Siber Journal of Transportation and Logistic (SJTL)
E-ISSN: 2987-1050
P-ISSN: 2987-1026
+62 822 1012 3600 https://research.e-siber.org siberpublisher.info@gmail.com
DOI: https://doi.org/10.38035/sjtl.v3i2

Analysis of Logistics Cost Efficiency in Indonesia's Transportation System

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Abstract: Indonesia's logistics costs remain high, at around 23-24% of PDB, well above the global average and that of other Southeast Asian countries, reducing national competitiveness. Land transportation contributes about 50% of domestic logistics costs. Multimodal transportation-combining multiple modes under one contract-is an efficient solution by simplifying administration and lowering costs. The national logistics system (Sislognas) continues to be developed through technology investment and stakeholder collaboration. Initiatives such as the National Logistics Ecosystem (NLE) and Indonesia National Single Window (INSW) 2.0 accelerate administrative processes and reduce waiting times at ports, thereby helping to reduce logistics costs. The transformation of INSW into Lembaga National Single Window (LNSW) strengthens the integration and coordination of the national logistics system. With multimodal and digitized processes, logistics cost efficiency is expected to improve, supporting Indonesia's economic growth and competitiveness.

Keyword: Efficiency, Cost, Logistics, Transportation, Indonesia

INTRODUCTION

The logistics and transportation business is essential to drive a country's economy. The logistics sector plays an important role in ensuring the smooth flow of goods and services from upstream to downstream in the entire supply chain in Indonesia. (Sudrajat et al., 2024) Logistics efficiency has evolved into more than just a competitive advantage in today's increasingly competitive and dynamic business environment. It is now an essential part of the company's operational success and customer satisfaction. The distribution of goods within the country in Indonesia is greatly aided by land transportation, which is the main option. This mode plays a major role in connecting factories with customers across the country, accounting for about 50% of domestic logistics costsWith an increase from 197.0 billion tons kilometers (tkm) in 2019 to 201.3 billion tons-kilometers (tkm) in 2023, it has become clear that land transportation is essential for transporting goods across goods (Policy, 2024).

Despite playing an important role, Indonesia still faces a major problem related to high logistics costs. Data shows that Indonesia's logistics costs are still very high compared to neighboring countries. This figure reaches 23-24% of GDP and ranges from 17% of production costs (Policy, 2024) This comparison is far beyond the global average which is in the range of 13-15% and much higher than other Southeast Asian countries such as Singapore (6%) and the Philippines (7%). (Wirabrata & Silalahi, 2012) This condition creates a major obstacle for the business sector, lowers profit margins, and ultimately affects the competitiveness of Indonesian products in the international market.

It should be noted that the published logistics cost data differs slightly For example, data from the ministry of national development planning (PPPN) shows that national logistics costs in 2022 will reach 14.1% of GDP, and will reach 23.08% of GDP when combined with export logistics costs of 8.98%. (Policy, 2024) On the other hand, another report states that logistics costs will reach 24% of GDP, (Wirabrata & Silalahi, 2012) or 23-25% of the price of the final product. It is difficult to get consistent numbers due to differences in the business of calculation (GDP, cost of production, or price of the final product) and the method of measurement. This difference is significant because it can affect public opinion, government policy goals, and business plans. The overall logistics burden may not be met if the reduction in logistics costs is limited to the domestic component (14.1%). Therefore, to ensure that the data is consistent and comparable, standardization of logistics cost measurement methodologies across the country has become critical. Governments and researchers should pay close attention to this issue.

Improvinglogisticsefficiencyis atopprioritygiventhe importance ofthis issue. Efficiencymeansincreasedspeed and customer serviceandreduced costs. Inthiscasethe Indonesian archipelago, multimodal transportationoffers a promising solution. Multimodal transportationrefers to the use of variousmodesof transportation, such asland, rail, sea, and airtotransportgoodsfrom thestartinglocationtothe final location. One ofits keyfeaturesisthat thisentire process is managed under a singlecontract, withonecompany fully responsibleforthe entirejourney. This one-contract idea is thebasis that drives multimodaltransportationto bemoreefficientShipping involving multiple modesof transportationoften requiresseparate contractswitheach modal operator in conventional logistics practices. Thisleads to complicated administration, possibleoverlappingtasks, and high costs. Witha singlecontract, the administrative burden of the service user companyissignificantly reduced, and the responsibilityis centralized on a single multimodal operator. In additionto reducingthe administrativeburdenthis simplification also reducesthe risk oferrors, speeds up the process and allows for betterprice negotiationsdue to volume consolidation. Thisdirectlyreducescosts and improvesoperational efficiency, makingmultimodaltransportationa highlyeffectiveapproach toaddresscost issueslogistics in Indonesia.

Logistics, in its most basic sense, is the process of planning, executing, and controllingthe flow of goods and services, as well asrelated information, fromstarttofinishtofulfill customer needs (Sudrajat et al., 2024)Procurementof storage, inventory management, transportation, warehousing, packaging ofsecurity aspects, and handlingof goods and services, bothraw materials, intermediategoods andfinished goods, areall important parts of this process (Kasengkang et al., 2016)

A supply chain strategy known as logistics cost efficiency focuses on optimizing various parts of the supply chain, such as storage transportation, material handling, and investment management. The main goal is to save money but still provide fast and good service to customers.

The types of logistics costs are very diverse and can be categorized as follows:

- **Transportation costs**: thisis the most importantcomponent oflogistics costs, and includesallthe costs associated

- **Warehouse (warehousing and storage) costs:** include costs associated with storage facilities, such as rent, utility costs, warehouse labor, and maintenance and repairs.
- **Inventory carrying costs:** Costs incurred from owning and holding inventory. This includes capital costs, insurance, taxes, and possible inventory loss due to loss, theft, or obsolescence.
- **Packaging and material handling costs:** expenses for packaging materials used to protect goods during transit and storage, as well as labor costs for the process of packaging and preparing goods, and the cost of equipment such as forklifts and conveyors used to move goods within the warehouse or during loading and unloading operations.
- **Order management and administration costs:** costs required to process customer orders, keep records, communicate, and various other administrative tasks that help the flow of goods.
- **Reverse logistics costs:** expenses covering the return of products by customers to manufacturers or distributors, recycling, repair, or disposal.
- **Customs duties and taxes:** government fees associated with the import and export of goods, as well as other taxes applicable in the supply chain.
- **Direct and indirect costs:** logistics costs can be divided into two categories: direct costs, which are directly related to the movement of goods (such as fuel), and indirect costs, which are indirectly related to efficiency (such as risk and delay costs).

