Application of the Process Mapping for Identification of Waste for Sustainable Performance Improvement in the Service Processes

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Abstract: This paper examines the pivotal role of high-quality aftersales service in maintaining global automotive industry competitiveness and sustainability. It presents the methodology for utilizing lean principles in sustainable performance improvement by identifying and eliminating waste in aftersales processes. The approach is exemplified through a case study in road freight vehicle service and maintenance using process mapping. The methodology involves developing a comprehensive process map, analyzing current inefficiencies, and proposing improvement measures. The methodology enhances operational efficiency and contributes to sustainable performance in terms of economic, environmental, and social factors. The methodology is generalized and outlines successful improvement phases and sub-steps.

Keywords: process mapping, sustainable performance, automotive industry, lean, waste identification

1. Introduction

In the automotive aftersales industry, efficiency and continuous improvement are of paramount importance, particularly in the context of sustainability pressures and escalating input costs. This paper presents a methodological framework based on process mapping to identify areas for enhancement. A case study uncovered specific shortcomings, such as the ad hoc provision of spare parts (SP), and their impact on sustainability is assessed. This paper addresses economic, environmental, and social factors intending to enhance the competitiveness and sustainability of automotive aftersales processes in alignment with broader societal and environmental imperatives.

The research focuses on optimizing service procedures at the selected company's service center within the automotive aftersales sector. This entails comprehensive process analysis and process mapping using BPMN methods to identify shortcomings and their root causes and consequences. Initially, delineating the process boundaries and determining the modeling perspective and detail level was imperative. The methodology evolved iteratively throughout the research due to its cyclical nature. A methodology gradually emerged for data collection and process mapping, validated and refined through controlled workshops with the research team and company representatives. This iterative process ensured goal achievement and maximized output informativeness. The paper commences with a literature review defining fundamental concepts of process analysis, process mapping, BPMN, and root cause analysis.

The subsequent sections present the case study, detailing the process analysis based on time study and BPMN process mapping as an analytical tool for identifying causes and effects of process deficiencies. It provides a general overview of the map creation process and its logic, facilitating the identification of optimization measures to enhance productivity and eliminate waste. Data and information were meticulously gathered to capture and map processes, utilizing methods such as time capture, historical data analysis, questionnaire surveys, and structured interviews. Process specifications emerged from brainstorming sessions with service center staff, aligning with management's priorities and expectations.

Finally, the methodology's generalization is presented with a comprehensive flowchart outlining successful improvement phases and sub-steps. While the generalization of the methodology is considerable, it's crafted to encourage widespread application in industrial process improvement activities, ensuring its scalability and adaptability.

The paper highlights the proposed methodology's positive impact on operational efficiency and sustainability across economic, environmental, and social dimensions within the automotive aftersales sector. By adhering to these principles, organizations can enhance their competitiveness and progress towards broader sustainability objectives, thereby contributing to economic prosperity, environmental stewardship, and social welfare.

2. Literature Review

2.1. Waste identification

Waste within production processes, whether physical or abstract, poses a common and significant challenge to enhancing the efficiency of said processes (Woźniak et al. 2017). The capacity to recognize various forms of waste accurately at an early stage is thus evolving into highly valuable expertise across various sectors and service offerings. Since the latter part of the 20th century, the topic of waste identification has been closely associated with the principles of lean production or lean management, given that the persistent endeavour to pinpoint and eradicate waste is frequently highlighted as a fundamental tenet of the lean philosophy (Hartanti et al. 2020). Activities associated with waste reduction align closely with the core mission of the Lean philosophy, which focuses on continuously enhancing performance by eliminating non-value-added activities for the customer (Manimay 2013, Douglas et al. 2015, Gupta et al. 2016). Organisations can achieve higher efficiency and enhance customer satisfaction and competitiveness by implementing and adhering to the principles of Lean, thus reducing waste and avoiding unnecessary costs. In the realms of Lean and KAIZEN principles, the notion of waste is commonly denoted by the Japanese term "MUDA" or waste in operational processes (Gupta et al. 2016, Narayanamurthy et al. 2017, David 2014).

