DOI: 10.21791/IJEMS.2026.04

Research paper

Lean Concept Implementation: Waste Reduction on Road Transport in Apparel Industry

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Abstract. Logistics costs have become a concern for the Indonesian government, and in 2024, they accounted for 14% of the Gross Domestic Product (GDP). Transportation costs are one of the elements of logistics costs. This condition has compelled leaders and teams in the apparel industry to allocate resources efficiently, effectively, and productively, with minimal waste. Based on this reason, the organization sought to identify the root causes of waste and implement improvements in transportation. These wastes of road transportation were identified and reduced by DMAIC (Define, Measure, Analyze, Improve, Control) method and lean tools, including Value Stream Map (VSM), Lean Metrics, Five Whys (5Ws), Transportation Overall Vehicle Effectiveness (TOVE) – Overall Equipment Effectiveness (OEE), transport software, and SmartSheet. Data collection and observations were conducted in 2024 and 2025, resulting in improvements across various aspects, including a 75.75% reduction in parking time, a 4.67% decrease in distance traveled, an 82.66% decrease in vehicle utilization, and a 16.66% reduction in transportation costs. The Lean concept remains an effective tool for reducing waste.

Keywords: Logistics Cost, Transportation Waste, DMAIC Method, Lean Tools, Improvements.

Introduction

The global sales of apparel and footwear, as predicted by Euromonitor [1], were expected to grow by approximately 2% in 2024 in constant terms, and to recover by late 2025 or early 2026. However, interest rates will still be high and are likely to continue squeezing consumers' disposable incomes. In terms of category, children's wear and sportswear were set to rise in the wider industry. Anticipating this challenging condition, leaders and teams are beginning to allocate resources in efficient, effective, and productive ways. Every division in the organization improves its main activities. In an organization of apparel company, creative art and design division has improved its design more interesting for babies and kids, marketing and sales has started offering and selling the products to shopping centres to make products more reachable to consumers, supply chain management as an extension of logistics management [2] has improved the accuracy of inventory, optimized the vehicle's capacity and minimized travel time, human capital division has reviewed benefit and compensation, training and rules of the game in order to more attractive than before. Logistics, as a component of supply chain management [3], accounts for a portion of an organization's costs, ranging from 5% to 35% of its

DOI: 10.21791/IJEMS.2026.04

revenue [4]. Logistics costs also became a concern for the Indonesian government in 2014, accounting for 24% of Gross Domestic Product (GDP). By 2024, it had successfully decreased to 14% of GDP [5]. From this data, leaders must pay attention to logistics costs. Logistics costs include transportation, warehousing, inventory, administration, and packaging costs. Therefore, when one wants to reduce logistics costs, they must also reduce their component costs. It was identified that transportation has been the main logistics operational driver component in which lean logistics has been applied [6].

Costs that add no value are categorized as waste [7], and they cause systems to be inefficient. Waste is also stated as "Any substance, material or object which the holder discards or intends or is required to discard" [8]. There are seven types of waste according to Ohno [9]: overproduction, idleness, extra processing, unnecessary movements, non-conformities, and excessive stock. Lean philosophy is implemented to minimize waste, optimize core resources, and foster a corporate culture committed to increasing customer satisfaction [10]. The Lean concept is an approach to continuous improvement that focuses on eliminating or minimizing waste and unnecessary actions, also known as non-value-added activities [11]. The Lean concept also increases customer value [12].

At this apparel company in Jatiuwung, Gandasari, Banten, Indonesia, some waste was generated during road transportation activities. The causes generated by road transportation included downtime, underutilized truck capacity, uncontrollable distances, such as unmatched goods shipped to customers that necessitated a second shipment to the same customer, and non-optimal routes. The scope of road transportation was to deliver orders to external customers. From the listed wastes above, the company needs to reduce waste and improve efficiency in terms of time and cost in road transportation by implementing the lean concept.

The research questions are:

1. How does the apparel industry identify the transportation wastes?
2. How many improvements will be made by implementing the lean concept?

Understanding the answers encourages everyone to implement the lean concept in their organization.

1. Theoretical background

1.1. Definition, types and effect of waste on the organization

Waste is anything that does not have added value. Waste is something customers are unwilling to pay for [13]. That is why the organization should eliminate or at least reduce all forms of waste; then the remaining ones will be the thing that has value for the organization. Waste elimination means synchronizing the demand of the whole process, from start to end, in manufacturers to be able to control the production speed and to rearrange all the transportation management from storing, load planning, delivering, and distributing the products by executing the demands ordered with no waste of inventory [14].

There are two types of waste: obvious and hidden. It is important to identify and eliminate hidden waste, as it often exceeds the obvious waste.

DOI: 10.21791/IJEMS.2026.04

According to Rodrigues et al [15], they categorize the waste into eight types:

a. Transport means unnecessary movement for material, tools, and equipment
b. Inventory means excessive raw material, supplies, or work-in-process (WIP) inventories. This excessive inventory will result in higher rent for spaces that, in fact, the organization does not need to spend the extra money.
c. Motion means unnecessary movement and motions of the worker or machine. To overcome this waste, one needs to modify the layout to make it more ergonomic.
d. Waiting means the idleness of a worker or a machine
e. Overproduction means producing more than what is demanded by the customer or producing faster than what is scheduled and this condition will cause higher stock in the warehouse
f. Over-processing means doing more work or unnecessary work by man or machine processing, in other words, means non-added value work
g. Defects mean imperfections or abnormalities that impair quality, function, or performance, and generally reduce the profit.
h. Skills refer to the underutilized skills of a worker.

