

Lean Service Transformation Using Value Stream Mapping to Improve Time Efficiency and Reduce Operational Waste in Automotive Service Workshops

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Abstract

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This study aims to improve routine vehicle service efficiency at PT Sun Star Prima Motor Siliwangi using Value Stream Mapping (VSM) within a Lean Service framework. A case study approach was employed using observation, interviews, and company data. VSM was applied to map the current state, classify activities into Value Added (VA), Non Value Added (NVA), and Necessary but Non Value Added (NNVA), and identify waste and bottlenecks. A Future State Map was developed to streamline workflows and eliminate waste. Results show that total processing time decreased from 184.27 to 140.79 minutes, demonstrating that Lean Service and VSM can reduce lead time, improve operational efficiency, and enhance customer satisfaction in automotive service operations.

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1. INTRODUCTION

The automotive service industry in Indonesia has experienced substantial growth, driven by the increasing number of motor vehicles and the rising mobility of the population. This trend has directly intensified the demand for vehicle maintenance and repair services that are not only of high quality but also efficient, timely, and accurate (Wijaya, 2023). Automotive repair and maintenance service providers must deliver high quality services while maintaining efficient operations to meet growing customer expectations for speed, responsiveness, and timely service completion. The increasing number of motor vehicles has led to a growing demand for maintenance services that are both timely and of high quality. Under these circumstances, service quality has become a critical factor, as it is directly associated with previous studies, which suggest that the rapid development of the service industry requires companies to continuously enhance service quality in order to meet the ever-increasing needs of customers (Langit & Insanita, 2022).

PT Sun Star Prima Motor operates across vehicle sales, spare parts distribution, and vehicle maintenance and repair, with workshop services representing a key customer touchpoint due to the regular nature of vehicle maintenance. Customer satisfaction at the Siliwangi branch, however, remained below the company's target, indicating a gap between customer expectations and actual service experience. A survey of 46 customers identified several service related concerns, particularly regarding service quality and timeliness. The main customer complaints are summarized in Table 1.

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Table 1.

Customer Complaints Reported Between January and October 2025

Customer Complaints	Number of Complaints (Customers)
The vehicle service completion time exceeded two hours.	18
Delays occurred in communicating the need for spare part replacement.	8
Employee did not promptly inform customers about delays in the service process.	9
Customers experienced excessive waiting time before receiving the initial consultation with a service advisor.	5
The estimated service completion time was inconsistent with the reported availability of spare parts.	6

The customer complaint analysis shows that excessive service completion time is the main source of dissatisfaction, followed by poor communication regarding service delays and spare part requirements. Customers also reported discrepancies between estimated completion times and spare part availability, as well as prolonged initial consultation waiting times. These findings highlight service timeliness and communication effectiveness as key areas requiring process improvement to enhance operational efficiency and service quality.

Table 2.

Comparison of Standard and Actual Processing Times Across Each Stage of the Vehicle Service Process.

Process	Standard Time (minutes)	Actual Time (minutes)
Vehicle Reception	15	21
Work Order (WO) Preparation	5	12
Spare Parts Retrieval and Preparation	5	11
Vehicle Service Process	55	79
Final Inspection	10	18
Vehicle Washing	15	23
Payment Process	5	10
Vehicle Handover and Service Explanation	10	10
Total	120	184

The comparison presented in Table 2 reveals a substantial gap between the planned service duration and the actual time required to complete each stage of the vehicle service process. Lean Service offers an appropriate methodology for achieving this objective by streamlining service activities, reducing non-value-added tasks, and enhancing overall process efficiency (Prakoso *et al.*, 2025). Value Stream Mapping (VSM) serves as a practical tool for implementing Lean Service by providing a comprehensive visualization of service workflows. It facilitates the identification of value added and non-value-added activities, uncovered process bottlenecks, and supports the elimination of operational waste, thereby improving service efficiency and overall organizational performance (Imah & Astuti, 2023).

Lean Service and Value Stream Mapping (VSM) have been extensively applied in previous studies as effective approaches for eliminating operational waste and enhancing process efficiency across both service and manufacturing sectors. For instance, research conducted at PT KAI DAOP 8 Surabaya employed Lean Service and VSM to address excessive waiting times in ticketing services, resulting in a significant reduction in lead time and an improvement in Process Cycle Efficiency (PCE) (Mollah *et al.*, 2018). Another study investigating the Door PU process at PT XYZ employed an integrated approach combining Lean Manufacturing, Value Stream Mapping (VSM), Process Activity Mapping (PAM), and Root Cause Analysis (RCA). The proposed framework successfully identified major sources of operational waste, particularly defects and waiting, and contributed to significant improvements in Process Cycle Efficiency (PCE) (Novitasari & Iftadi, 2020). Although

Lean Service and VSM have proven effective in various sectors, their application in automotive service workshops remains limited, particularly in assessing discrepancies between standard and actual service times. This study addresses this gap by applying Lean Service integrated with VSM to identify waste and bottlenecks, evaluate service lead time, and develop improvement strategies to enhance operational efficiency and service quality.