The initial seven categories of waste, specifically waste related to overproduction, waiting, redundant transportation, excessive processing, excess inventory, unnecessary motion, and defects, the scope of waste has grown over the years, adapting to changing requirements, resulting in the current classification of eight different waste types (Gelmez et al. 2020). In particular, the eight categories of waste encompass defects and rework, overproduction, idle time, untapped skills, transportation, stockpiling, unnecessary movement, and surplus processing (Hofer & Naeve 2017). More detailed characteristics of typical waste categories of lean management are given below (Muñoz-la Rivera et al. 2021, Rawabdeh 2005):

- W1 – Waste of overproduction: Producing more than required leads to overstaffing, storage, and transportation costs. Causes a significant amount of resources to be tied up, which otherwise could be used for value-adding operations.
- W2 – Waste of available time (waiting): All the time that is not spent on value-adding activities.
- W3 – Waste in transportation: Carrying work that does not add value to the final product for a customer.
- W4 – Waste of processing itself (overprocessing): Unnecessary transactions involved in the process.
- W5 – Waste of movement: Any unnecessary movement performed by sources.
- W6 – Waste of available stock (inventory excess): Excessive amount of supply stored with respect to customer needs and value.
- W7 – Waste of making defective products: Deviation of products from the customer requirements or specifications.
- W8 – Unused Employee Creativity: This is a situation of not using the potential efficiently, making an organization benefit less than possible.

The fundamental methodologies employed for waste identification encompass ad hoc observation, organized interviews, surveys via questionnaires, or on-site gemba inspections. Advanced techniques utilized for waste identification include Value Stream Mapping (VSM) and Time Study. Value Stream Mapping serves as a pivotal instrument for commencing process scrutiny and is widely acknowledged as a benchmark in process enhancement. Considering the extent and characteristics of the examined processes, the time study was selected as the optimal instrument. While a time study may not directly enhance processes, it is crucial to pinpointing inefficiencies and metrics that inform strategic decision-making. As a standard, 7 steps are used to structure time studies (Rawabdeh 2005):

I.   Identify the objectives and define the study process.
II.   Determine the study duration and the number/cycles of measurements and observations.
III. Select appropriate observers and provide all necessary resources.
IV. Explain the details of the time study to the observers and members of the research team.
V.   Clarify and standardize all rules for measuring and recording observations.
VI. Carry out the time study.
VII. Data processing and presentation of study results.

2.2. Business Process Mapping and Notation

Process analysis is a technique utilized to examine and comprehend the different stages and elements within a process, with the ultimate aim of enhancing the process's efficiency (Tsai et al. 2015). The procedure encompasses the dissection of a procedure into its constituent tasks. Subsequently, the arrangement and progression of these tasks are scrutinized to pinpoint opportunities for enhancement. Process analysis is a versatile practice relevant across various domains, such as computer science, analytics, scalability, and parallel computing (Tirado et al. 2022). Process mapping is a methodology utilized to visualize and examine the sequential steps, tasks, and interrelations encompassed within a given procedure. This approach furnishes a coherent and methodical outline of the procedural progression, facilitating enhanced comprehension of the operational mechanisms and avenues for enhancement. Typically, process maps employ symbolic representations and schematic illustrations to delineate process components, including but not limited to tasks, determinations, inputs, and outputs (Antonacci et al. 2018). Organizations can pinpoint inefficiencies, bottlenecks, and areas needing enhancement through the process mapping technique. This tool holds significant value in enhancing process visibility, facilitating communication, and fostering collaboration, ultimately resulting in enhanced performance and cost reduction. BPMN, an acronym for Business Process Model and Notation, is a standardized language and notation utilized for the modeling and documentation of business processes. This framework offers a visual depiction that aids stakeholders in comprehending, conveying, and analyzing intricate processes clearly and consistently and recognizing areas necessitating enhancement, like bottlenecks or inefficiencies. Utilizing symbols and diagrams, BPMN represents distinct components of a process, including tasks, events, gateways, and flows (Barbrow & Hartline 2015, Zarour et al. 2019). BPMN is a valuable tool for depicting process maps through visual representation of the order, progression, and interconnections among activities within a given process. This technique facilitates the discernment of procedural actions, decision-making junctures, and interrelationships, thereby offering a holistic perspective of the process flow (Intrigila et al. 2021). Furthermore, BPMN can enhance processes by analyzing and enhancing the depicted processes. By leveraging BPMN, entities can pinpoint chances to simplify, automate, or reconstruct processes to enhance effectiveness (Lenort et al. 2019), cut expenses, and boost overall productivity. Techniques like performance analysis, simulation, and process redesign can be employed to analyze and enhance BPMN models (Soliman et al. 2022). Root cause analysis is a methodical approach to recognize the underlying reasons behind issues or procedure inaccuracies. Its objective is to surpass merely addressing symptoms and instead concentrates on pinpointing the fundamental factors contributing to issues. The root cause analysis process aids organizations in comprehending the origins of problems and empowers them to enforce efficient corrective measures to avert reoccurrence. Business Process Model and Notation (BPMN) diagrams can be advantageous in pinpointing the chronological order of events and tasks that culminate in an issue. This simplifies the process of retracing back to the fundamental cause. Moreover, BPMN proves useful for documenting the identified root causes and their interconnections within the process illustration. This record aids in disseminating and exchanging the analysis findings with stakeholders, promoting a shared comprehension of the identified root causes and the suggested corrective measures (Tsakalidis et al. 2019). Process mapping tools like BPMN enable the identification of inefficiencies and areas for enhancement within manufacturing services. By visually portraying manufacturing processes through BPMN diagrams, organizations can scrutinize the process flow and pinpoint non-value-adding activities, leading to inefficiencies. Such inefficiencies include overproduction, waiting, transportation, unnecessary motion, defects, and inappropriate processing. By examining the BPMN diagrams, organizations can implement lean manufacturing principles and methodologies to eradicate or diminish inefficiencies, including value stream mapping, standardization, visual management (Olkiewicz et al. 2023), 5S, and continuous improvement (Gupta et al. 2016, Alexander & Iskandar 2023, Ahmad et al. 2017).