The most direct effect of waste will be on cost and become a burden for the organization. The higher cost means the higher price, because price equals cost plus profit. The organization may maintain the price, but the profit will be reduced. If the company does not inspect the waste, especially hidden waste, profits will shrink. To eliminate this, one can implement the lean concept to increase the performance and effectiveness of organizations by eliminating processes that do not add value [16]. Lean manufacturing has made a significant contribution to the financial sector [17].

1.2. Transportation waste

Transportation is a key component of logistics [18], which originated in the military to support the movement of troops and equipment from one location to another. Excess transportation is waste and should be eliminated to zero ground. The longer the transit times, the more the inventories, the more space and energy needed. Transportation can reduce inventory and warehousing costs while accelerating delivery to the end customer. Inventory can be reduced by making more shipments as needed, but this can result in higher costs, and one must be aware of this. Customers always expect a high level of quality and efficient delivery of their goods. Transportation is used to find the optimal balance between costs, inventory, and service levels. The main goal of transportation is to be consistent, reliable, and flexible. According to Achahchah [19], “this goal needs to be executed in a difficult environment: high customer demands, cost reduction deadlines, shorter lead-time requests, personnel shortages, market capacity problem, network complexities, environmental issues, increasing congestion or traffic flow, legal requirements, fuel cost increase, and road taxes”.

Transportation waste is an unexpected phenomenon that occurs during a transport activity and refers to an observable, recorded fact at a particular place and time that affects physical flows, necessitating unplanned tasks and producing inefficiencies in the process. [20] has identified the classification of transportation activity classes, the main causes of transportation waste, and the consequences of transportation waste.

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Perez, C.T., Sommer, L., Costa, D.B. and Formoso, C.T [21] in their research established that the classification of transportation activity classes is divided into three categories:

a. Necessary: the flow of the process is expected to occur and can be identified at the contributory tasks level.

b. Avoidable: the process of transportation that produces waste or distracts from the process, which must be reduced to a minimum level or eliminated.

c. Unnecessary or idle: this category must be reduced or eliminated by improving the accuracy of information or the planning process, thereby decreasing inefficient time. Table 1 lists the waste category, activity and details.

Wastes	Activity	Details
Waiting	• Picking orders outside the area • For available space for customers	• Searching for items to be picked • Waiting for the production instruction • The lift truck driver is busy, or the tasks may be more than the personnel's capacity • There is a queue in the customer location
Resource utilization	Loading into the truck or other vehicles	Around 80% truck or vehicle capacity utilization
Movements	Picking customers' orders	Unnecessary movement for searching the SKUs
Overproduction	Documentation	5 documents that take 29 minutes
Over process	In transit	Distance in excess 20 Km or more
Behavioral or psychological	All activities	No targets during the processes

Table 1. Wastes, Activity, Details.

Source: Garza, et al [22]

According to Guzdek et al [23], the main causes of waste in transportation are:

a. access/mobility problems: it relates to any kind of route obstruction that makes the transport activity spend more time in traffic;

b. storage or warehouse space: it relates to the imbalance between the volume of goods and available space;

c. equipment: it relates to unavailability, breakdown, or equipment that is not suitable for transportation;

d. personnel in division or department: it refers to a lack of workers to perform the transportation tasks;

e. material for packing: it relates to bad packing conditions of the material, which can slow down the transportation and make it more difficult; and

f. information: it relates to inaccurate information for the employees for correct transportation performance.

Guzdek et al [23] also stated that transportation waste has consequences such as:

a. Defective or damaged material: the material being transported is damaged during transportation activity;

b. Working conditions are at risk: unsafe working conditions were caused by the transportation activity;

c. a new transport operation or transport vehicle: it would be required in the near future, then the movement will be faster;

d. a farther distance: a worker must move a longer distance than was planned; and

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e. Ergonomic problem: The ergonomic conditions of transportation operations are in poor condition, which may cause a person to become tired quickly.

A strong relationship exists between lean practices, such as Total Quality Management (TQM), Just-in-Time (JIT), Radio Frequency Identification (RFID), Transportation Management System (TMS), and Total Productive Maintenance (TPM), and both financial and operational performance within transportation companies [24].

The purpose of implementing lean practices is to deliver higher benefits to customers by eliminating unnecessary processes and activities, as well as reducing the useless movement of materials or personnel, thereby lowering costs [25]

1.3. Lean tools that are commonly used in road transportation

Garza et al. [22] used the Transportation Value Stream Map (TVSM) to identify waste and support improvement initiatives in road transport operations, and TOVE to increase overall vehicle effectiveness. TVSM is a tool adapted from traditional VSM (Value Stream Mapping) by [26], and TOVE is an extended version of OEE used in the TPM approach to improve production equipment [27] and Overall Vehicle Effectiveness (OVE) measurement [28].

Both Deesrisak et al. [29] and Garza et al. [22] have divided transportation into four parts: initial or shipment preparations, serving clients, transit, and closing or final. These parts consist of several types of transportation.

