TRANSPORTATION COLLABORATION STRATEGY IN EXPORT AND IMPORT OPERATIONS TO REDUCE CARBON EMISSIONS: A CASE STUDY OF PT. XYZ

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Abstract

This thesis discusses transportation collaboration strategies in export and import activities at PT. XYZ to reduce carbon emissions. The research aims to identify efficient shipping methods that can minimize environmental impact. Through an analysis of various collaboration schemes, this study evaluates the comparison of carbon emissions produced from collaborative and non-collaborative shipping. The research findings indicate that non-collaborative shipping generates approximately 1,680,102,896 tons of carbon emissions annually, whereas collaborative shipping has successfully reduced emissions to 699,743tons per year, achieving a total reduction of 58%. The implementation of collaboration strategies not only positively impacts emission reduction but also provides financial benefits to the company, with transportation cost savings of up to 15%. These findings are expected to serve as a reference for the development of green policies in the transportation and logistics industry.

Keywords: Carbon Emissions, Transportation Collaboration Export-Import Activities, Emission Reduction, Green Policies

INTRODUCTION

Climate change refers to the gradual alteration of global weather and temperature patterns, primarily driven by the accumulation of greenhouse gases (GHGs) such as carbon dioxide (CO_2) in the atmosphere. Since 1900, the Earth's temperature has increased by 1.1°C, and extreme weather events as well as sea-level rise of up to 56 cm are projected by 2100 (Source: Intergovernmental Panel on Climate Change (IPCC). The principal causes of these phenomena include fossil fuel combustion, deforestation, and industrial activities (UNFCCC, 2021). In response, the Paris Agreement was established as a global initiative to limit global warming to below 1.5°C above pre-industrial levels by reducing GHG emissions through Nationally Determined Contributions (NDCs), which outline each country's strategies and targets to mitigate and adapt to climate change (Source: UNFCCC, 2015).

Indonesia, as a signatory to the Paris Agreement, has pledged to reduce its GHG emissions by 29% by 2030 through domestic efforts and up to 41% with international assistance (Source: Ministry of Energy and Mineral Resources, 2022). Progress has been evident: in 2022, Indonesia achieved an emissions reduction of 118.2 million tons of CO_2 exceeding the target of 116 million tons, mainly through initiatives in the energy sector such as energy efficiency improvements, adoption of renewable energy, and cleaner production technologies (Source: OECD, 2022).

Indonesia's Greenhouse Gas (GHG) Emission Reductions by Sector in 2022

Sector	Emission Reduction (million tons CO_2e)	Contribution (%)	Key Initiatives
Energy	118.2	77%	Energy efficiency, renewable energy adoption, and cleaner production technologies
Manufacturing / Industry	12.0	8%	Green industry programs, industrial energy efficiency, use of alternative fuels
Transportation	9.0	6%	Biofuel programs (B30–B35), electric vehicles, and eco-friendly public transport

Source: Ministry of Energy and Mineral Resources (2022); Ministry of Environment and Forestry (2023); Ministry of Industry (2022); Ministry of Transportation (2022); OECD (2022).

The manufacturing and transportation sectors also contribute to these reductions through decarbonization and the development of low-carbon logistics, addressing the 24% share of global emissions attributed to transportation (Source: IEA & UNEP, 2022). As part of the national strategy toward achieving Net Zero Emissions (NZE) by 2060, PT XYZ, Indonesia's leading automobile manufacturer, has committed to becoming a pioneer in low-emission vehicle production and industrial decarbonization. The company's roadmap targets carbon neutrality by 2035 and zero CO_2 emissions by 2060 through measures encompassing all emission scopes: direct emissions (scope 1), energy-related indirect emissions (scope 2), and logistics-related indirect emissions (scope 3) (IPCC, 2021). As part of the national strategy toward achieving Net Zero Emissions (NZE) by 2060, PT XYZ, Indonesia's leading automobile manufacturer, has committed to becoming a pioneer in low-emission vehicle

production and industrial decarbonization. The company's roadmap targets carbon neutrality by 2035 and zero CO_2 emissions by 2060 through measures encompassing all emission scopes: direct emissions (Scope 1), energy-related indirect emissions (Scope 2), and logistics-related indirect emissions (Scope 3) (IPCC, 2021).