2. METHODS

Lean principles have been increasingly adopted in service systems through the lean service approach, which aims to maximize customer value by continuously eliminating waste and improving process performance. In contrast to conventional service improvement methods, Lean Service promotes an integrated perspective that emphasizes workflow optimization, standardized procedures, and seamless information flow across organizational functions (Setiawan, 2022). The methodological framework provides a systematic representation of the research procedure adopted in this study is illustrated in Figure 1.



Figure 1.
Methodological Framework

Within this framework, Value Stream Mapping serves as a key analytical instrument for examining the entire service process, visualizing material and information flows, identifying operational bottlenecks, and classifying activities into Value Added, Non Value Added, and Necessary but Non-Value Added. Based on this conceptual foundation, the present study applies the Lean Service framework and Value Stream Mapping to identify operational waste and develop process improvement strategies for the routine vehicle service process (Darunanto *et al.*, 2023).

A case study methodology was adopted to examine the routine vehicle service operations at PT Sun Star Prima Motor Siliwangi. This approach was selected because it facilitates a comprehensive investigation of service activities within their real operational context, allowing the identification of process inefficiencies and opportunities for operational improvement (Anggit & Setyorini, 2022). The case study approach enabled an in-depth investigation of the implementation of Value Stream Mapping (VSM) in routine vehicle service operations, while facilitating the systematic identification and assessment of various forms of operational waste throughout the service process.

2.1 Operational Waste Identification

Operational waste in service processes refers to activities that consume resources without creating value for customers, thereby reducing operational efficiency and extending service delivery time. In service operations, common forms of waste include excessive waiting, unnecessary transportation or movement, overprocessing, underutilization of human resources, and inadequate standardization of service procedures. These inefficiencies often result in service bottlenecks, prolonged processing times, delays in task completion, and ultimately a decline in the quality of service delivered to customers (Pujiyanto *et al.*, 2021). In addition, inadequate employee competencies, inefficient communication flows, and unnecessarily complex administrative procedures are recognized as significant contributors to operational waste in service systems. Consequently, a comprehensive waste identification process is required to systematically determine the root causes on inefficiencies and establish priorities for continuous improvement and sustainable operational excellence (M. Agustin, 2016).

The waste identification process commenced with direct field observations of the service workflow to identify activities that potentially contributed to process inefficiencies and service delays. Subsequently, time data were collected for each service activity to determine the actual cycle time and lead time, providing a quantitative basis for evaluating process performance and identifying value-added and non-value-added activities within the service workflow (Febrianto *et al.*, 2025). Subsequently, Value Stream Mapping (VSM) was employed to categorize all service activities into value added (VA), non-value added (NVA), and necessary but non value added (NNVA) classifications, providing a systematic framework for assessing process efficiency and identifying value creation throughout the service workflow. (Khalidzky *et al.*, 2025).

2.2 Current State Mapping

Current State Value Stream Mapping (CSVSM) was developed to capture the actual condition of the routine vehicle service process by comprehensively mapping both material and information flows across the entire service operation. The mapping process enabled the identification of activity sequences, interdependencies among service operations, and information exchange that influence overall process performance (A. H. Agustin & Donoriyanto, 2023). In addition to process visualization, the current state analysis was conducted to identify activities associated with excessive waiting, unnecessary movement, workflow inconsistencies, and other operational inefficiencies that negatively impacted service performance and customer value. By systematically examining these process constraints, the CSVSM facilitated the identification of root causes contributing to process waste and reduced operational efficiency. The insights obtained from this analysis subsequently formed the basis for designing the Future State Value Stream Mapping (FSVSM) and developing targeted improvement strategies to enhance service performance and minimize non-value-added activities (Francesca & Nurmianto, 2018).

2.3 Process Improvement

Improvement initiatives were developed by redesigning the service workflow through the removal of redundant process steps, simplification of inefficient administrative procedures, and integration of information flows to improve coordination among service activities. These improvements were intended to establish a more streamlined, standardized, and responsive service process while maximizing customer value and operational performance (Ahsan *et al.*, 2025).

Further process optimization was achieved through the reconfiguration of work allocation, enhancement of cross-functional coordination, and elimination of unnecessary movement and handling activities to establish a more efficient and synchronized service workflow. The proposed improvement initiatives were formulated based on the dominant operational waste identified during the analysis phase, ensuring that improvement efforts were systematically prioritized and focused on interventions with the greatest potential to enhance operational efficiency, reduce service lead time, and improve overall service quality (Suwanda & Rahadi, 2023).