Part One: Shipment Preparations

The activities were route planning, loading the truck, closing and waiting for the documents, and scheduling maintenance. Figure 1 explains these activities

Figure 1. Shipment Preparations
Source: Deesrisak, et al [29]

Part Two: Serving the clients
The activities include waiting for a space to become available and unloading the truck.
Part Three: Transit
The activities include driver break, transporting goods to the destination, and returning to the plant at an average speed.
Part Four: Closing or Final activities
The activities include unloading returned products and returning documents, cheques, or cash to the office.

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2. Research methodology

The main objective of the methodology is to explain the methods used, including data collection instruments, data calculations and analyses using statistical methods, and other related methods, software, and tools, as needed, to inform the reader how to conduct this research. This research can be considered quantitative, as it seeks to analyze and record information gathered through data analysis. The data collected was the performance of transportation and warehouse operations throughout 2024 and early 2025. After that, the data was analyzed using lean tools and software, such as MyRouteOnline. Figure 2 describes the framework of research, which means that when one implements the lean concept, there will be some improvements in the transportation sector.

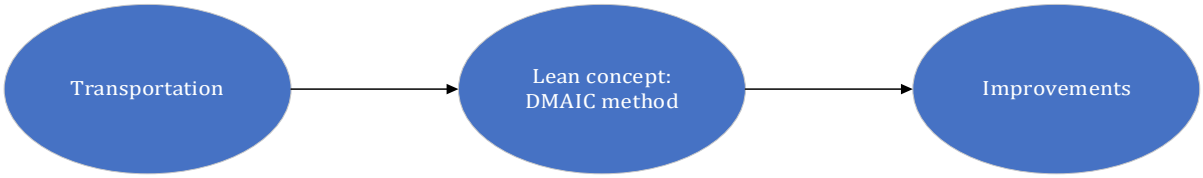

Figure 2. Framework of research
Source: authors

2.1. Methods used in research

According to Solorzano et al. [30], the implementation of the lean principle always starts with tool 5S – Seiri (Short), Seiton (Set in Order), Seiso (Shine), Seiketsu (Standardize), Shisuke (Sustain), to maintain basic conditions and needs, and Kaizen is used to improve the process. The kaizen problem-solving method is usually associated with the Deming method, which consists of the Plan-Do-Check-Act (PDCA) cycle, but it can also be referred to as Define, Measure, Analyze, Improve, and Control (DMAIC), as used in the Lean concept [31], [32], [33]. These four tools or methods are summarized in Table 2, making them easier for researchers and managers in their organizations to understand.

PDCA	DMAIC	A3	8D
Plan	Define	Identify and clarify the problem	Identify and build the team
	Measure	Divide the problem into several stages Set a target or a goal	Define problem
			Contain symptom
	Analyze	Analyze the root cause of the problem Develop countermeasures	Identify the root cause of the problem
			Choose corrective actions
Do	Improve	See countermeasures	Implement corrective actions
Check	Control	Evaluate and monitor the results and processes	Make change permanent
Action		Standardize achievement	Recognize the team

Table 2. Four Methodologies to Kaizen Problem Solving
Source: Miletic & Miletic [34]

According to Table 2, the DMAIC methodology was employed. This methodology was equipped with specific tools in transportation, VSM, and STEWs (Seven Transportation Extended Wastes), as well as TOVE. These tools will improve road transport operations. There are four stages for improving road transport, as shown in Figure 3.

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Figure 3. Four stages of a systematic method to improve road transport operations
Source: Manrique, Lam, & Ugaz [25]

2.2. Software used in this research

Software will make the job easier and faster. In this research, the authors used three software tools: Smartsheet, transportation software – specifically, the traveling salesman problem (TSP) at https://www.MyRouteOnline.com [35], and Microsoft Excel. Smartsheet is a web-based diagram application [36] that enables users to collaborate visually on creating, revising, and sharing diagrams, thereby enhancing organizational processes, systems, and structure. In this research, Smartsheet was used for value stream mapping. MyRouteOnline is an online software that was founded by Inbal Baruch in late 2009. Baruch developed an online system that is suitable for small organizations. MyRouteOnline software is a web-based, simple, straightforward, and affordable solution for students and those with limited budgets for research, regardless of the organization's size. The service is very easy to use and significantly reduces the time required for route planning. All the stop-points are visible on the map, allowing one to get a visual idea of their route and make any necessary adjustments to meet their needs. The other supporting tool was a Global Positioning System (GPS) tracker that was already installed on the trucks.

3. Results, analysis and interpretation

3.1. Case Study

This research was conducted at an apparel company in Jatiuwung, Tangerang, which is one of the most famous brands of baby and children's apparel. Focusing on the slogan 'high quality and affordable price,' this company aims to minimize waste to the lowest level. Minimizing waste is a concept of lean. The DMAIC method was already described in Table 2. Table 3 outlines the sequence of DMAIC steps, lean tools, actions, and measurement methods.