To achieve these targets, PT XYZ has designed several key initiatives, including: Transition to renewable energy in manufacturing operations, particularly through solar rooftop installations and the purchase of green electricity, Adoption of energy-efficient production technologies, such as waste heat recovery, automated control systems, and lightweight materials to reduce energy intensity, Expansion of low-emission vehicle production, including hybrid, plug-in hybrid, and fully electric vehicle (EV) models, Carbon offset and circular economy programs, focusing on waste reduction, component reuse, and recycling within supply chains, Green logistics transformation, aimed at optimizing transport networks and reducing logistics-related emissions.

In line with the fifth initiative, PT XYZ has developed a collaborative transportation scheme involving its logistics partners, suppliers, and distributors. This initiative promotes shared logistics and route optimization to minimize empty runs, reduce fuel consumption, and lower carbon intensity per shipment. Through this transport collaboration, PT XYZ not only improves operational efficiency but also strengthens its contribution to Indonesia's national emission reduction goals. PT XYZ integrates renewable energy certificates, promotes energy conservation among employees, and collaborates with logistics companies to reduce fuel consumption and transport frequency. This study aims to quantify and analyze emissions from these operations, evaluate the effects of collaborative versus non-collaborative logistics policies, and assess both the environmental and financial impacts of emission reduction strategies.

REVIEW OF LITERATURE

Collaborative Logistics as a Pathway to Automotive Supply Chain Decarbonization

The automotive industry is a key driver in global decarbonization, requiring manufacturers to manage not only operational (Scope 1–2) but also supply chain and logistics emissions (Scope 3). According to the SBTi (2025) and IPCC (2021), achieving net-zero targets demands integrated strategies across production, energy, and logistics systems. Studies indicate that collaborative logistics such as shared transport, route optimization, and load consolidation can substantially cut CO_2 emissions and logistics costs. Research by Matusiewicz (2023) and OECD (2022) shows emission reductions of up to 30% through freight collaboration, while Bain & Company (2024) highlight that supply-chain partnerships are crucial for addressing Scope 3 challenges. In Indonesia, the transport sector remains a major emission source. National policies (KLHK, 2023; Kemenhub, 2022) promote efficiency, electrification, and integrated logistics. Yet, research on collaborative transport models among OEMs, suppliers, and logistics providers remains scarce especially concerning measurable impacts on Scope 3 emissions.

This study addresses that gap by evaluating PT XYZ's collaborative transport initiatives within its decarbonization roadmap, quantifying potential emission reductions and identifying key enablers for broader application in Indonesia's automotive supply chain.

Concept of Carbon Emission Reduction

Carbon emission reduction is a fundamental approach to mitigating the accelerating impact of climate change. The concept of sustainable supply chain theory emphasizes collaboration among stakeholders to achieve operational efficiency and reduce environmental impact through shared responsibility in logistics and production activities. Likewise, the sustainable transportation concept focuses on minimizing environmental degradation by adopting efficient and ecofriend ly logistics methods, such as optimizing delivery routes and transitioning to cleaner transportation systems (Creutzig et al., 2015; Litman, 2020). Through these integrated frameworks, industries can align operational strategies with global sustainability goals while lowering carbon footprints across supply networks.

Shipping Methods in the Supply Chain

The choice of shipping methods significantly influences the level of carbon emissions generated within a supply chain. In the non-collaborative scheme, each company manages logistics independently, often leading to redundant trips and higher fuel consumption, resulting in elevated carbon emissions. Conversely, the collaborative scheme promotes joint logistics management among companies, optimizing transportation efficiency, reducing the total number of trips, and consequently lowering carbon output (Kahn Ribeiro et al., 2007; Saghir & R. D., 2020). This cooperative model not only enhances environmental performance but also fosters operational cost savings and resource efficiency within the industrial logistics framework.