2.4 Future State Mapping

Future State Value Stream Mapping (FSVSM) was developed to illustrate the proposed service process after the implementation of improvement initiatives aimed at eliminating operational waste and optimizing workflow efficiency. The future state design emphasized the removal of non-value added activities, simplification of service procedures, and integration of information and service flows to establish a more streamlined and responsive operational process. Subsequently, a comparative analysis between the Current State Value Stream Mapping (CSVSM) and the FSVSM was performed to evaluate the effectiveness of the proposed improvements in reducing process lead time, improving workflow continuity, and eliminating bottlenecks that adversely affected service performance. (Mulyati & Rananisa, 2019).

Within the Lean Service framework, the future state map is designed to create a more efficient and customer focused service system by eliminating non-value added activities, streamlining workflow sequences, optimizing information and service flows, and reducing overall process lead time. Moreover, the FSVSM provides a structured basis for comparing the proposed process with the current state, enabling the evaluation of improvement effectiveness and supporting continuous improvement toward higher operational performance and service quality (Imah & Astuti, 2023).

3. RESULT

3.1 Operational Activity

Based on direct observations, a systematic analysis of the routine vehicle service process was conducted to identify the sequence of service activities and characterize the existing operational workflow. This analysis provided a comprehensive understanding of the interactions among service activities, enabling the evaluation of process performance and the identification of potential sources of operational inefficiency. Mapping in the current workflow also established the foundation for subsequent Value Stream Mapping (VSM) analysis and process improvement initiatives aimed at enhancing service quality and customer satisfaction. The detailed sequence of service activities is presented in Table 3.

Table 3.
Sequence of Process Activities in the Routine Vehicle Service Workflow

Main Process	Activities	Code
Vehicle Reception	Customer reception	AP.1
	Vehicle registration	AP.2
	Customer complaint identification	AP.3
	Initial vehicle inspection	AP.4
Work Order Preparation	Service data entry	BP.1
	Service time and cost estimation	BP.2
	Work order generation and printing	BP.3
	Service confirmation and vehicle handover to the technician	BP.4
Spare Parts Preparation	Spare parts requirement verification	CP.1
	Spare parts availability check	CP.2
	Spare parts retrieval and preparation	CP.3
Vehicle Service Process	Initial vehicle diagnosis and inspection	DP.1
	Interior condition inspection	DP.2
	Exterior condition inspection	DP.3
	Installation of protective covers and engine compartment inspection	DP.4
	Vehicle positioning on the car lift	DP.5
	Wheel removal and brake system inspection	DP.6
	Engine oil and oil filter replacement	DP.7
	Wheel reinstallation and vehicle lowering from the car lift	DP.8
	Removal of protective covers and final service bay inspection	DP.9
Final Inspection	Post-service inspection	EP.1
	Functional and performance testing	EP.2
Vehicle Washing	Interior cleaning	FP.1
	Exterior cleaning	FP.2
	Vehicle drying	FP.3
Payment Process	Explanation of service charges	GP.1
	Payment processing and receipt issuance	GP.2
Vehicle Handover and Service Explanation	Explanation of completed service and repair work	HP.1
	Vehicle handover to the customer	HP.2

3.2 Classification of Process Activities

The routine vehicle service process was analyzed using Value Stream Mapping (VSM) to classify each activity into three categories; Value Added (VA), Non Value Added (NVA), and Necessary but Non Value Added (NNVA). The activity classification criteria shown in Table 4 provide the conceptual foundation for the VSM analysis conducted in this study.

Table 4.
Criteria for Process Activity Classification

Category	Classification Criteria
Value Added	The activity directly creates customer value, changes the vehicle or service condition, and is something the customer is willing to pay for.
Non Value Added	The activity consumes time and resources without adding customer value and can potentially be eliminated without affecting service quality.
Necessary but Non Value Added	The activity does not directly create customer value but is required for operational control, safety, quality assurance, administrative, or regulatory purposes.

Each process activity was systematically assessed based on its ability to create customer value, transform the service outcome, and fulfill operational or regulatory requirements. Applying these criteria ensured a consistent and objective evaluation of the service process, thereby enabling the accurate targeted process improvement strategies.

Table 5.
Classification of Process Activities

No.	Activity Description	Code	VA	NVA	NNVA
1	Customer reception	AP.1			✓
2	Vehicle registration	AP.2		✓	
3	Customer complaint identification	AP.3			✓
4	Initial vehicle inspection	AP.4	✓		
5	Service data entry	BP.1		✓	
6	Service time and cost estimation	BP.2		✓	
7	Work order generation and printing	BP.3		✓	
8	Service confirmation and vehicle handover to the technician	BP.4			✓
9	Spare parts requirement verification	CP.1			✓
10	Spare parts availability check	CP.2			✓
11	Spare parts retrieval and preparation	CP.3			✓
12	Initial vehicle diagnosis and inspection	DP.1	✓		
13	Interior condition inspection	DP.2	✓		
14	Exterior condition inspection	DP.3	✓		
15	Installation of protective covers and engine compartment inspection	DP.4	✓		
16	Vehicle positioning on the car lift	DP.5	✓		
17	Wheel removal and brake system inspection	DP.6	✓		
18	Engine oil and oil filter replacement	DP.7	✓		
19	Wheel reinstallation and vehicle lowering from the car lift	DP.8	✓		
20	Removal of protective covers and final service bay inspection	DP.9	✓		
21	Post-service inspection	EP.1		✓	
22	Functional and performance testing	EP.2	✓		
23	Interior cleaning	FP.1			✓
24	Exterior cleaning	FP.2			✓
25	Vehicle drying	FP.3			✓
26	Explanation of service charges	GP.1			✓
27	Payment processing and receipt issuance	GP.2			✓
28	Explanation of completed service and repair work	HP.1			✓
29	Vehicle handover to the customer	HP.2			✓