Step	DMAIC method	Lean tools	Action
1	Define the problem	TVSM	To make a map for activities
2	Measure	Lean Metric	Parking time = Total time – travel time; all in minute Travel distance (KM) was recorded by GPS tracker that already installed in a truck Truck utilization (M^3) = $\frac{Loaded\ volume\ in\ a\ truck}{Capacity\ of\ a\ truck}$ Cost of transport (USD per KM) = $\frac{Cost\ incurred}{total\ travel\ time}$ Cost incurred covered fuel cost, toll road cost, maintenance cost, parking fee
3	Analysis	5Ws	To raise a question about why this could happen for five times
4	Improve	TOVE	TOVE = quality x performance x administration x operating
5	Control	KPI monthly report	To monitor the index of TOVE and Lean metric

Tabel 3. General steps and actions for lean concept implementation in transportation
Source: authors

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This company has experienced some problems in transport that already listed in table 4 below:

No	KPI - Problems	Unit of Measurement	Conditions in 2024
1	Parking time	Minute	33.38
2	Travel distance	Kilometer	104.84
3	Vehicle (truck) utilization	Percentage	40.44
4	Cost of transport	USD per kilometer	0.18

Table 4. Conditions in 2024 – before Lean implementation

Source: authors

These problems have remained stagnant for several years, and the research team has made some improvements to address those conditions.

This section covers data analysis, results, and discussion. There were two parts: transportation and the warehouse.

3.2. Road transportation

To obtain transportation data, the authors followed the steps outlined in Table 3. Figure 4 explained the value stream mapping for transportation.

DMAIC Step 1 - Define:

This step was mapping the process of transportation's activities in order to get the whole journey time and metric time.

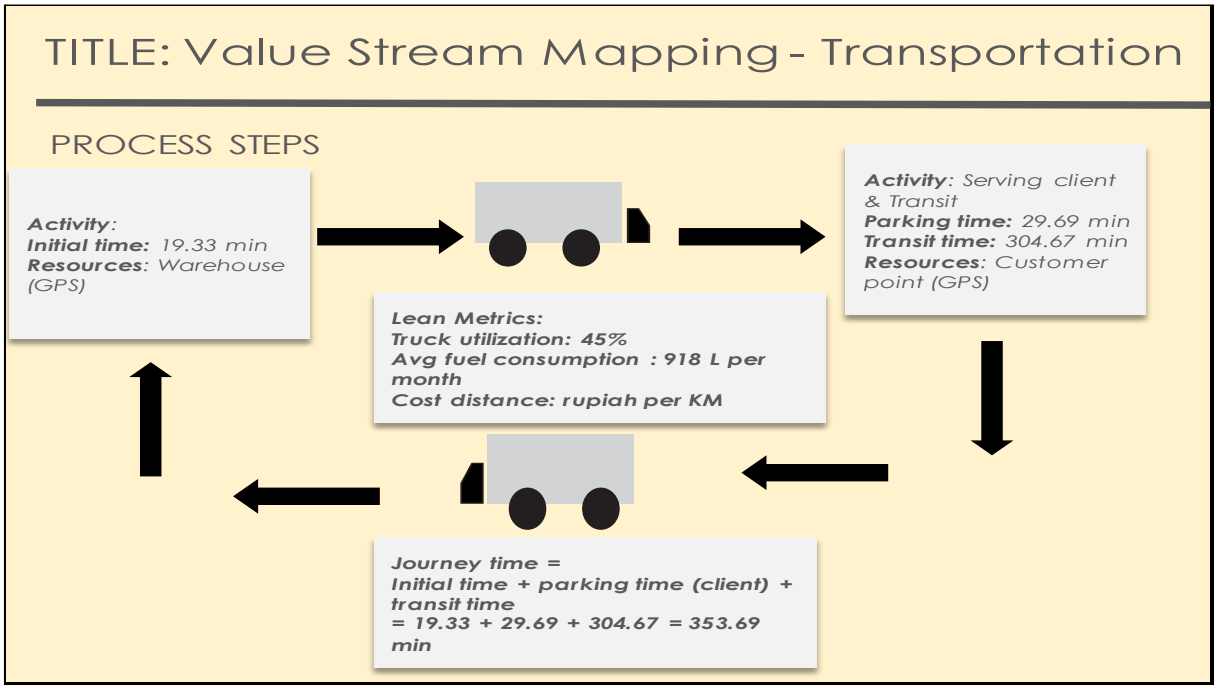

Figure 4. VSM – transportation

Source: Authors

DMAIC Step 2 - Measure: Parking time, Travel distance, Transport cost, and Utilization of truck

This step was measuring time, distance, cost, and utilization of the vehicle – truck. Table 5 listed waste of the category, activities and results

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Wastes	Activities	Results
Parking	Searching for the empty parking lot Queuing and waiting for a turn	33.38 minutes
Resource Utilization	Loading the truck	40.44% truck capacity utilization
Over processing	Transit time	Distance in excess: 0, because GPS time was less than MyRouteOnline
Behavioral	Safety	No accidents found in 2024 (hit or to be hit)

Table 5. Transportation Wastes

Source: authors

3.3. Parking time

The GPS monthly report for November and December 2024 was downloaded from its application. These reports provided information about the initial time, parking time, in-transit time, total journey time, and distance. Table 6 lists this information.