Logistics cost efficiency can be affected by a number of variables. These include the quality and availability of adequate transportation infrastructure, the level of technology integration in logistics operations, optimization of inventory and warehouse management, transportation and delivery route planning, improved efficiency of warehouse operations, increased supply chain visibility for better decision-making, and programs for continuous workforce skills development. In addition, due to the complexity of the industry and the supply chain itself, strong institutional and cross-sectoral coordination is essential.

In today's logistics world, the term "multimodal transportation" refers to the transportation of goods through a minimum of two transportation events, such as land, rail. sea, and or air. The main feature of multimodal transportation is that the entire journey of the goods, although involving various modes, is managed as a multimodal transportation document under one contract and starts from one location where the goods are received.(Nirmala, 2017) This indicates that one company is fully responsible for the entire journey, which makes the customer experience easier.

The multimodal transportation process usually starts with "collection", or picking up the goods from the shipper, which is usually done by truck. Then the goods are transferred to a primary mode of transportation, such as a ship for long ocean shipments, a train for efficient land shipments, or an airplane for fast air shipments. In the last stage, the goods are moved back to the shipper, often by truck. From the customer's point of view, the entire process is efficiently managed by a single service provider, although behind the scenes there is complex coordination between the various mode operators.

Multimodal transportation offers several significant advantages to businesses and the logistics industry:

- **Increased efficiency:** it allows the use of certain modes of transportation, such as rail for fast long-distance transportation, along with other modes of transportation, such as trucks for flexible local delivery. This combination maximizes transit time and freight size.
- **Cost savings:** by optimizing the use of different modes of transportation, businesses can take advantage of the most cost-effective operations for each stage of the journey. For example, using trains or ships for long distances and trucks for short distances can result in more affordable shipping costs for the entire package.

- **Simplified management:** having one contract that covers the entire journey simplifies shipping for businesses. They only need to work with one transportation operator, which significantly reduces the administrative work and coordination efforts that are usually required when interacting with multiple carriers.

Although the terms "multimodal" and "intermodal" are often used interchangeably, there are important differences. However, intermodal transportation may also carry separate contracts for each market segment, even if the goods remain in the same unit of load (e.g., containers). Multimodal transportation specifically carries one contract and one entity that looks after every aspect of the journey.

The implementation of multimodal transportation has not gone unnoticed. This system requires intermodal infrastructure, such as dry port terminals that are connected to railways and highways. In addition, cross-sectoral coordination among various stakeholder interests (government, operators, and logistics players) is needed. One of the key components of success is a strong and resilient human spirit when dealing with multimodal operations. (Wirabrata & Silalahi, 2012)

Indonesia's logistics system, also known as the national logistics system (sislognas), is based on various processes, activities, and functions that are integrated in the planning, execution, and distribution of goods and services from start to finish within the national transportation system. (Sudrajat et al., 2024)

The main objectives of sislognas are to improve logistics business operations, enhance national security, and ultimately improve people's welfare. The main components that are the focus of sislognas development are investment in logistics technology, close collaboration among logistics actors, development of strategic infrastructure that can reduce impacts, and optimization of distribution routes to reduce delivery time and costs.

One of the most important initiatives in sislognas is the development of a national logistics ecosystem (NLE). The NLE is an information system designed to integrate various key players in the logistics system, such as customs, quarantine, port authorities, financial services, and banking, and various units under the ministry of transportation, including inaPortNet, SIMALA, SITOLAUT, and SIJUKA. (Sudrajat et al., 2024) The purpose of the NLE is to move international trade in goods and documents from the point of departure to the point of delivery. As such, it will speed up administrative procedures, reduce waiting times, and handle logistics costs in an understandable way.(Dhany Novianto)

In addition to the SLE, Indonesia also has the Indonesia national single window (INSW) system, which was created in 2010. This system serves to facilitate the enforcement of export import regulations, integrate licensing business processes, and improve supervision. In order to improve the efficiency of the national logistics system and the speed of the nation, the government launched INSW 2.0 in June 2023. The focus of INSW 2.0 is on standardization, simplification, harmonization, and synchronization of logistics business processes, which is an important step in creating a more efficient system.

The transformation of INSW from a portal to an agency (LNSW) is a well-executed strategic plan. Initially, INSW served as a digital platform to facilitate the export-import process. However, the government stated that digitization alone was not enough to address the complex logistics issues that arose. Therefore, INSW was rebranded as LNSW, an institution with a stronger focus on integrating, maintaining, and developing end-to-end processes rather than just providing a platform. The results of this institutional strengthening can be seen in the decline. In 2022, ships spend 2.84 hours in port, down from 4.06 hours in 2017.

As a direct indicator of transformation success, dwelling time is one of the key influences on the level of logistics costs in a business. This indicates that logistics problems in Indonesia are not merely technical (e.g., poorly functioning digital systems), but also related to organization and coordination. The role of LNSWs as integrators will be crucial to

the government's efforts to achieve efficiency. It is also evident that digitalization requires significant institutional reforms to deliver tangible results in terms of logistics efficiency.

In logistics, metrics and key performance indicators (KPIs) are important tools to assess and evaluate work performance. Metrics are quantitative measures of work performance, while KPIs are specific metrics that focus on overall work performance and the ability to meet the strategic goals of the company or organization.(Yazid, 06/24/2023)

Effective transportation management brings a variety of significant benefits, which directly contribute to logistics cost efficiency:

- Cost savings: through optimization of transportation routes, selection of the right carrier, and consolidation of loads, businesses can significantly lower the cost of goods distribution.
- Improved operational efficiency: transportation management systems (TMS) automate and streamline many processes, reducing manual labor and the use of physical documents. This contributes to increased efficiency in the planning, execution, and maintenance of transportation activities.
- Optimized route planning: TMS helps in optimizing route planning to reduce travel time and extend transit time, which contributes to more efficient use of raw materials and faster delivery.
- Improved supply chain visibility: working with parents, guardians, and customers to effectively share information improves supply chain visibility, enables proactive decision-making, shortens the time needed for processing, and reduces disruptions.
- Better customer service: efficient transportation management contributes to on-time delivery, reduced transit time, and improved customer satisfaction in all aspects.
- Goods load optimization and inventory management: effective transportation management lowers inventory levels by ensuring that products arrive on time, reducing the need for safety stock, and increasing inventory turns
- Carbon footprint reduction: by reducing emissions and fuel consumption, efficient transportation and route optimization contribute to environmental sustainability. To measure logistics performance and cost efficiency, several important metrics can be used:
- On - time delivery (OTD) / on - time delivery rate: reduces the percentage of arriving deliveries according to schedule. It is a measure of service quality and may affect fines or surcharges.
- Transit time: the total value of goods required to move from the initial destination to the final destination. This metric is critical for reducing delivery time and can affect the capital costs incurred during the journey.
- Cost per mile (CPM) or cost per kilometer (CPK): the total transportation cost divided by the total amount of time. This indicator gives a clear picture of the operational efficiency of the cost per unit distance under consideration.
- Transportation cost per unit: this is calculated by dividing the total shipping cost by the number of cargo units shipped. This is a silent indicator of the cost effectiveness of each item purchased.
- Carrier performance: the performance of the transportation service provider is evaluated based on criteria such as OTD, timeliness, and cost.
- Load factor or cube utilization: the performance of a transportation service provider is evaluated based on criteria such as OTD, timeliness, and cost. Lower vehicle occupancy percentage. Optimization of this metric means making the most of the available space, reducing the number of trips required, and ultimately lowering the cost per unit of goods.

- Empty miles percentage: percentage of mileage traveled plus obstacles. Identifies empty trips that are operating costs.
- Dwell time: waiting at a facility, such as a terminal, warehouse, or port. Long term waiting can increase operating costs, labor costs, and freight flows.
- Inventory carrying cost: costs associated with inventory management and storage. The need for security stock can be reduced by more efficient and timely delivery, which lowers this cost.
- Order accuracy: a percentage of dissolved orders will be disposed of without issue. This has a negative impact on customer satisfaction and return shipping costs.
- Inventory turnover: there are several popular products sold and marketed during the relevant time period. High performance indicates efficiency in stock management.
- Average order processing time: this is the condition required to ship from order receipt to order ready.
- Shipping cost per shipment: the total shipping cost is equal to the number of shipments made.
- Order fulfillment rate: the percentage of successful orders determined by the specified time and specificity.

Operational metrics and multimodal logistics have a very interesting relationship. Operational indicators include metrics such as OTD, transit time, load factor, and waiting time. Other metrics are inventory carrying cost, CPM/CPK, and transportation cost per unit. There is a strong link between operational and financial performance. For example, increasing load factor (more goods per trip) gradually decreases CPM/CPK as the cost of the trip is shifted to more expensive merchandise units. Decreasing dwell time lowers vehicle and warehouse operating costs. Due to more affordable safety stock requirements, OTD and transit time can reduce inventory carrying costs so that capital is not always as long as it should be in inventory. Therefore, companies cannot just focus on the cost aspect alone to achieve logistics efficiency in a multimodal system. They must actively monitor and optimize operational metrics across every mode of transport and transfer. This means investing in technology (such as TMS and WMS), learning new routines, and working together as a team to simultaneously improve operational efficiency and reduce costs, creating the best synergy in a multimodal system.

METHOD

This research uses a qualitative descriptive approach. The purpose of descriptive research is to systematically describe and analyze phenomena, conditions, and characteristics relevant to the logistical efficiency of multimodal land transportation systems in Indonesia. (Nurahman & Widodo, 2021) This allows comprehensive data collection to provide an accurate and in depth picture of the topic under study.

Although the research is heavily based on secondary data, the qualitative approach allows for a deeper understanding of complex contexts, policies and case studies. It allows for the interpretation of relationships between variables that may not be fully quantifiable as well as nuances in industry practices and business operations. As a result, this research not only presents the facts, but also examines the implications and nuances. (Sustainability), 2024)

The data used in this research is secondary data. Secondary data is data that has been collected by others and is available for further analysis.

Secondary data sources used in this study include:

- Scientific journals: journal of transportation & logistics management (JMTRANSLOG) (Wibowo & Chairuddin, 2017), journal of transportation and logistics business management (JMBTL) (Tohir et al., 2023), journal of multimodal transportation (Antarmoda, 2018) , journal of transportation and logistics technology (Soelistyo Pribadi et al., 2022) , journal of transportation and logistics cyber.

- Industry articles and reports: publications from research institutions, consultancies and logistics industry associations that provide up-to-date data and analysis on logistics costs and transportation performance in Indonesia. These sources include reports from Supply Chain Indonesia, PwC, World Bank LPI, and related publications from logistics companies.
- Textbooks: recent books (2015 - 2025) that discuss logistics management, and transportation economics in Indonesia. Examples include books on modern transportation economics, integrated logistics management, and transportation operations management.
- Government regulations: regulatory documents relevant to multimodal transport and logistics in Indonesia, such as government regulation (PP) number 8 of 2011 on multimodal transport and minister of transportation regulation (PM) number 8 of 2012 on the implementation and operation of multimodal transport. (نایچدرگم et al., 2011)
- The data collection method used a literature study: The primary method of collecting data for this study was through a comprehensive literature review. This involved the systematic analysis, identification, and analysis of information from various sources relevant to the topic of logistics efficiency and multimodal land transportation systems. To ensure comprehensive and up-to-date information, the study was conducted using scientific data, government websites, journal portals, and book annotations.
- Document analysis: After collecting various sources, an analysis was conducted on official documents. This includes published case studies, press releases, government policies, and year-end reports. The purpose of the document analysis was to present relevant quantitative and qualitative information, such as cost statistics, performance metrics, descriptions of government initiatives, and the specific implementation of the study.
- Content analysis: This method was used to analyze texts and information from various sources. The aim was to identify key concepts, important ideas, and emerging issues related to logistics cost efficiency and multimodal transportation. This process helps in classifying information and establishing relationships between data points.
- Descriptive analysis: The identified information and data are presented in a logical manner. The purpose of this descriptive analysis is to provide comprehensive and systematic examples of existing conditions, logistical components, relevant work metrics, and current regulations and procedures. The study was conducted in easy-to-understand academic language, thus providing a clear context to the reader.
- Information synthesis: Combining and integrating findings from different sources is a crucial step. The aim is to develop a coherent argument and provide a deeper understanding of the research topic. This synthesis process identifies causal relationships, possible contradictions between data, and implications that may not have been apparent if only one source had been examined. This allows for the development of a cohesive and analytical narrative.
- Discussion of potential quantitative methods for future studies: Although this study focused on a qualitative descriptive approach, it is important to discuss relevant quantitative methods that could be used in case studies or long-term research to analyze the cost efficiency of multimodal transport. These methods provide more precise tools for optimization and correction:
- Cost comparison: This method uses the cost efficiency formula, namely (existing cost - planned cost) / existing cost x 100%. (Nurahman & Widodo, 2021) This formula is very useful for comparing current operational costs with costs determined after a new strategy is implemented or the results of the optimization process. Its application can explain clearly and concisely about cost savings.