Collaboration Impacts, Carbon Reduction Methods, Research Flow, and Previous Studies

Collaboration in logistics offers multidimensional benefits, including reduced operational costs, improved fuel efficiency, and greater sustainability in industrial supply chains (Rustam & Santosa, 2020). Previous studies reinforce these strategies: Chien et al. (2016) found that reduced vehicle speed lowers CO_2 emissions, while Zhang and Liu (2023) demonstrated that IoT-based fleet management can cut emissions by up to 20%. Similarly, Lee and Lee (2020) highlighted the potential of electric vehicles to halve emissions, underscoring the importance of technological innovation and logistics optimization in achieving carbon neutrality.

RESEARCH METHOD

This study employs a quantitative approach with descriptive analysis to measure and compare carbon emissions generated from export and import activities at PT. XYZ, one of Indonesia's largest automobile manufacturers located in Karawang. The research focuses on evaluating emission differences before and after implementing collaborative shipping practices. PT XYZ currently manages a decentralized logistics system where most suppliers deliver materials independently to the manufacturing plant. This approach often results in low truck utilization, frequent partial shipments, and higher fuel consumption. Consequently, logistics activities contribute a significant portion of PT XYZ's Scope 3 emissions, especially from domestic inbound transportation. To address these inefficiencies, PT XYZ initiated a collaborative transportation program that integrates deliveries from multiple suppliers through shared routes and consolidated shipments. The scheme is coordinated via a centralized logistics management system and supported by third-party logistics providers

(3PLs). This collaboration allows optimization of delivery frequency, load factor, and route planning, leading to lower transportation costs and reduced CO_2 emissions.

Data were collected throughout January–December 2024 using secondary data from company reports, policy documents, and logistics records, as well as interviews with logistics managers and field observations to ensure data accuracy. The procedure involved problem identification, data collection, emission calculation using appropriate formulas, and evaluation of the financial and non-financial impacts of collaborative logistics. Data were analyzed using descriptive statistics to quantify total emissions under both schemes, complemented by qualitative analysis to interpret policy impacts. To ensure data validity and reliability, triangulation was conducted by comparing information from documents, interviews, and direct observations, all verified by the External Logistic Management Department of PT. XYZ.

RESULTS AND DISCUSSION

Calculation of Carbon Emissions (PT. XYZ Calculation Concept

After mapping the import and export logistics cycles and conducting direct discussions with PT. XYZ's logistics department, accurate operational data were obtained for analysis. Four shipping agents (A, B, C, D) handled the containerized cargo throughout 2024, with fluctuating monthly import and export volumes. Shipping agent C consistently recorded the lowest export activity, averaging 16 full containers per month. These fluctuations highlight variations in logistics flow and transportation frequency, directly influencing fuel consumption and carbon emissions.

Comparison Between Current and Collaborative Schemes

In the current logistics scheme, import and export operations were managed separately. Empty import containers were returned to depots after unloading before new empty containers were collected for export. This cycle created redundant transportation trips, increasing fuel use and greenhouse gas (GHG) emissions. Using the IPCC 2006 method, total emissions for all shipping agents under current conditions reached 1,680,102.90 tons of CO_2, while PT. XYZ's internal calculation yielded 1,161 tons of GHG. The high emission level was attributed to frequent truck trips between PT. XYZ, the port, and depot facilities, with unoptimized container utilization.

Collaborative Scheme Emission Calculation

Under the collaborative logistics scheme, empty import containers were reused for export shipments without returning them to depots. This approach eliminated unnecessary transportation activities, such as empty container retrieval and "losbak" (return trips without cargo). The emission calculation is based on both IPCC 2006 and PT. XYZ formulas showed that the collaborative model achieved a total emission of 699,743 tons of CO_2, significantly lower than the non-collaborative system. Specifically, the shipping agent A's GHG emission decreased to 483.44 tons, illustrating the direct impact of optimized logistics coordination on fuel efficiency.