	Initial time (min)	Parking time (min)	Transit time (min)	Total journey time (min)	Total distance (KM)	Destination points per route
Route 1:	15	13.00	188	216.00	76.52	4
Route 2:	17	26.67	188	231.67	80.82	4
Route 3:	10	22.00	179	211.00	95.31	3
Route 4:	5	21.33	490	516.33	93.10	7
Route 5:	34	33.33	316	383.33	105.92	7
Route 6:	23	18.60	446	487.60	124.97	8
Route 7:	27	27.29	389	443.29	130.40	6
Route 8:	6	24.67	244	274.67	102.86	4
Route 9:	14	32.00	387	433.00	104.83	7
Route 10:	22	21.78	356	399.78	108.58	10
Route 11:	24	83.50	230	337.50	88.05	3
Route 12:	35	76.33	243	354.33	92.08	4
Average	**19.33**	**33.38**	**304.67**	**357.38**	**100.29**	**6.00**

Table 6. Observations of Transport operations

Source: GPS from Nov to Dec 2024

Using a GPS attached to the truck, one route consists of several destination points, or customer points. The trip report was generated from www.GPS.id. Initially, there were three activities: loading goods into the truck, preparing shipping documents, and checking and matching the picking documents with the shipping documents. During parking time, this occurred at the customer's point and included: searching the empty parking lot, queuing and waiting for a turn, unloading and checking the customer's processes, and printing the goods receipt. In transit time, this includes travel time between customers and the return to the starting point. However, this time does not include parking time.

Total journey time = Initial time + Parking time + Transit time

3.4. Travel distance

According to Table 7, the distance must be compared with the software MyRouteOnline. From this comparison, one can determine the magnitude of the deviation. Here is one comparison: GPS indicated 130.4 km, and MyRouteOnline software indicated 135.17 km. The difference was only 3.66%. This indicated that the software was highly accurate and that the driver was highly skilled in shipping the

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goods. In short, MyRouteOnline software was used for routing, and GPS was used to monitor truck movement.

Table 7 shows all distances generated by GPS and by the software MyRouteOnline; the average distance from GPS was lower than that from the software, indicating the routes and drivers shipped the goods efficiently.

	Total distance (KM) – GPS tracker	**Total distance (KM) - MyRouteOnline**	**Deviation**	**Destination point per route**
Route 1:	76.52	75.65	-1.14%	4
Route 2:	80.82	78.15	-3.30%	4
Route 3:	95.31	96.31	1.05%	3
Route 4:	93.10	107.17	15.11%	7
Route 5:	105.92	119.28	12.61%	7
Route 6:	124.97	128.87	3.12%	8
Route 7:	130.40	135.17	3.66%	6
Route 8:	102.86	87.14	-15.28%	4
Route 9:	104.83	125.47	19.69%	7
Route 10:	108.58	92.96	-14.39%	10
Route 11:	88.05	95.73	8.72%	3
Route 12:	92.08	116.2	26.19%	4
Average	**100.29**	**104.84**	**4.67%**	**6.00**

Table 7. Distance from GPS versus from MyRouteOnline Software

Source: Authors

Figures 5 and 6 show the distance outputs, one from GPS and the other from the software.