- Transportation optimization: This study uses a linear programming model using techniques such as the modified distribution method (MODI) and the least cost (LC) method. The main objective is to minimize the overall transportation cost and optimize the distribution of goods from different sources to different destinations. The model takes into account source capacity, destination demand, and the per-unit cost of shipping between locations.
- Data envelopment analysis (DEA): DEA is a non-parametric method used to assess the relative efficiency of decision-making units (DMUs) in logistics activities.(Gestao & Producao, May 2020) In the context of multimodal transportation, DMUs can be terminals, routes, or even logistics companies. By identifying inputs (such as material costs, labor costs, etc) and outputs (such as operating costs, cargo volume, etc). DEA can determine which units are the most efficient and where other units can improve their productivity.
- Cost-benefit analysis (CBA): A comprehensive evaluation tool for comparing the benefits and costs of a transportation project or service, such as a multimodal project, is CBA. (Gibson & Wallace, 2016) This method quantifies various types of costs (such as capital, operational, and external costs such as pollution and congestion) and benefits (such as travel time, safety, and positive environmental outcomes) in monetary terms to determine economic and social outcomes.
- Analytical hierarchy process (AHP): AHP is a method used to analyze and prioritize factors that affect logistics costs in complex situations. (. & Santoso, 2020) This method allows the process of breaking down a problem into hierarchical components, assigning weights to each criterion, and evaluating alternatives based on comparisons. In case studies, AHP can help identify the most detrimental cost elements, as found in the analysis of logistics costs at cikarang dry port.

RESULTS AND DISCUSSION

Indonesia's multimodal land transportation system is an important component of national logistics efficiency improvement initiatives. In the domestic context, road transportation plays a dominant role. This mode accounts for about half of all domestic logistics costs. (Policy, 2024) Data shows that the volume of road freight transport continues to increase significantly, from 197.0 billion ton-kilometers (tkm) in 2019 to 201.3 billion tkm in 2023. This figure indicates that although other modes of transportation such as sea and air have a role in the distribution of goods, dependence on land transportation, especially trucks, is still very high in meeting distribution needs throughout Indonesia. (Sitorus, 2022)

Modal integration in Indonesia's multimodal system includes a combination of land (trucks), rail, sea, and air, all on a single track. This aims to simplify the logistics process for service users. One example of multimodal implementation by the government is the integration of the sea toll program. The program, which initially focused on sea transportation, has now been redesigned with pioneer land transportation and pioneer cargo air transportation to distribute logistics to 3TP (underdeveloped, remote, outermost, and border) areas.(NIRMALA, May 2017) A concrete example of this synergy can be seen in the H-5 and T-19 routes, which connect Surabaya - Merauke - Oksibil and ensure that goods can reach isolated areas.

The strategic use of road transport as the "final mile" link in a multimodal system is critical. Data shows that road transportation dominates domestic distribution, accounting for more than 50% of domestic logistics costs and 90.4% of all logistics costs in 2020. (Policy, 2024) Trucks are often used for "distribution" (final delivery to the recipient) and "collection" (collection of goods from the recipient) in multimodal transportation schemes. (Sitorus, 2022) This shows that although other modes (sea, rail, air) may influence primary or long-distance transportation, road transportation is essentially the crucial start-finish link in the multimodal

chain. Therefore, the efficiency of the entire multimodal system will be greatly influenced by the efficiency of the land segment, which includes route planning, load optimization, and waiting time reduction. The emphasis on ground transportation efficiency is not only about lowering the cost of the product itself, but also about improving its durability and speed.

First and last mile are very important for the multimodal system as a whole. Investments in road infrastructure, traffic management, and transportation technology management will have a positive impact on overall multimodal logistics efficiency as challenges in these areas can help improve efficiency in other modes.

Analyzing logistics components is an important step in understanding the structure of the mutimodal transport system in Indonesia. Based on information from the Ministry of National Development Planning (Ministry of PPN), the Coordinating Ministry for Economic Affairs, and the Central Bureau of Statistics (BPS), the three main components of Indonesia's domestic logistics in 2022 are transportation costs, warehousing and storage costs, and administrative costs. (Policies, 2024)

Among the total domestic logistics costs reaching 14.1% of GDP in 2022, the largest and most significant contribution comes from land transportation costs. This costs about 7% of GDP, or about 50% of all domestic logistics prices. This clearly shows the importance and urgency of concentrating on the efficiency of the road transportation sector. Although smaller, other cost components also have an impact on overall logistics costs. The percentage of GDP affected by sea transportation is 3.6%, air transportation is 0.8%, warehousing transportation is 1.5%, and administrative costs are 1.2%. (Policy, 2024)

Contribution of Indonesia's domestic logistics component in 2022. One of the largest contributors (50%) to domestic logistics costs is land transportation. Specific quantitative information (percentage of GDP and total domestic costs) that can be used as a basis for more in-depth analysis or comparisons over time. It also confirms that the focus on land transportation in a multimodal context is particularly relevant as price reductions in this sector will have a significant impact on overall national logistics costs.

As evidenced by the logistics performance index (LPI) published by the World Bank, logistics work practices in Indonesia highlight various obstacles that must be overcome. With an LPI score of 3.15, Indonesia fell to number 46 out of 160 countries in 2018. However, by 2023, this ranking improves to number 63 out of 139 countries, with an LPI score back at 3. (Policy, 2024) This ranking study raises important questions regarding the effectiveness of logistics efficiency improvement initiatives in Indonesia.