Comparison Results and Emission Reduction

The comparative analysis between the two logistics models revealed a reduction of 980,359.67 tons of CO_2, equivalent to a 58% decrease in total emissions when applying the collaborative scheme. This substantial reduction demonstrates that synchronized logistics operations through container sharing and better route planning can effectively minimize

transport redundancy, improve energy efficiency, and reduce environmental impact. The results also validate that PT. XYZ's collaborative logistics strategy aligns with sustainable transportation principles, supporting the company's long-term carbon reduction goals.

Financial Impact

Table.1
Import and Export Operational Cost Efficiency through Collaboration Scheme

Operation	Import and Export Activity Cycle	Main Activity	Cost	Total Trip		Total Cost		Cost Reduction
				Current Condition	Collaboration Scheme	Current Condition	Collaboration Scheme	
Import	Transporter Yard to PT. XYZ	Returning Empty Container to Depot	Rp 2,450,000	4412	767	Rp 10,813,520,000	Rp 1,880,820,000	Rp 8,936,700,000
	PT. XYZ to Depot Empty Shipping Agent							
	Depot Empty Shipping Agent back to Yard							
	Administration Fee (D/O, L/O)		Rp 800,000	4412	767	Rp 3,529,600,000	Rp 613,600,000	Rp 2,916,000,000
Export	Transporter Yard to Depot Empty Shipping Agent	Picking Up Empty Container at Depot	Rp 1,443,000	4563	918	Rp 6,581,709,000	Rp 1,345,734,000	Rp 5,235,975,000
	Depot Empty Shipping Agent to PT. XYZ							
	PT. XYZ back to Transporter Yard							
	Administration Fee (D/O, L/O)		Rp 800,000	4563	918	Rp 3,650,400,000	Rp 734,400,000	Rp 2,916,000,000
			Total			**Rp 24,625,229,000**	**Rp 4,574,754,000**	**Rp 20,028,475,000**

Reduction in Empty Container Transportation Costs (Return Empty Container)

1. Before Collaboration:
   The cost of returning empty containers reached Rp 10,853,520,000. This figure is considerably high because the company had to bear the transportation costs of returning empty containers to their origin after unloading imported goods at PT. XYZ.
2. After Collaboration:
   The cost significantly decreased to Rp 1,886,820,000. This substantial reduction occurred because imported empty containers no longer needed to be sent back to their origin; instead, they were directly allocated for export purposes.

Reduction in Empty Container Transportation Costs for Export

1. Before Collaboration:
   The cost of shipping empty containers for export reached Rp 6,613,400,000. This cost arose because empty containers had to be sent from storage locations to factories or exporters.
2. After Collaboration:
   The cost decreased to Rp 1,353,534,000. This reduction occurred because imported empty containers already available at the export location could be reused directly.

Reduction in Administrative Costs for Empty Containers (Import and Export) – LOLO

1. Before Collaboration:
   The total administrative costs for import and export amounted to Rp 3,529,600,000 + Rp 3,666,400,000 = Rp 7,196,000,000. These costs included various administrative processes such as document handling, licensing, and other related fees.
2. After Collaboration:
   The total administrative cost decreased to Rp 613,600,000 + Rp 750,400,000 = Rp 1,364,000,000. This decrease occurred because the number of containers requiring administrative processing was reduced.

Total Cost Savings from Collaboration

1. Before Collaboration: The total cost incurred was Rp 24,662,789,000
2. After Collaboration: The total cost incurred was Rp 4,604,354,000.
3. Savings: This collaboration resulted in cost savings of Rp 20,058,435,000 or approximately 81.33%.