Based on the activity classification presented in Table 5, the routine vehicle service process is dominated by Value Added activities, particularly inspection, diagnosis, maintenance, oil replacement, functional testing, and component reinstallation, which directly enhance vehicle quality and performance. Administrative activities such as customer registration, data entry, cost estimation, work order preparation, and post service inspection are classified as Non Value Added because they do not directly create customer value and therefore offer opportunities for simplification or integration. Meanwhile, Necessary but Non Value Added activities, including customer reception, spare parts verification, vehicle cleaning, payment, and vehicle handover, remain necessary to support service continuity and customer satisfaction. This classification provides a basis for prioritizing waste reduction and process improvement.

3.3 Identification of Operational Waste

Operational waste was identified based on the seven categories of Lean Waste, namely waiting, overproduction, overprocessing, transportation, motion, inventory, and defects. Each service activity was evaluated by examining whether it generated delays, duplicated work, unnecessary movement, excessive processing, surplus outputs, excess inventory, or service errors that did not contribute to customer value. The classification criteria adopted in this study are presented in Table 6 and served as the basis for determining the dominant waste associated with each activity in the routine vehicle service process.

Table 6.
Criteria for Identifying Operational Waste

Waste Type	Identification Criteria
Waiting	Activities involving idle time caused by delays in information, customers, employees, equipment, approvals, or material availability before the next process can begin.
Overproduction	Activities that generate documents, information, or outputs earlier or in greater quantities than required by the subsequent process or customer demand.
Overprocessing	Activities involving duplicate inspections, repeated data entry, unnecessary approvals, excessive documentation, or additional process steps that do not increase customer value.
Transportation	Unnecessary movement of documents, materials, spare parts, or vehicles between different work areas without adding value.
Motion	Unnecessary movement of employees caused by poor workplace layout, inefficient workstation design, or searching for tools and materials.
Inventory	Excess inventory of spare parts, work-in-process vehicles, documents, or materials beyond operational requirements, resulting in additional storage or handling.
Defect	Errors, incorrect information, rework, repeated servicing, or service failures requiring corrective actions before delivery to the customer.

In the context of Lean Service, waste represents activities that consume time, resources, or effort without creating value for the customer, thereby reducing overall process performance. The results of the waste identification for the routine vehicle service process at PT Sun Star Prima Motor Siliwangi are presented in Table 7.

Table 7.
Identification of Operational Waste

No.	Activity Description	Kode	Waste
1	Customer reception	AP.1	-
2	Vehicle registration	AP.2	-
3	Customer complaint identification	AP.3	-
4	Initial vehicle inspection	AP.4	-
5	Service data entry	BP.1	Overprocessing
6	Service time and cost estimation	BP.2	-
7	Work order generation and printing	BP.3	Overproduction
8	Service confirmation and vehicle handover to the technician	BP.4	Waiting
9	Spare parts requirement verification	CP.1	-
10	Spare parts availability check	CP.2	Waiting
11	Spare parts retrieval and preparation	CP.3	Waiting
12	Initial vehicle diagnosis and inspection	DP.1	Overprocessing
13	Interior condition inspection	DP.2	Overprocessing
14	Exterior condition inspection	DP.3	Overprocessing
15	Installation of protective covers and engine compartment inspection	DP.4	-
16	Vehicle positioning on the car lift	DP.5	-
17	Wheel removal and brake system inspection	DP.6	-
18	Engine oil and oil filter replacement	DP.7	-
19	Wheel reinstallation and vehicle lowering from the car lift	DP.8	-
20	Removal of protective covers and final service bay inspection	DP.9	-
21	Post-service inspection	EP.1	Overprocessing
22	Functional and performance testing	EP.2	-
23	Interior cleaning	FP.1	-
24	Exterior cleaning	FP.2	-
25	Vehicle drying	FP.3	-
26	Explanation of service charges	GP.1	-
27	Payment processing and receipt issuance	GP.2	-
28	Explanation of completed service and repair work	HP.1	Overprocessing
29	Vehicle handover to the customer	HP.2	-

The waste identification results presented in Table 7 show three major types of waste; overprocessing, waiting, and overproduction, with overprocessing being the most dominant. Overprocessing occurs in repeated inspections, post service verification, and service explanations. Waiting is found in spare parts verification, retrieval, and vehicle transfer. Overproduction occurs in work order preparation and printing. These waste increase service time and reduce process efficiency, highlighting the need for Lean Service and Value Stream mapping to streamline workflow, eliminate waste, and improve service performance.