Indonesia's logistics performance is based on the World Bank's LPI. This internationally used logistics performance indicator provides a macro-level overview of where Indonesia stands in relation to other countries. Clearly illustrating Indonesia's growth rate and LPI score for the period 2018 - 2023, this data is critical for identifying outstanding issues or problems. The research also serves as a valuable tool to analyze the effectiveness of government initiatives and policies that have been undertaken over the period. If work is going well questions about why this is happening and what needs to be improved will arise. This data can be used to discuss various factors that contributed to the failure, such as infrastructure, bureaucracy, or technological adaptation, all of which are relevant to the logistical analysis of cost efficiency.

A phenomenon that requires careful analysis is the paradox of the decline in the LPI ranking in the midst of various government initiatives. The Indonesian government has implemented a number of strategic initiatives to improve logistics efficiency and reduce costs, including the development of the national logistics ecosystem (NLE), INSW 2.0, infrastructure development and improvement (dry ports, ports, and toll roads), and the sea toll program.(Dhany Novianto) Theoretically, every action here should be positively correlated with logistics productivity growth. However, the LPI data shows just the opposite.

This phenomenon can be explained by several factors. Firstly, the scale of Indonesia's logistics is large and complex, including the country's geography, lack of adequate infrastructure across the country, and lingering bureaucratic issues. The improvements that have been made may not be sufficient to address the scale of the problem or its impacts that have not been adequately addressed in each region. On the other hand, major infrastructure projects and system reforms take time to assess system shortcomings. A downgrade in the 2023 LPI may determine the conditions prior to new initiatives in terms of how large their impact will be or how comprehensive their impact will be. Third, the LPI has a relative value, other countries may make faster or more significant improvements, so even if Indonesia has internal problems, its position may be reflected in the world rankings. However, external factors such as the global economic downturn, pandemics, or supply chain disruptions (e.g., significant tonnage truck operations in Lebaran 2025, resulting in daily losses of IDR 1 - 2 trillion in the land, warehousing, manufacturing, shipping, and export-import sectors) (Dan & Penurunan, 2025) can affect overall logistics performance, regardless of internal operations. The above paragraphs indicate that current strategies may need to be evaluated, implemented, or adjusted. It also shows that logistics efficiency is a long-term goal; innovation and improvement are essential to strengthen and improve markets around the world.

To measure the cost efficiency of transportation logistics in more detail, several key metrics are particularly relevant:

- Cost per mile (CPM) or cost per kilometer (CPK): this metric compares all transportation costs to the total amount of time. This is important for road models as it gives a clear picture of fuel efficiency, driver labor costs, and vehicle costs per unit of distance.
- Load factor or cube utilization: this metric identifies some deficiencies in the transport vehicle used as an indicator. Increasing the load factor gradually reduces the cost efficiency per unit of goods produced as travel costs are shifted to larger volumes.
- Empty miles percentage: identifies the distance traveled by the vehicle without any assistance. Empty trips are a significant operating cost, and a reduction in this metric is a silent indicator of improved efficiency.
- Dwell time: refers to the time a vehicle waits at a warehouse, port, or terminal facility. High dwell time can increase the operational costs of vehicle costs (such as demurrage), labor costs for work (such as waiting for drivers), and the flow of goods in the supply chain.
- Inventory carrying cost: costs associated with inventory management and ownership. Transit time and delivery status have a significant impact on this metric. Faster and more efficient deliveries can reduce the need for safety stock, which lowers the capital cost spent on inventory.

Reduced transportation logistics efficiency. Operational metrics (such as load factor and lead time) have a direct impact on financial (cost) metrics. This helps in the development of a comprehensive improvement strategy. Analysis to pinpoint specific areas of inefficiency in the multimodal surface transportation system.

The Indonesian government has announced its commitment to improving logistics efficiency through various regulations and policies. The legal requirements for multimodal transport have been clearly established, most notably through government regulation (PP) number 8 of 2011 on multimodal transport. The main purpose of this regulation is to define multimodal transport as the use of at least two different modes of transport in a single line. It also provides clear information on multimodal business (both domestic and international), multimodal transport documents, operator responsibilities, and fare customization. (Multimodal, 2012)

The Minister of Transportation's Regulation (PM) number 8 of 2012 on the operation and business of multimodal transportation is then cited in this section. Business license

requirements for multimodal businesses, standards for competent human resources, processes for implementing activities, and administrative support for employees are all included in this PM. (Multimoda, 2012)

The existence of these regulations goes beyond providing a legal umbrella; they serve as a structural foundation that promotes efficiency and integration. Setting up "one contract as a multimodal transportation document" and defining "one company responsible for the entire journey" are two important ways to improve logistics operations. This effectively integrates and facilitates processes, information, and responsibilities across all different modes of transportation. Without clear legal guidelines regarding one entity and one contract, administrative complexity and fragmentation of responsibilities will undoubtedly become a major obstacle to cost-effectiveness. Therefore, this regulation is not only about legality but also about creating an ecosystem that enables operational and financial integration. In its most comprehensive form, it can reduce overall logistics costs by reducing duplication of efforts and minimizing coordination risks.

In addition to the legal framework, the government has also launched various other strategic initiatives and policies:

- Transportation infrastructure improvement: The government continues to make significant investments in the development and improvement of transportation infrastructure. This has led to the construction of new roads and improvements to existing ones, such as the Serang - Panimbang and Jakarta Outer Ring Road 2 (JORR 2) toll roads. These improvements aim to improve the distribution of goods, reduce vehicle operating costs (BOK), and manage time effectively. The development of seaports (such as kuala tanjung and patimban ports) and airports are also considered important to improve international trade and efficient domestic distribution. (Dhany Novianto)
- Digitalization and technology integration:
- In order to improve the efficiency of the national logistics system, the government launched the INSW 2.0 system in June 2023. This system focuses on streamlining, standardizing, simplifying and harmonizing logistics business processes.
- The goal of the national logistics ecosystem (NLE) is to integrate various important stakeholders in the transportation industry and harmonize the transportation of goods and documents. (Sudrajat et al., 2024).
- The government is also encouraging the use of contemporary logistics technologies such as the internet of things (loT), big data, and artificial intelligence (AI) for real-time monitoring, predictive analysis, and routine optimization, all of which improve operational efficiency. (Dhany Novianto)
- Sea toll program: launched in 2015, this program aims to improve the efficiency and effectiveness of logistics in Indonesia through the provision of subsidized transportation services, particularly for 3TP (underdeveloped, remote, outermost, and border) areas. The main objective is to reduce disparities in the price of goods and logistics costs in these areas. This program also aims to maximize return cargo in order to increase efficiency. (This program also aims to maximize return cargo in order to increase purchasing efficiency and effectiveness. (Cenderawasih & Strategis, 2021)
- Simplification of regulations and bureaucracy: efforts are being made to strengthen administrative procedures at ports, airports and borders as well as export-import regulations. One example is the many prohibitions and restrictions (lartas) that hinder the ability of goods to be sold.(Dhany Novianto)
- Improving the quality of human resources (HR): the government highlights the importance of competent HR. Therefore, education and training programs in logistics