Positive Financial Impact for Transportation Service Companies

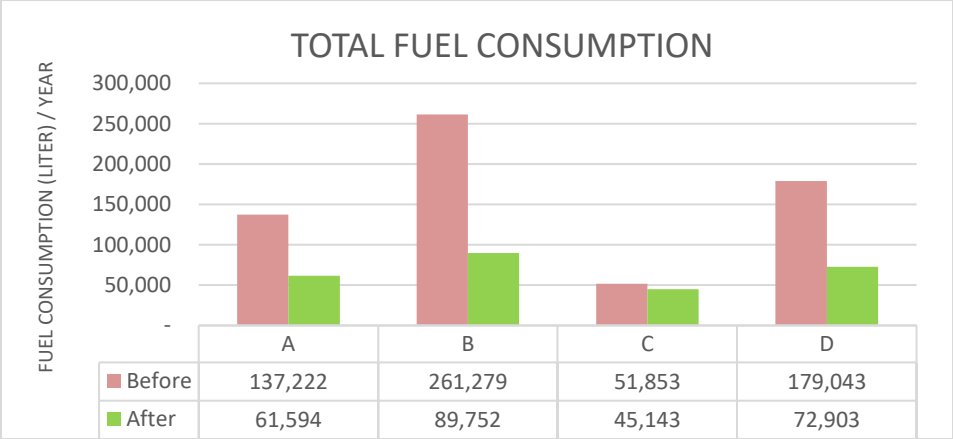

Figure 1.
Fuel Purchase Cost Reduction Graph

Total Reduction in Fuel Consumption

Based on Figure 4.4 above, it can be seen that the collaboration activities, primarily aimed at reducing carbon emissions, also had a positive impact felt by transportation service companies. This is proven by a significant reduction in the purchase of diesel fuel (B35 type). If compared, transportation companies handling orders for Shipping Agent B experienced the most significant decrease in fuel consumption, from around 261,279 liters to 89,752.25 liters. Transportation companies handling orders for Shipping Agent A also experienced a

considerable decrease, from 137,222 liters to 61,594.70 liters. Transportation companies handling orders for Shipping Agent D remained in a normal condition, while companies handling orders for Shipping Agent C showed the smallest decrease compared to others.

Total Reduction in Fuel Purchase Costs

Based on Figure 4.5 above, the cost savings resulting from reduced carbon emissions also had a significant impact from the decreased purchase of bio-solar fuel. Fuel purchase cost before collaboration: Rp 4,279,905,380. Fuel purchase cost after collaboration: Rp 1,831,873,420. Hence, the total cost savings amounted to Rp 2,448,031,960 or approximately 57.20%.

Non-Financial Impact

In addition to the financial impact described above, the collaboration in shipping also provides positive non-financial impacts for PT. XYZ and related stakeholders. The following are several non-financial impacts obtained:

Improved Company Reputation

1. Positive Image:
   By reducing carbon emissions through shipping collaboration, PT. XYZ demonstrates its commitment to environmental sustainability and corporate social responsibility.
2. Stakeholder Trust:
   This can enhance the company's positive image in the eyes of stakeholders, including the public, customers, investors, and the government.
3. Competitive Advantage:
   A good reputation as an environmentally conscious company can serve as a competitive advantage for PT. XYZ in the automotive market, which increasingly values sustainability issues.

Contribution to Sustainable Development Goals (SDGs)

1. Climate Change Action:
   By reducing carbon emissions, PT. XYZ contributes to achieving Sustainable Development Goal No. 13 on climate action.
2. SDG Alignment:
   By lowering carbon emissions, PT. XYZ automatically contributes to SDG activities, such as reducing fossil fuel use, increasing renewable energy adoption in production facilities, and investing in technology and innovation to enhance production efficiency and reduce carbon emissions.

External and Internal Impacts of Collaboration

Shipping Agent and Depot Companies

1. Shipping and depot companies that own import containers rely on renting empty containers for export. If there is no demand for empty containers, they lose a major source of income, meaning they cannot earn revenue from leasing empty containers to customers, including PT. XYZ.
2. These companies have already spent money to purchase or rent many containers. If those containers are not used, the expenditure becomes wasteful, reducing the profit that could be gained from the investment.
3. Unused empty containers must be stored in depots or warehouses. If there are too many empty containers, storage space becomes limited. This increases storage costs because the company must find more space to store the unused containers.