3.4 Current State Value Stream Mapping

The Current State Value Stream Mapping (CSVSM) provides an overview of the routine vehicle service process by mapping material and information flows across eight major stages, from vehicle reception and administrative processing to vehicle handover. As shown in Figure 2, the map enables the identification of VA, NVA, and NNVA activities, as well as operational waste affecting service efficiency. VA activities, such as vehicle diagnosis, oil replacement, brake inspection, maintenance, and functional testing, directly contribute to customer value, while NVA activities mainly involve administrative procedures, repeated inspections, and selected washing activities. Meanwhile, NNVA activities, including spare parts verification, payment, and vehicle handover, remain necessary to maintain service continuity, accuracy, and customer satisfaction.

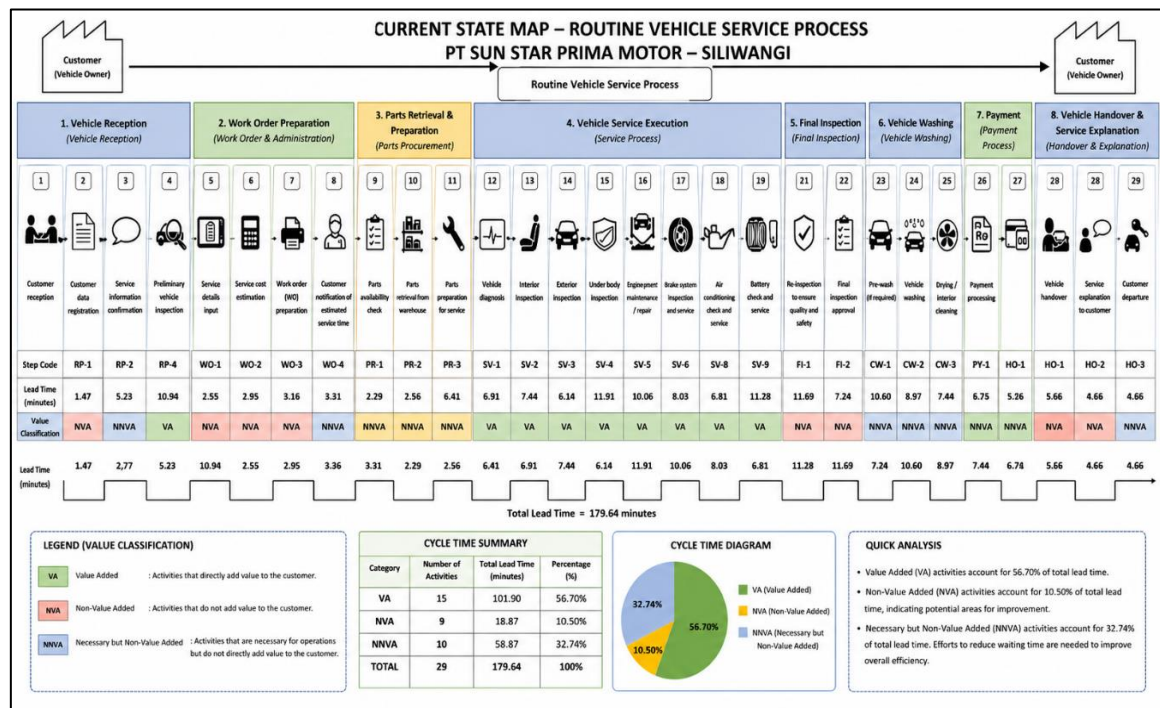


Figure 2.

Current State Value Stream Mapping for the Routine Vehicle Service

3.5 Root Cause Analysis of Operational Waste

Based on the analysis of the Current State Value Stream Mapping, several activities within the routine vehicle service process were identified as containing operational waste that adversely affected process efficiency. The identified waste consisted of overprocessing, overproduction, and waiting, occurring at different stages of the service workflow. A root cause analysis was subsequently conducted by examining the operational activities, the types of waste generated, and the underlying factors contributing to process inefficiencies. The findings of this analysis provide the foundation for formulating targeted process improvement initiatives aimed at enhancing the efficiency and effectiveness of the routine vehicle service process. The identified operational problems and the corresponding root causes of waste are summarized in Table 8.