and supply chain management continue to be developed to create a skilled workforce that can handle complex systems and technologies. (Dhany Novianto)

- Collaboration and synergy between parties: the finance minister's regulation (PMK) no. 71 of 2022, which provides an increase in VAT rates for related sectors, is one example of how the government encourages cooperation between the industry and government sectors. Another is the implementation of incentives for the logistics industry. (Dhany Novianto)

About the legal framework governing logistics and multimodal in Indonesia. Basic (PP 2011) to practical implementation (PM 2012), incentive support (PMK 2022), and program integration (Perpres 2021). Each regulation has an explicit or implicit objective to improve efficiency. For example, PMK 71/2022 silently reduces operational costs through tax incentives. It provides a good reference point to discuss how the government is working to reduce logistics costs and promote multimodal transportation.

Case study of the implementation of logistics cost efficiency in Indonesia's land multimodal transportation system

To provide more specific examples of how to improve logistics efficiency in Indonesia's multimodal land transportation system, several implementation studies can be examined.

Case study of cikarang dry port (CDP)

The Cikarang dry port (CDP) in West Java is one example of a multimodal facility that is being implemented with the aim of improving logistics efficiency. CDP serves as an extension of urban and maritime transportation. The aim is to reduce the congestion that often occurs at Tanjung Priok and speed up the delivery of goods. With a capacity of up to 8 million TEUs per year, CDP is expected to solve logistics problems in the Jabodetabek region.(Dhany Novianto)

The cost-effectiveness offered by dry ports, such as CDP, varies depending on the type of cargo. According to research, dry ports can reduce logistics costs for less container load (LCL) shipments by 10% to 30%. (Murdjito & Christino Boyke, 2015) The reason behind this cost reduction is that in contrast to corporate shipping depots located in port areas, dry ports allow for more efficient consolidation of goods and have lower costs. However, for full container load (FCL) shipments, it is generally cheaper than shipping through a dry port, especially if the packing (or containerization) process has already been completed at the shipping industry location. However, using a dry port is more costly if the stuffing is done at the depot. (Murdjito & Christino Boyke, 2015)

The difference in dry port efficiency by cargo type shows that dry port efficiency is not universal for all cargo types. Due to the consolidated quantities, dry ports serve as an efficient consolidation point for LCL, lowering the shipping cost per unit. However, for FCL, a single transfer point (dry port) can result in "double handling costs" (two times of handling), which only increases the cost, especially if the replenishment of goods has been done at the delivery location. The implication is that the dry port utilization strategy should be tailored to the characteristics of the cargo. Businesses should conduct a thorough cost-benefit analysis to determine whether dry ports are an effective solution for their cargo types and supply chain flows. Government efforts in dry port development also need to emphasize this distinction, either by offering different incentives or promoting services tailored to specific cargo types.

According to a study conducted by CDP in 2020 using the Analytical Hierarchy Process (AHP) method, transportation costs are the most significant logistics cost factor, accounting for 42.63% of overall costs. This is influenced by administrative costs (27.52%) and inventory (29.84%). (. & Santoso, 2020) Within the transportation cost category,

elements such as Costs associated with loading and unloading, customs fees, and expedition services have the highest priority, indicating areas that should be optimized.

Case study of transferring logistics from truck to train

Modal shift from truck to rail is an increasingly used strategy to improve logistics efficiency, especially for medium to long distances. The benefits of this modal shift are significant. The use of trains can reduce carbon emissions by up to 70% when compared to trucks, making it more environmentally friendly. In addition, it increases the efficiency of goods delivery due to the larger carrying capacity of trains. Another issue is traffic congestion on highways, which in turn reduces waiting times and indicates operational costs, such as fuel and trucking costs.(Erika, 17 september, 2024)

In terms of cost efficiency, rail can reduce prices by a significant amount at a more affordable price per unit. For example, the estimated cost of shipping cargo from Jakarta to Surabaya using rail is around IDR 468,000 per ton (calculated using 780 km x IDR 600 per ton-km). Compared to shipping via truck, this method is much more affordable, especially for large volumes and long distances. In addition, trains show much higher efficiency in fuel consumption, at around 6 liters per 1000 ton-km, compared to trucks that consume around 40 liters per 1000 ton-km.

A case study conducted on logistics company XYZ shows the positive results of this strategy. After moving most of the logistics from trucks to trains, XYZ was able to reduce carbon emissions by 70%, improve shipping efficiency, reduce operational costs, and increase profitability.(Erika, 17 september, 2024)

One important aspect that emerges from this case study is the synergy between cost efficiency and environmental sustainability. Findings from the truck-to-rail logistics analysis showed that "up to 70% reduction in carbon emissions", "operational cost savings", and "improved shipping efficiency" were the results.(Erika 17 September, 2024) This shows that in the context of transportation, the goals of cost efficiency and environmental sustainability are not always achieved; rather, they can be enhanced. Utilizing more energy-efficient modes, such as rail, naturally reduces fuel consumption (a significant operating cost) and carbon emissions. Greater rail carrying capacity also means higher costs per unit of cargo. For businesses and policymakers, this is a "win-win" solution. Switching to greener modes of transportation, such as rail, is not just about meeting corporate social responsibility (CSR) goals or environmental regulations, but also contributing to a long term reduction in logistics costs. This should be a key component of the national logistics strategy to achieve the challenging deadlines.