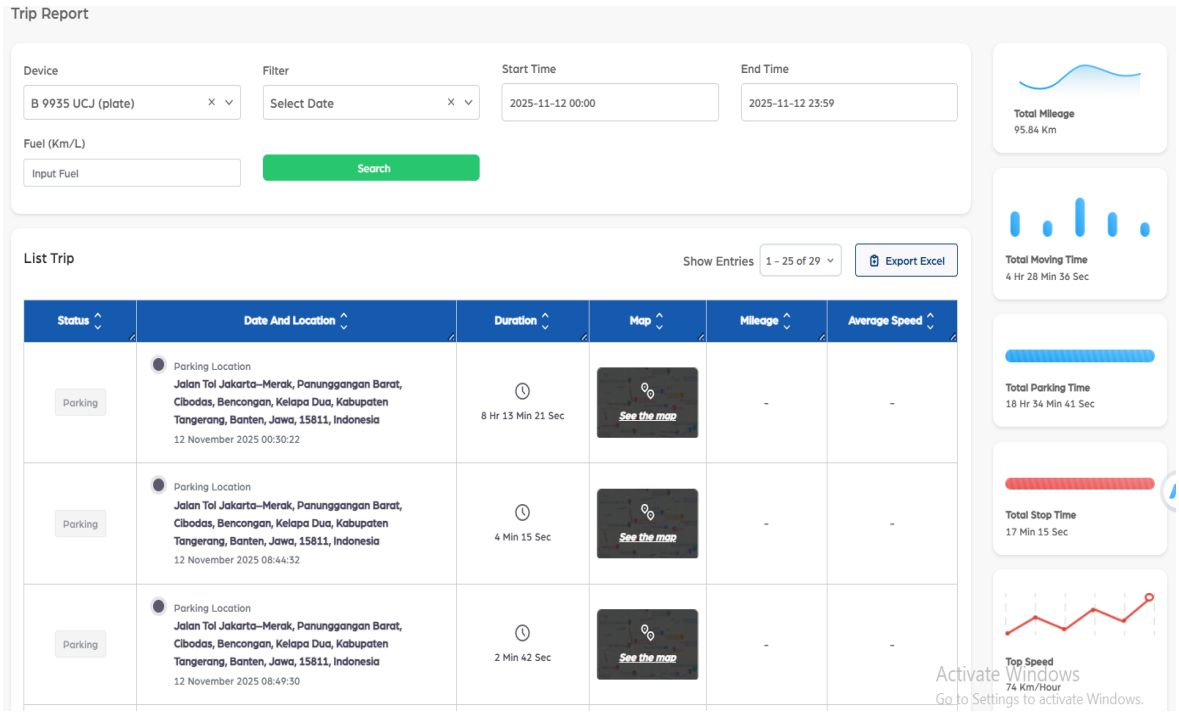

Figure 5. GPS output for distance

Source: GPS tracker

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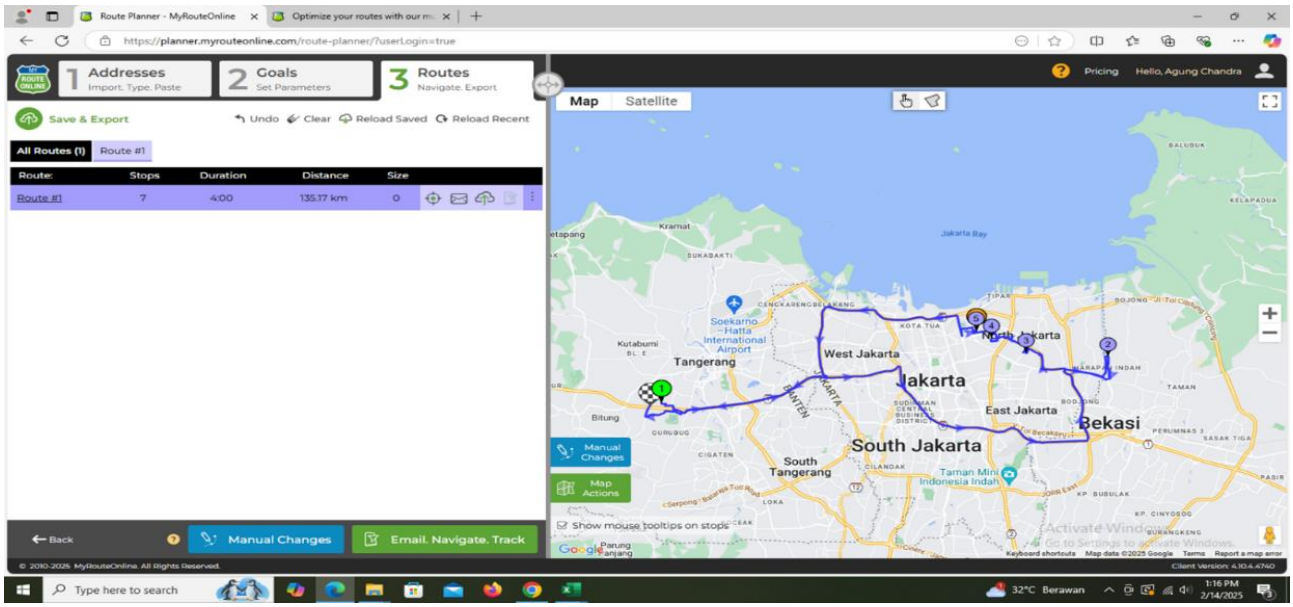

Figure 6. MyRouteOnline Software Output for distance
Source: MyRouteOnline software [31]

3.5. Utilization of the vehicle

Truck utilization was 40.44% in 2024, as shown in Figure 6. An underutilized truck does not necessarily mean the company must decrease the number of trucks; instead, one should examine the number of destinations per route per truck. The daily routing plan must be designed so that it does not exceed working hours. When the activity exceeds the working hours, an extra cost will be incurred, such as overtime or extended operational rental costs. When making the daily routing plan, one must use software such as MyRouteOnline. There will then be a trade-off between overtime and utilization.