2.3. Lean principles and sustainable performance

Sustainable performance refers to the ability of an organization to achieve economic, environmental, and social objectives while ensuring long-term effectiveness and efficiency (Staniuk et al. 2022). It involves integrating sustainability principles into various aspects of operations, such as manufacturing processes (Woźniak & Jakubowski 2015, Szajna et al. 2021), supply chain management, and product development. Sustainable performance metrics should be easy to use, robust, and reflect the three dimensions of sustainability – economic, environmental, and social. Achieving sustainable performance requires a balance between profitability, environmental stewardship, and social responsibility, aiming to meet current needs without compromising the ability of future generations to meet their own needs. This holistic approach to performance evaluation is crucial for organizations looking to thrive in a rapidly changing business landscape while contributing positively to society and the environment (Naeemah & Wong 2023, Utama & Abirfatin

2023). Lean principles, such as waste minimization and value enhancement, are closely linked to sustainability. Integrating Lean, Six Sigma, and sustainability has shown positive outcomes in manufacturing (Gabryelewicz et al. 2021), improving economic and environmental performance. Lean practices positively influence sustainable supply chain performance, with green practices mediating this correlation. The synergy between Lean and Green practices has been found to impact supply chain performance positively, emphasizing the need for organizations to invest in green practices alongside Lean methodologies. An integrated sustainable green lean six sigma agile manufacturing system (ISGLSAMS) provides a comprehensive approach to meeting business, societal, and ecological needs under a single umbrella, enhancing financial, market, social, environmental, operational, and sustainable performance. Overall, the relationship between lean principles and sustainability is crucial for achieving long-term success in various industries (Hariyani & Mishra 2022, Batwara et al. 2023). The synergy between lean and green practices is evident in manufacturing industries, where lean principles drive environmental sustainability initiatives. Lean practices, focused on waste reduction, naturally align with green practices aimed at environmental conservation. Integrating lean and green strategies not only enhances competitiveness but also leads to improved economic, environmental, and social performance. Additionally, the integration of Lean, Six Sigma, and sustainability has positively impacted pollution prevention programs and overall environmental performance. By combining lean tools like Value Stream Mapping with green tools like Life Cycle Analysis, organizations can effectively identify and eliminate waste while addressing environmental concerns (Chamier-Gliszczynski & Krzyzynski 2005, Chamier-Gliszczynski 2011). This integrated approach optimizes processes and contributes to sustainable manufacturing practices (Kosasih et al. 2023, Mostafa & Dumrak 2020). Waste elimination plays a crucial role in contributing to sustainability by reducing environmental impact, improving resource efficiency, and enhancing overall operational performance (Chamier-Gliszczynski 2010). Lean Manufacturing focuses on eliminating waste throughout the production process, leading to reduced resource consumption and minimized environmental footprint. Integrating lean practices with green initiatives in SMEs can significantly enhance sustainability performance by addressing harmful emissions and promoting eco-friendly practices. By eliminating wasteful activities and optimizing resource utilization, organizations can achieve cost savings, energy efficiency (Kuczynski et al. 2021), and improved product quality, aligning with sustainable manufacturing principles. Overall, waste elimination benefits the environment and enhances economic efficiency and social responsibility, contributing to a more sustainable and resilient business model (Suresh et al. 2023, Huang et al. 2023). Lean and green approaches play a crucial role in enhancing the sustainability of business processes. Integrating Lean, Six Sigma, and sustainability has positively improved economic and environmental performance. Top management commitment is vital in ensuring the success of lean and green practices within organizations (Ignatowicz et al. 2021). Small and medium enterprises (SMEs) can benefit from implementing lean and green practices, contributing significantly to supply chain sustainability. Sustainable manufacturing strategies, such as lean manufacturing, focus on waste elimination and environmental gains, aligning with green practices to achieve sustainability goals. Organizations can drive continuous improvement and environmental benefits by following a waste elimination process that combines lean principles with sustainable outcomes (Hasan et al. 2023, Çiğal & Saygili 2022, Crosby & Badurdeen 2022).