Compares the two most relevant modes of land transportation in the multimodal context in Indonesia - trucks and trains - from the point of view of operational and financial efficiency. By providing clear quantitative and qualitative data, rail has advantages in terms of material costs, capacity, and environmental factors, which encourage users to participate in a multimodal system. In a multimodal system, this understanding is essential to optimize the use of modes in each phase of the journey to achieve full logistics efficiency.

Case study of sea toll program and multimodal integration

Launched in 2015, the Sea Toll program is a Government of Indonesia initiative with the main objective of reducing the price gap between northern and southern parts of Indonesia. The program is implemented through the provision of subsidized freight services that run consistently and reliably. To date, the Sea Toll Program has completed 30 projects impacting almost all regions of Indonesia, with the main focus on the northern region. (Cenderawasih & Strategis, 2021) The Ministry of Transportation has integrated the Sea Toll Program with pioneer land transport and air bridges (cargo pioneer air transport) to ensure

that logistics distribution reaches communities in 3TP (Disadvantaged, Remote, Outermost, and Border) areas.

This multimodal integration allows goods that have been arranged using the Sea Toll to be arranged more easily in inland areas that are difficult to access. For example, logistics shipments from Surabaya that arrive at Merauke Port via Sea Toll will be continued by subsidized transportation to Merauke Airport and pioneer transportation to Oksibil Airport in the Bintang Mountains. (Cenderawasih & Strategis, 2021) This program has a very significant impact on prices and costs. Residents in the 3TP areas can purchase goods at more affordable prices due to the multimodal subsidies. Prior to Tol Laut, the price of goods in the Bintang region was very high due to the increased cost of shipping logistics by air, indicating that the area could only be reached by air. (Cenderawasih & Strategis, 2021) The program has succeeded in lowering these costs, so that the general public can enjoy more affordable prices. In addition, the Sea Toll Program actively encourages the optimization of return cargo from the 3TP regions to western Indonesia. As this reduces the travel costs of empty return cargo, this optimization of return cargo is critical to improving the effectiveness and efficiency of cost distribution throughout the process. The goal of initiatives such as Singgah Pelabuhan's "Rumah Kita" program is to socialize the program and encourage education and local businesses to create returns.

The Tol Laut program, as a multimodal intervention for economic and economic efficiency, indicates that the government can use multimodal transport as a tool to achieve more ambitious socio-economic goals, such as price stability and equitable development, ultimately achieving the goal of pure logistics efficiency. (Cenderawasih & Strategis, 2021) The subsidies offered in this program may only increase the government's operational costs, but the "efficiency" in this case comes from a macro-level perspective: reduced costs for end-users, increased purchasing days, and regional economic growth. The goal of reverse load optimization is to improve the operational efficiency of the program itself by reducing the cost of "empty reverse loads", which are typically inefficient in logistics. The program demonstrates that logistics efficiency is not only about managing long-term transactions but also about generating greater economic and social benefits through strategic interventions. It illustrates how multimodal transportation, supported by appropriate regulations, can be a valuable tool for regional development and transportation inequality. In addition, it can also be used to comprehensively improve transportation efficiency by reducing two-way traffic distances.

Challenges and opportunities for improving logistics cost efficiency

Efforts to improve logistics cost efficiency in Indonesia's inland multimodal transportation system are based on a range of factors that consistently deliver significant benefits.

Challenges:

- Inadequate infrastructure: Despite numerous transportation infrastructure projects in various parts of Indonesia, such as roads, bridges, and highways, the main cause of rising logistics costs remains infrastructure. These infrastructure gaps cause physical damage to goods. (Dhany Novianto)
- Bureaucracy and complex regulations: Often complex administrative procedures at ports and borders, as well as poor import-export regulations, can result in long waiting times and unnecessary expenses for business owners. (Dhany Novianto)
- High land transportation costs: Road transportation still manages to control and contribute significantly to domestic logistics costs. (Policy, 2024) Problems such as severe congestion and large-tonnage truck operations (e.g. in Lebaran 2025) can result

in huge economic losses, reaching trillions of rupiah per day. (Dan & Penurunan, 2025)

- Lack of cross-sectoral coordination: Coordination among government agencies is poor, and there is no organization that effectively functions as a high-quality logistics integrator. Such fragmentation can hinder the implementation of integration policies. (Wirabrata & Silalahi, 2012)
- Quality of human resources: The need for competent and professional logisticians is high. Unsatisfactory work performance can be caused by the complexity of multi-modal systems and technologies, which can be efficient tools.(Dhany Novianto)
- Reverse load imbalance: Challenges in optimizing return loads, especially from Indonesia's coastal regions, result in some operations being empty during return trips, which is a cost-cutting measure and reduces overall logistics efficiency. (Cenderawasih & Strategis, 2021)

Opportunities:

- Digitalization and technology integration: The adoption of technologies such as IoT, Big Data, and AI offers significant opportunities to improve operational efficiency, data accuracy, product visibility, and route optimization. The development of systems such as NLE and INSW 2.0 are important steps in creating an integrated digital logistics system. (Dhany Novianto)
- Multimodal infrastructure development: Multimodal facilities such as dry ports and intermodal connections (such as building rail lines to ports) can significantly reduce congestion and speed up the distribution of goods. (Dhany Novianto)
- Collaboration and synergy between parties: Public-private partnerships and close cooperation among industry players can lead to more comprehensive and insightful policies that can improve logistics efficiency. (Dhany Novianto)
- Utilization of renewable energy: Investing in environmental sustainability (e.g., electricity) and energy efficiency technologies in logistics facilities can reduce raw material costs and carbon emissions while improving the company's image.
- Logistics human resource development: A thorough and comprehensive education and training program will create logistics work processes that are more efficient, flexible to new technologies, and able to handle industry complexities. (Dhany Novianto)
- Distribution route optimization: Leveraging technology for more efficient route planning and cargo consolidation can significantly lower transportation costs.