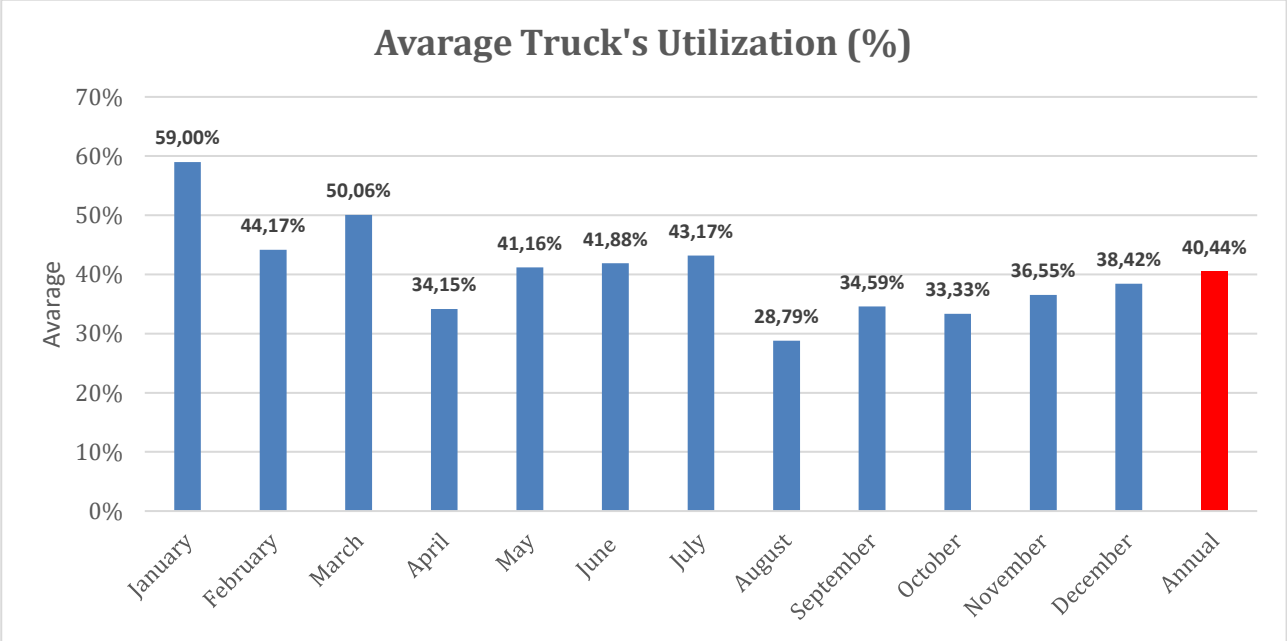

Figure 7. Utilization of Vehicle
Source: Authors

DOI: 10.21791/IJEMS.2026.04

3.6. Cost of transport

Table 8 presents the various types of costs, including the cost of transport, the cost per customer's destination, the cost per distance (in kilometers), and the cost of volume shipped.

Period	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Cost of transport (fuel & toll road) in USD	1,150	1,110	874	852	934	843
The amount of customer's destination	220	184	159	166	173	124
Cost per customer's destination in USD	5.23	6.03	5.50	5.13	5.40	6.80
Distance (kilometer)	7,163	6,597	5,512	5,970	5,245	4,803
Cost per kilometer in USD	0.16	0.17	0.16	0.14	0.18	0.18
Volume shipped (meter cubic)	216	133	167	169	162.1	120
Cost per meter cubic in USD	5.32	8.34	5.23	5.04	5.76	7.02

Table 8. Cost of Transport

Note: 1 USD = IDR 15,000 (based on assumption used in APBN – State Budget 2024)

Even though the cost of transport decreased in December 2024, the cost per kilometer (cost of distance) did not decrease, because the cost of distance was affected by the total number of customer destinations.

DMAIC Step 3 - Analysis:

There were two routes with longer-than-average parking times: routes 11 and 12. Then, using the 5Ws from smartsheet.com (see Figure 7), the solution was to have a person in charge who checks the goods regularly, once a month.

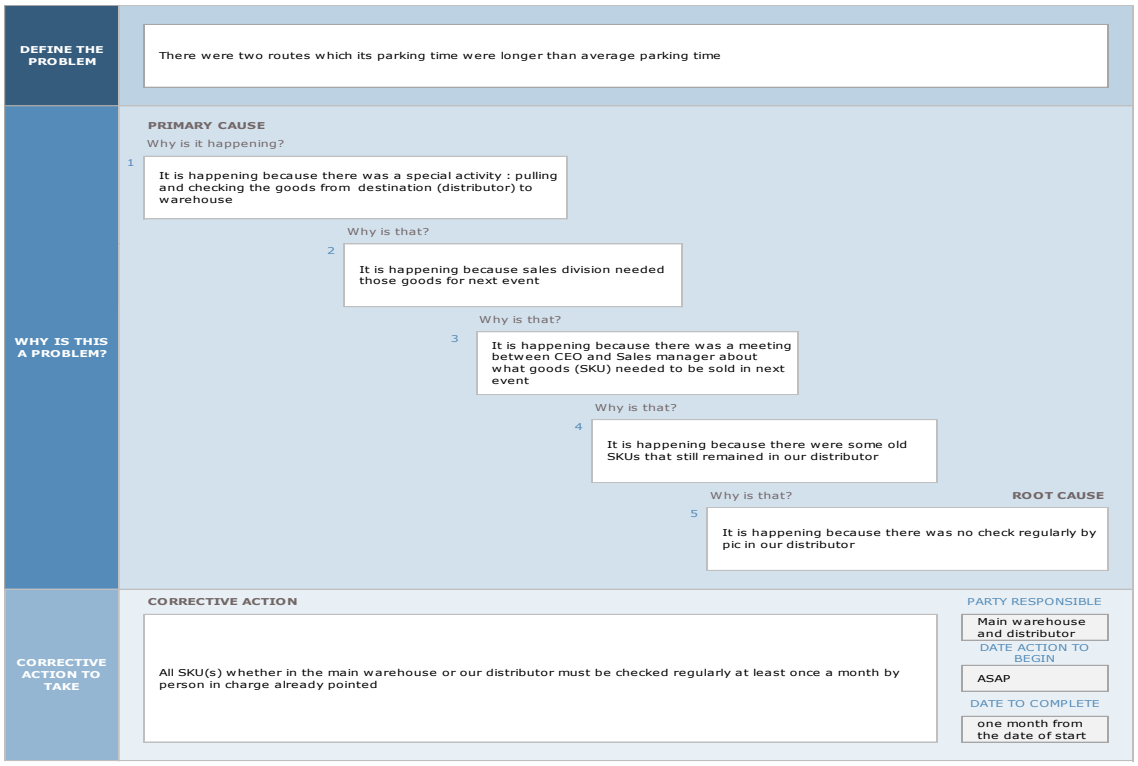

Figure 8. 5Ws form to generate the solution

Source: 5Ws by authors, which form was from smartsheet.com

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In February 2025, parking time data was collected again to monitor the effects of the improvements already implemented. The results showed an improvement, with the average parking duration decreasing to 13 minutes, as seen in Table 9, compared to 33.38 minutes in the fourth quarter of 2024.