Table 8.
Root Cause Analysis

No.	Operational Issue	Code	Waste	Root Cause
1	Service data entry	BP.1	Overprocessing	Service data are entered separately into the work order (WO) system, although vehicle information has already been collected during the vehicle reception process.
2	Work order generation and printing	BP.3	Overproduction	Work orders (WO) are still printed in hard-copy format, although service instructions can be delivered electronically to technicians through a digital system.
3	Service confirmation and vehicle handover to the technician	BP.4	Waiting	Technician confirmation is performed only after the work order has been printed, resulting in unnecessary waiting time within the service workflow.
4	Spare parts availability check	CP.2	Waiting	Spare parts inventory information is not directly integrated with the verification process, requiring additional time to confirm parts availability.
5	Spare parts retrieval and preparation	CP.3	Waiting	Spare parts storage locations are identified manually, which prolongs the retrieval and preparation process.
6	Initial vehicle diagnosis and inspection	DP.1	Overprocessing	The technician repeats the initial vehicle inspection even though the vehicle condition has already been assessed during the reception stage.
7	Interior condition inspection	DP.2	Overprocessing	The vehicle interior is inspected repeatedly despite having been examined during the initial reception process.
8	Exterior condition inspection	DP.3	Overprocessing	The vehicle exterior is re-inspected during the service stage although the inspection has already been completed during the initial service intake.
9	Post-service inspection	EP.1	Overprocessing	The post-service inspection is conducted as a separate activity and has not yet been integrated with the inspection performed after the removal of the fender cover.
10	Explanation of completed service and repair work	HP.1	Overprocessing	Service and repair results are communicated manually to customers, requiring more time than an integrated digital information system.

3.6 Process Improvement Strategy

Table 8 summarizes the results of the 5W+1H analysis used to formulate process improvement strategies for the routine vehicle service process. The analysis reveals that the predominant sources of operational waste are overprocessing, waiting, and overproduction, each of which contributes to increased service lead time and reduced operational efficiency. By systematically examining what the problem is, why it occurs, where and when it takes place, who is involved, and how the issue can be addressed, the 5W+1H framework provides a comprehensive basis for identifying appropriate corrective actions.

The 5W+1H analysis resulted in several process improvement initiatives focusing on digital system integration, workflow simplification, the implementation of integrated information systems, the adoption of digital checklists, and the optimization of inventory management and interdepartmental communication. The implementation of these improvement initiatives is expected to enhance the effectiveness of the routine vehicle service process by reducing non value added activities, minimizing waiting time, improving operational efficiency, and delivering higher service quality and customer satisfaction.

Table 9.
5W+1H Analysis

Activity	What	Why	Where	When	Who	How
Service data entry	Duplicate vehicle data entry occurs during the service reception process	1. Vehicle registration and service data entry are performed separately. 2. Administrative systems are not integrated. 3. Vehicle information entered multiple times.	Front desk and administrative office	During routine vehicle reception	Service Advisor	1. Integrate vehicle registration and service data entry into a single process. 2. Implement an integrated digital information system. 3. Simplify the administrative workflow.
Work order generation and printing	Physical work orders are still used during the service process.	1. Job information is distributed through printed documents. 2. A digital work order system has not been implemented. 3. Paper-based documents delay information distribution.	Administrative office and technician work area	During work order preparation	Service Advisor and Administrative Staff	1. Implement a digital work order (WO) system. 2. Adopt a paperless workflow. 3. Integrate electronic work order delivery directly to technicians.
Service confirmation and vehicle handover to the technician	Waiting time occurs before the vehicle enters the service process.	1. Technician confirmation is performed only after the work order has been printed. 2. Job information is not automatically transmitted. 3. Communication remains manual.	Vehicle reception area and technician work area	After administrative processing	Service Advisor and Technician	1. Implement an automated notification system. 2. Integrate work order confirmation and distribution. 3. Accelerate information flow between departments.
Spare parts availability check	Technicians experience waiting time while confirming spare parts availability.	1. Inventory information is not available in real time. 2. Warehouse and service systems are not integrated. 3. Inventory verification is performed manually.	Vehicle reception area and technician work area	When spare parts are required	Technician and Warehouse Staff	1. Implement a real-time inventory management system. 2. Integrate inventory data with the service system. 3. Provide a real-time spare parts availability dashboard.
Spare parts retrieval and preparation	Spare parts retrieval requires excessive time.	1. Storage locations are not clearly identified. 2. No navigation system is available for locating spare parts. 3. Warehouse layout is inefficient.	Spare parts warehouse and technician work area	During spare parts retrieval	Technician and Warehouse Staff	1. Apply barcode or RFID identification to storage locations. 2. Redesign the warehouse layout. 3. Develop a digital spare parts location system.
Initial vehicle diagnosis and inspection	Initial vehicle inspection is repeated unnecessarily	1. Initial inspection has already been completed during vehicle reception. 2. Inspection results are not integrated into the service system. 3. Interdepartmental coordination is inadequate.	Spare parts warehouse	Before vehicle servicing	Service Advisor and Technician	1. Integrate initial inspection results into the service information system. 2. Implement digital inspection checklists. 3. Develop an integrated inspection Standard Operating Procedure (SOP)
Interior condition inspection	Interior inspection is repeated by technicians.	1. Previous inspection results are not digitally documented. 2. Inspection procedures are duplicated. 3. Information sharing between departments is insufficient.	Vehicle reception area and service bay	Before repair activities	Technician and Service Advisor	1. Implement a digital inspection documentation system. 2. Revise the interior inspection SOP. 3. Eliminate redundant inspection activities.