4. On the positive side, collaboration ensures the availability of empty containers from shipping agents for PT. XYZ's export needs. There are no longer issues related to container availability at the depot.

Transportation Service Companies

One of the main impacts is a decrease in export and import delivery orders. Transportation companies typically earn revenue from orders to collect empty containers from depots for PT. XYZ or to return empty containers from PT. XYZ to depots. However, these orders have now decreased, leading to lower income from trailer truck rentals. This can directly affect cash flow and the company's ability to cover operational costs. On the other hand, due to PT. XYZ's collaboration initiative, transportation companies also benefit from reduced fuel purchases. Due to the collaboration, the frequency of transportation activities around the depot area has decreased, thereby reducing traffic congestion often caused by truck queues. The air quality around the depot area has become cleaner than before.

Internal Impacts

Cost

1. The use of empty containers for export can reduce transportation costs for returning containers to their country of origin. This decreases the company's logistics costs as they can use capacity more efficiently.
2. For exporting companies, this collaboration can reduce container procurement costs since they no longer need to purchase or rent additional containers.

Productivity

1. The company can maximize the use of existing transportation capacity, increasing throughput (the number of goods shipped) while minimizing the idle time of empty containers.
2. This collaboration can create efficiency within the global supply chain, which in turn improves the company's internal performance by accelerating the flow of goods to and from export destinations.
3. By enhancing shipping efficiency, delivery time can be shortened, increasing customer satisfaction through faster and more reliable deliveries.

Short Term Risks

1. Used containers may experience physical damage, such as leaks or weakened structures, which can lead to product damage during export, such as moisture exposure or contamination due to non-waterproof containers.
2. Used containers previously used to transport certain goods may still contain residual chemicals, dirt, or substances that can contaminate exported goods, leading to unfit products or additional cleaning costs.
3. Some export destination countries may have strict regulations regarding the use of used containers, especially concerning hygiene, safety, or physical condition. Containers that do not meet standards could delay the export process and cause product rejection.
4. Non-standard or damaged containers may delay shipments, causing losses to PT. XYZ in terms of time, reputation, and additional costs.

Long Term Risks

1. If frequent issues arise with product quality, such as damaged or contaminated goods due to used import containers PT. XYZ's reputation in the international market may be

harmed. Poor reputation can negatively impact long-term relationships with customers and business partners.
2. Although used import containers are cheaper in the short term, in the long term, additional costs may arise for more frequent repairs and maintenance compared to new containers. This can increase logistics and operational expenses.
3. Poorly managed used containers can create environmental problems, both in waste management and in the use of harmful materials. If PT. XYZ neglects sustainability aspects, this could damage the company's image in the global market, which increasingly emphasizes environmental responsibility.
4. Export destination countries may introduce stricter regulations concerning used import containers, such as quality standards, waste management, or labeling. Failure to comply with these rules in the long term could hinder access to certain markets.
5. The use of non-standard used containers could pose health and safety risks to workers or related personnel in the logistics process, such as chemical leaks or other hazardous conditions.

CONCLUSION

Research shows that collaborative shipping can significantly reduce the carbon emissions produced by companies. Specifically, non-collaborative shipping generates approximately 1,680,102.90 tons of CO_2 per year, while collaborative shipping produces only 699,743 tons, representing a total reduction of 58%. In addition to lowering emissions, collaborative shipping also provides financial benefits for PT. XYZ, with transportation cost savings of up to 15%. This demonstrates that a collaboration strategy is not only environmentally beneficial but also enhances corporate economic performance. The study highlights the importance of collaboration among companies in export and import activities to achieve greater shipping efficiency and minimize environmental impact. Individual company efforts are less effective than collective initiatives within the same industry. The findings suggest that promoting collaborative shipping practices can yield positive impacts not only for PT. XYZ, but also for the broader transportation industry, contributing to long-term sustainability.

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