3. Research Methodology

3.1. Research design

The proposed methodology was developed during the improvement efforts of the selected automotive aftersales company, which focused on the service and maintenance of road freight vehicles. It was determined that the investigation would focus on the processes linked to individual orders and their ensuing service operations from the perspective of the service advisors. These personnel and their duties were recognized as essential to the effectiveness and output of the service center, but they were overburdened in the long run. The primary objective was to enhance overall cost efficiency and performance while promoting the company's sustainable development by improving the social aspects of business processes. This includes fostering a better work-life balance for service advisors and maximizing the utilization of their advanced organizational, technological, and communication skills, which were previously underutilized due to an overload of operative, administrative, and low-value tasks. By eliminating these unproductive activities, the aim is to enable service advisors to focus on high-value tasks, thereby increasing company productivity and employee satisfaction. Figure 1 illustrates the fundamental structure of the research methodology. The process diverged from the conventional approach, which typically commences with formulating a general methodology based on a comprehensive literature review and assumptions derived from the research team's expertise. Subse-

quently, this methodology is validated through a case study on a specific problem to ascertain the practical viability of the proposed methodology.

In contrast, the methodology development process presented in this paper proceeded inversely. Firstly, a specific problem from an industrial environment was defined, for which a solution procedure was then planned. This was continuously developed while conducting a literature search of the problem under study and analyzing and mapping the current state of the selected industrial system. Finally, the procedure for solving the selected problem was generalized and translated into a general methodology for improving various business processes across industries.
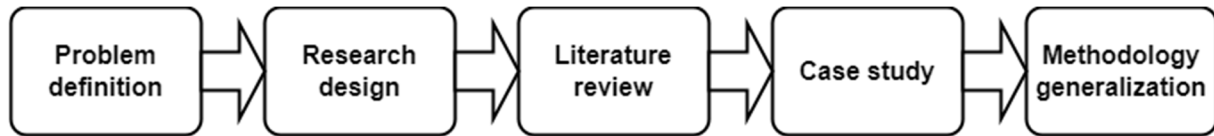

Fig. 1. Research methodology

3.2. Literature review

The objective of the literature search was to delineate fundamental concepts in the domains of waste identification, process mapping, lean principles, and sustainable performance. The literature search was based on analyzing the current state of knowledge in these areas. The analyzed publications were primarily scientific articles, demonstrating a higher relevance and topicality than traditional book sources. This approach was necessary given the rapid development of the areas under study. One of the principal outcomes of the literature search is the definition of the relationship between lean management principles and sustainable performance. The primary focus of the entire research project is based on this connection. To analyze the current state of knowledge, dozens of publications were analyzed and filtered in turn until a final set of 32 sources was created and used to prepare this paper. The primary search terms employed in identifying potential sources and subsequent analysis were as follows: lean management, sustainable performance, waste identification, automotive after-sales, service processes, process mapping, continuous improvement, and so forth.