The most important thing to discuss is the tension between aspirations for the future and the reality of implementation. The government has a clear vision and has introduced various strategic initiatives (NLE, INSW 2.0, Sea Toll, infrastructure development, digitalization, and tax incentives) that, in theory, should be used to calculate logistics costs. (Dhany Novianto) However, the LPI data showing a decline in performance (Cenderawasih & Strategis, 2021) and very high logistics costs indicate a significant delay in the implementation and coordination of work in the field. This can be caused by bureaucratic red tape, lack of coordination between departments or organizations, implementation problems, or suboptimal implementation capabilities. In addition, the pace of change in the global logistics sector may be faster than the pace of reform in Indonesia. To achieve significant logistics efficiency, Indonesia must not only continue to focus on good governance, but also on consistent implementation, ensuring that each initiative is carried out in a timely and well coordinated manner. Real-time and flexible impact evaluation of previously implemented changes is also critical. Structural reforms are needed to address various issues, including bureaucratic inefficiencies, data fragmentation, and poor physical-digital integration. In addition, human resource capacity building should be a top priority to ensure that logistics

work is done efficiently and effectively by utilizing new technologies and systems. This is a step towards more holistic and integrated action, not just fragmented projects or policies.

CONCLUSION

Several key findings emerge from the analysis of the logistics efficiency of Indonesia's multimodal land transportation system. First, logistics costs in Indonesia are still very high, reaching around 23-24% of GDP, while freight costs as the main contributor account for more than 50% of all domestic costs. This indicates that the land transportation sector is a crucial area for efficient intervention.

However, although the government has implemented several important policies and regulations, such as Government Regulation No. 8/2011 on Multimodal Transport, Minister of Transportation Regulation No. 8/2012, development of the National Logistics Ecosystem (NLE), Indonesia National Single Window (INSW) 2.0, Sea Toll Program, and various infrastructure and tax investments, Indonesia's logistics performance in the World Bank's Logistics Performance Index (LPI) is still struggling. In 2023, Indonesia's ranking has decreased from 46 in 2018 to 63 in 2023. This decline indicates the uneven impact of improvements across regions, lack of cross-cutting, and complex implementation challenges.

Third, multimodal transportation has significant potential for logistics improvement. This can be achieved through routine optimization, cargo consolidation, and prudent management under a single line. According to a case study, Cikarang Dry Port can provide significant efficiency for cargo with lower containerized loads (LCL). On the other hand, the logistics challenge from truck to rail not only results in significant operational costs but also significant carbon emissions, highlighting the cooperation between economic and environmental goals. Through multimodal sea-land-air integration, the Sea Toll program has successfully reduced price disparities in the 3TP regions and addressed long-standing socio economic issues due to strategic policy interventions.

Workplace metrics such as Cost per Mile/Kilometer (CPM/CPK), Load Factor, Dwell Time, and Inventory Carrying Cost are critical to assessing and determining overall logistics cost efficiency. Optimization of these operational metrics is directly related to logistics costs.

Theoretical and practical implications

- Theoretical implications: This research facilitates a theoretical understanding of the dynamics of logistics efficiency in developing countries with deteriorating infrastructure. It indicates that efficiency is not only influenced by economic factors, but also by flexible regulations, strong implementation capabilities, and synergy between economic and social goals. The concept of "efficiency" is needed to address social and macroeconomic issues, not just from a business microeconomic perspective. In addition, this study shows that the decline in the LPI amid government initiatives indicates that logistics improvements are relative improvements that encourage innovation and adaptation.
- Practical implications: This highlights the importance of adopting advanced technologies (such as TMS, WMS, IoT, and AI), optimizing operations in each multimodal transfer, and selecting the appropriate mode of transportation based on cargo and time characteristics. Focusing on improving load factor, reducing empty kilometers, and extending waiting time, will gradually reduce profitability. For the government, this is a reminder that effective policy implementation requires strong execution, effective cross-sectoral coordination, and thorough evaluation to ensure the desired impact is achieved. The gap between aspirations and implementation realities suggests that more attention should be paid to governance and execution capacity.

Suggestions and recommendations

Based on the findings and implications that have been described, the following suggestions and recommendations can be proposed:

- **For future research:**
- Conduct more in-depth quantitative research using techniques such as Data Envelopment Analysis (DEA) or Cost-Benefit Analysis (CBA) to assess the logistics efficiency of land multimodal dedicated routes in Indonesia. This research could concentrate on clearly and concisely comparing prices between two modes and identifying the most critical operational bottlenecks.
- Analyze the impact of government initiatives such as the NLE and Tol Laut Program on national logistics costs and delivery times by considering external factors of interest and changes in the market.
- Conduct more in-depth case studies of businesses that have successfully implemented multimodal transportation systems to identify best practices, potential solutions, and educational opportunities that can be applied to other industries.
- To meet Indonesia's logistics needs, a more comprehensive approach is needed to provide consistency and standardization of data, which will make comparison and evaluation easier.
- **For the government:**
- Acceleration and integration of infrastructure: The ongoing development and integration of multimodal infrastructure, such as efficient first- and last mile components, will significantly lower the currently dominant transportation costs. This includes the construction and maintenance of dry ports using rail and toll road networks.
- Policy and regulatory alignment:
- Ensure harmonization and consistency of regulations at all levels of government (both local and national) to reduce regulatory overlap, red tape, and uncertainty for logistics businesses. Top priority should be given to simplifying licensing and paperwork processes.
- Strengthening the government ecosystem: Accelerate the implementation and utilization of new digital systems, such as NLE and INSW 2.0. The government should also encourage the adoption of digital technology across Indonesia, including MSMEs, through education and incentive programs.
- Human resource development: Developing comprehensive and thorough education and training programs can help develop successful logistics work practices that are flexible to new technologies and capable of handling complex multi-modal systems. Collaboration with educational institutions and industry associations is essential.
- Incentives and collaboration: Offer more comprehensive incentives to businesses that invest in logistics efficiency, such as using environmentally friendly modes of transport (e.g., rail), optimizing reverse loads, and the use of technology. Encourage collaboration between government, industry and academia to develop innovative and cooperative solutions.
- **For industry players:**
- Technology investment: Implement transportation management systems (TMS), inventory management systems (WMS), and IoT/AI technologies to improve traffic visibility, optimize routes, and increase inventory management accuracy.
- Operational optimization: Emphasis is placed on improving load factors to maximize transport capacity, reducing empty miles to detect wastage, and extending waiting times at each multimodal transfer point to improve freight flow.

- Diversification of transportation modes: As an important component of a multimodal strategy, dynamically adjust cargo from trucks to more efficient modes, such as rail for long distances and large volumes.
- Supply chain collaboration: build a robust and transparent system with passengers, transportation operators, and customers to improve coordination, information exchange, and create efficiency in every area of the passenger ship.

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