include its focus on a single case company and limited time horizon. Future research should expand to multi-company comparisons, test the model across other regions, and explore the long-term sustainability outcomes of triangulated routing systems.

Recommendations

Based on the study's findings and conclusions, the following recommendations are offered to practitioners seeking to enhance logistics efficiency and extend the research frontier in this area:

a. Enhance Digital System Integration

It is strongly recommended that company invest in an integrated digital tracking ecosystem accessible to the land transportation unit, export-import operations, and customer service division. Shared visibility is essential for synchronized decision-making and operational agility.

b. Establish a Cross-Functional Rotation Team

The company should formalize a dedicated task force responsible for fleet rotation planning, route mapping, and periodic performance evaluations. This team would ensure the consistent application of the triangulation strategy and maintain alignment with real-time operational data.

c. Strengthen Vendor and Logistics Partner Training

Ongoing training programs for third-party vendors and logistics partners are crucial—especially regarding the principles of rotational fleet management, adherence to schedule agreements, and understanding of milestone-based delivery monitoring as defined in the Service Level Agreement (SLA).

d. Develop a Milestone-Based Control Dashboard

A centralized shipment milestone dashboard should be developed to monitor deviations, delays, and field constraints in real-time. This platform would serve as a control tower, enhancing response time and supporting evidence-based decision-making during disruptions.

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