Table 9. (Continued)
5W+1H Analysis

Activity	What	Why	Where	When	Who	How
Exterior condition inspection	Exterior inspection is repeated during the service stage.	1. Initial inspection results are not integrated. 2. Inspections are performed by different departments. 3. No shared information system is available.	Vehicle reception area and technician work area	Before servicing	Technician and Service Advisor	1. Integrate initial inspection records. 2. Use a shared digital inspection checklist. 3. Develop a standardized inspection SOP.
Post-service inspection	Final inspection is conducted separately, increasing process time.	1. Inspection activities are not integrated. 2. Duplicate inspection procedures exist. 3. Inspection workflow is inefficient.	Final inspection area.	After service completion	Technician and Final Inspection Staff	1. Combine the final inspection with the inspection performed after fender cover removal. <i>cover</i> . 2. Redesign the inspection workflow. 3. Clearly define inspection responsibilities.
Explanation of completed service and repair work	Explaining service results to customers requires excessive time.	1. Service information is communicated manually. 2. No digital communication platform is available. 3. Customer communication is inefficient.	Vehicle handover area	After service completion	Technician and Service Advisor	1. Implement a digital service information system. 2. Provide visual or infographic-based service summaries. 3. Standardize the communication of service outcomes to customers.

The proposed process improvements were developed to minimize operational waste and eliminate non-value added waiting time throughout the routine vehicle service process. These improvements aim not only to enhance workshop operational efficiency and workforce productivity but also to improve service quality, customer satisfaction, and the long term sustainability of business operations. The proposed improvements resulted in modifications to several stages of the service process, particularly administrative procedures, spare parts verification, and vehicle servicing activities. Several activities that were previously performed independently were integrated to reduce process time, improve workflow efficiency, and strengthen coordination among service personnel. Consequently, the redesign process is expected to provide a more efficient, structured, and customer oriented service system. The proposed improvements to the routine vehicle service process are presented in Table 10.

Table 10.
Improved Routine Vehicle Service Process

Main Process	Activity	Cycle Time (min)
Vehicle Reception	Customer reception	1,47
	Vehicle registration	2,77
	Customer complaint identification	5,32
	Initial vehicle inspection	10,94
Work Order (WO)	Service time and cost estimation	2,95
Preparation	Generation, electronic transmission, and confirmation of the digital work order	1,00
Spare Part Preparation	Verification of spare parts requirements and availability	2,29
	Spare parts retrieval and preparation	6,41
Vehicle Service Process	Installation of the fender cover and engine compartment inspection	10,91
	Positioning the vehicle on the car lift	10,66
	Wheel removal and brake system inspection	8,03
	Engine oil and oil filter replacement	6,81
	Wheel reinstallation and lowering the vehicle from the car lift	11,28
	Removal of the fender cover and final inspection of the service area	11,69
Final Inspection	Functional and performance testing of the vehicle	10,60
Vehicle Washing	Interior cleaning	8,97
	Exterior cleaning	7,44
	Vehicle drying	6,74
Payment Process	Explanation of service charges	5,25
	Payment processing and transaction receipt generation	4,60
Vehicle Handover and Service Explanation	Vehicle handover to the customer and explanation of the completed service and repair work	4,66
Total Cycle Time		140,79

As presented in Table 10, the proposed improvements to the routine vehicle service process resulted in the simplification and integration of several operational activities to enhance overall service efficiency. One of the most significant improvements was achieved in the administrative stage, where work order generation, electronic transmission, and confirmation were integrated into a unified digital system. This integration streamlined information flow and reduced the processing time for administrative activities to only one minute, thereby improving coordination between service advisors and technicians while minimizing delays before the service process begins.

At the vehicle reception stage, the proposed process redesign integrates customer reception, vehicle registration, customer complaint identification, and the initial vehicle inspection into a structured and efficient workflow. By consolidating these activities at the beginning of the service cycle, the process ensures the systematic collection of customer and vehicle information while reducing the potential for duplicate inspections and information inconsistencies during subsequent service stages. The spare parts preparation stage was improved by integrating the verification of spare parts requirements with the availability check into a single coordinated activity. This integration shortens the process flow and improves coordination between technicians and warehouse personnel.

The implementation of the proposed process improvement reduces the total cycle time of the routine vehicle service process to 140.79 minutes, indicating a significant improvement in operational efficiency compared with the previous process, enabling the company to reduce operational waste and enhance the operational effectiveness of its vehicle service activities.