Status	Start date	End date	Duration
Parking	12 February 2025 10:14:15	12 February 2025 10:30:18	16 Min 3 Sec
Parking	12 February 2025 10:31:10	12 February 2025 10:35:13	4 Min 3 Sec
Parking	12 February 2025 10:39:54	12 February 2025 10:41:28	1 Min 34 Sec
Parking	12 February 2025 10:53:16	12 February 2025 10:58:27	5 Min 11 Sec
Parking	12 February 2025 12:00:52	12 February 2025 12:11:40	10 Min 48 Sec
Parking	12 February 2025 12:30:30	12 February 2025 12:42:33	12 Min 3 Sec
Parking	12 February 2025 12:44:16	12 February 2025 13:00:53	16 Min 37 Sec
Parking	12 February 2025 13:04:07	12 February 2025 13:14:34	10 Min 27 Sec
Parking	12 February 2025 13:15:29	12 February 2025 13:53:18	37 Min 49 Sec
Parking	12 February 2025 14:43:50	12 February 2025 14:58:12	14 Min 42 Sec
Parking	12 February 2025 15:18:51	12 February 2025 15:27:54	9 Min 3 Sec
Parking	12 February 2025 15:53:04	12 February 2025 16:14:21	21 Min 17 Sec

Table 9. Parking time on 12 February 2025

Source: authors

At the end of January 2025, overall truck utilization reached 73.87%, up from 40.44% in December 2024, as shown in Table 10. This indicated an increase of approximately 82.66%.

	Truck A	Truck B	Truck C	Total
Volume (M3)	42.74	90.22	146.28	279
Kapasitas (M3)	72	135	171	378
Utilisasi (Vol/Kapasitas)	59.36%	66.83%	85.54%	73.87%

Table 10. Utilization of vehicles

Source: authors

The cost per kilometer in January 2025 decreased from 0.18 to 0.15, indicating that the driver covered a longer distance during the same period. This happened after Lean was implemented. A longer distance resulted from better route planning with the software at www.MyRouteOnline.com. The same thing happened on the cost per cubic meter. It went down from 6 cubic meters to 4 cubic meters. For more details, see Table 11.

Cost – Period	Jan 2025
Cost of transport in USD	1,121
Cost per customer's destination in USD	4.15
Cost per kilometer in USD	0.15
Cost per meter cubic in USD	4.02

Table 11. Cost of Transport in January 2025

Source: Authors

DMAIC Step 4 - Improve:

In this step, TOVE was utilized to enhance the transport operations in terms of quality, performance, administrative availability, and operational availability.

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Elements	KPI	Result	Average
Service losses – Quality efficiency	On time delivery	100%	100%
	Shipment accuracy (undelivered DO / total DO	100%	
Capacity losses – Performance Efficiency	Distance recommended by software / distance traveled	96%	96%
Availability losses: - Administrative availability efficiency	Expected date of report / actual date	100%	94.94%
- Operating availability	Expected parking time / real parking time	89.87%	

Table 12. TOVE

Source: authors

According to Table 12, there was an element that needed improvement: parking time. A congested road can be monitored through Google Maps or transportation software, and the parking time issue is illustrated in Figure 7.

DMAIC Step 5 – Control:

The controlling step is straightforward, but it should not be neglected. This phase must be consistently monitored by an appointed person or team. KPI and elements in TOVE must be prioritized as attached in Table 13.

Measurement	Before	After	% Improvement
Parking time (min)	33.38	13.00	75.75
Distance (KM)	104.84 (software)	100.29	4.67
Utilization of vehicles (%)	40.44%	73.87%	82.66
Cost of transport (USD/KM)	0.18	0.15	16.66

Table 13. Summary: Before and After Implementation of Lean on Transport

Source: authors

Conclusion

The apparel industry, including children's wear and sportswear, is facing a challenging situation: global sales of apparel and footwear are expected to recover between late 2025 and early 2026, but interest rates are expected to remain high. This condition has compelled leaders and teams to allocate resources efficiently, effectively, and productively, especially in terms of cost.

Logistics costs include transportation, warehousing, inventory, administration, and packaging; however, transportation has been the primary operational driver in which lean logistics has been applied.

By using the DMAIC method, lean tools such as VSM, 5Ws, OEE, and TOVE, as well as software like MyRouteOnline and Smartsheet, were employed. VSM as a tool for identifying problems, 5Ws as a tool for finding the root causes, OEE and TOVE as tools for improvements. There were improvements across various aspects, including a 75.75% reduction in parking time, a 4.67% reduction in distance, an 82.66% reduction in vehicle utilization, and a 16.66% reduction in transportation costs. This research also demonstrated that when an organization effectively implements the lean concept, significant improvements result.

DOI: 10.21791/IJEMS.2026.04

This research also had some limitations: the results were not all expressed in currency, and the picking and receiving activities were not directly measured, even though this could be inferred from customer complaints.

For future research, the researchers can evaluate the effectiveness of lean tools and identify the most effective lean tools for waste reduction and then apply these findings to organizations worldwide.

Author's contributions

A. Chandra: Conceptualization, Data collection and Experiments, Analysis.

C. Natalia: Literature Review, Review and Writing.

Funding

The research was funded by Universitas Mercu Buana, Jakarta and Universitas Katolik Indonesia Atma Jaya, Jakarta.

Acknowledgements

The publishing of this paper was supported by Universitas Mercu Buana and Universitas Katolik Indonesia Atma Jaya, Jakarta, Indonesia

Conflict of Interest

The authors declare no conflicts of interest regarding this manuscript.

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