3.7 Future State Value Stream Mapping (FSVSM)

In the proposed Future State Value Stream Map, several administrative and communication processes were integrated into a digital information system to accelerate information flow and eliminate duplicated tasks. Process improvements were also implemented in spare parts verification, vehicle handover to technicians, and the simplification of vehicle inspection procedures to reduce the overall service processing time. These improvements are expected to optimize the routine vehicle service process, enhance operational productivity, and deliver higher service quality and customer satisfaction. Overall, the Future State Value Stream Map demonstrates that the implementation of the Lean Service approach through Value Stream Mapping successfully establishes a more effective, efficient, and well-structured routine vehicle service process.

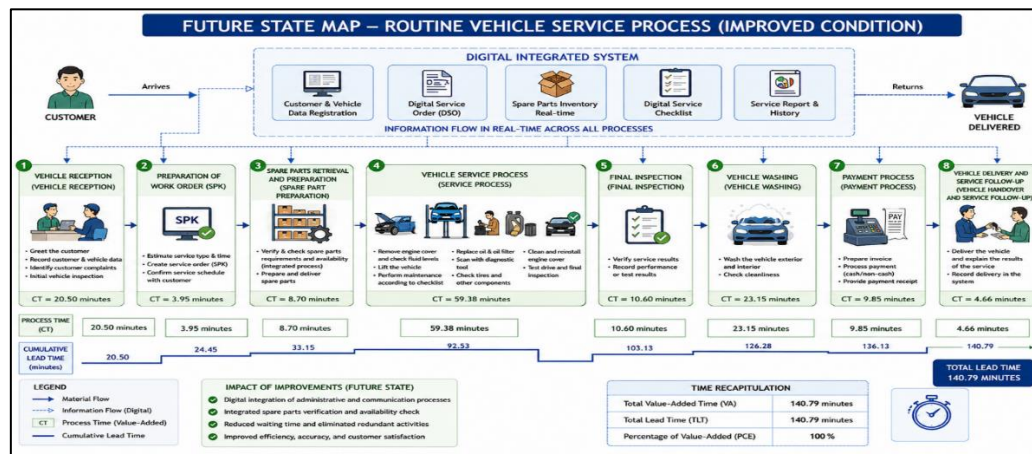


Figure 3.
Future State Value Stream Mapping

4. DISCUSSION

During the vehicle service stage, redundant inspections were eliminated by consolidating repeated vehicle condition checks into a standardized workflow, allowing technicians to focus on value added activities. As shown in Figure 3, the proposed Future State Value Stream Map reduced total lead time from 179.64 to 140.79 minutes, a reduction of 38.85 minutes (21.62%), through waste elimination, reduced waiting time, and workflow optimization. The integration of digital technologies, including electronic work orders (e-WOs), digital inspection checklist, and real time spare parts inventory, further improved information flow, coordination, and service responsiveness, thereby strengthening operational performance and supporting higher service quality and customer satisfaction.

To evaluate the effectiveness of the proposed process improvements, a comparison between the current state and future state conditions was conducted. The comparison focuses on key operational performance indicators, including process lead time and activity classification. The results are summarized in Table 11.

Table 11.

Comparison of Process Performance Before and After Improvement

Performance Indikator	Before Improvement	After Improvement
Total Lead Time (minutes)	179,64	140,79
Number of Process Activities	29	21
Value Added (VA) Activities	15	15
Non Value Added (NVA) Activities	9	0
Necessary but Non Value Added (NNVA) Activities	10	6

This study is limited to a single case study at an automotive service workshop, which may restrict the generalizability of the findings. In addition, the evaluation focused primarily on process efficiency through lead time reduction and waste elimination without assessing long-term implementation outcomes. Future research should validate the proposed improvements in different service environments and integrate Lean Service with complementary approaches, such as Six Sigma or simulation, to further enhance operational performance.

5. CONCLUSION

Delays in the routine vehicle service process were primarily caused by discrepancies between the standard processing time and the actual processing time across several service stages. These inefficiencies were associated with operational waste, particularly waiting, overprocessing, and overproduction. The application of Value Stream Mapping (VSM) successfully identified Value Added (VA), Non Value Added (NVA), and Necessary but Non Value Added (NNVA) activities, enabling the identification of process inefficiencies and the primary sources of operational waste. Based on the analysis of the Current State Value Stream Mapping (CSVSM), a Future State Value Stream Map (FSVSM) was developed to redesign and simplify the service workflow. The proposed improvements included the integration of digital information systems, the elimination of redundant activities, workflow standardization, and the optimization of information flow across service operations. As a result, the total process lead time was reduced from 179.64 minutes to 140.79 minutes, representing a reduction of 38.85 minutes (21.62%). These findings demonstrate that the implementation of Lean Service supported by Value Stream Mapping (VSM) is an effective approach for improving the efficiency of routine vehicle service operations. By eliminating operational waste and streamlining service processes, the proposed improvements not only reduce service lead time but also enhance operational

performance, service quality, and customer satisfaction. The proposed framework provides a practical reference for automotive service workshops seeking to improve process efficiency through continuous improvement and digital process integration.

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