3.3. Case study

The first phase of the case study includes process analysis based on time study. The focal point of the process analysis was to capture and map the processes. The general methods were implemented, such as time capture, historical data analysis, questionnaire surveys, and structured interviews to gather data and information. After initial observations and workshops, the focus and boundaries of the process under investigation were identified. The process specifications resulted from brainstorming sessions with service center staff at all management levels and aligning with the management's priorities and expectations.

3.4. Methodology generalization

Finally, the methodology proposed and improved during the implementation of improvement activities focused on the defined processes in the selected company was generalized. This general methodology is presented in the last chapter of this article in the form of a flowchart that describes the different phases and substeps that have proven successful in this type of activity. Although the generalization of the methodology is considerable, it is still designed in a way that encourages its application in industrial process improvement activities.

4. Case Study: Process Mapping for Sustainable Performance Improvement in Automotive Service Processes

4.1. Time study and waste identification

First, the time study process will be presented. Next, the results of the time study will be evaluated. Next, the causes and effects of identified shortcomings will be identified. Finally, the application of the BPMN method for process mapping and identification of the origin of waste will be described. As the whole analytic process is hardly a linear activity, the order of the description of individual steps is not important, because of the iterative nature of the whole process. The measurement and monitoring methodology was developed and refined during the gradual identification of problems. Table 1 presents examples of categories of activities recorded during time study.

Table 1. Examples of categories of recorded activities

Category name	Examples of activities
Communication with a customer	Receiving the car, handing over the car, arranging repairs, determining the extent of repairs, information on the status of repairs, information on SA prices, prices for work...
Communication with the mechanic	Organizing repairs, information on repair status, consultation on operational status of SA...
Invoicing	Rewriting and writing out documents, additional data and information gathering, consultation and problem solving, usually missing information, activities to finalize invoices...
Operative	Representation of other workers, random tasks (extraordinary questionnaires, for example coffee for the driver), consultations with management, consultations not related to repairs...
Pause	Lunch, snack, toilet, personal items...

After precisely and unambiguously determining the approach and perspective for developing process analysis and process maps. It was necessary to define the desired future state of the investigated process and, on that basis, identify the shortcomings of the current state and the barriers to transitioning to the future state. The desired future state was defined in two ways. The first one is optimization measures aimed at improving the sustainable performance of service advisors. Secondly, the aim was to maximize the number of complete orders. A complete order is one that is planned, completed within the specified time, the vehicle is handed over for servicing by the customer on time, the specified mechanic carries out the service, the invoice is issued before the vehicle is driven away, the repair time does not exceed the plan, all spare parts are available during the service, and no additional servicing is required. One output from observation and measurement was the frequency of incomplete orders, and through a questionnaire survey among service advisors and mechanics, the causes of these incomplete orders were identified. The assumption for increasing the overall efficiency of the service center was that incomplete orders are significantly more time-consuming for service advisors to process. Identifying shortcomings and causes of waste focused on the daily work routines of service advisors and the origins of incomplete orders. All identified shortcomings were discussed in the conclusion of the research, covering their causes, consequences, and impact on process efficiency. Desired future states of individual problem areas were outlined, and measures were proposed to eliminate the causes of the problem and achieve the desired state. The proposed measures were assessed based on their significance for improving sustainable performance and the demands for their implementation. These two factors were used to map all problematic areas into a significance matrix, which enabled the prioritization of proposed solutions based on their impact on the improvement of the sustainable performance of the service center. The 10 specific waste-generating shortcomings (Identified shortcomings – IS) have been identified, and these IS were classified with a five-point scale according to their expected impact:

- 5 – very high impact,
- 4 – high impact,
- 3 – medium impact,
- 2 – small impact,
- 1 – very small impact.

The nature of identified shortcomings can be divided into two groups:
- Specific – their origin can be assigned to a specific sub-process.
- General – Intertwines throughout the process.

Classification of identified shortcomings according to their impact on the sustainable performance efficiency of the process and their character is presented in Table 2.

Table 2. Classification of identified shortcomings according to their importance and nature

Character	Impact				
	5	4	3	2	1
Specific	IS1, IS3	IS7	IS8	IS10	
General	IS2, IS4	IS5, IS6	IS9		

Classification of shortcomings by type of waste is presented in Table 3. Sample case of identified shortcomings:

- IS1 – Inefficient system for preparation of a daily plan,
- IS2 – Not updating daily plans,
- IS3 – Non-systematic determination of the order execution sequence during the day,
- IS4 – Inefficient system of historical data collection,
- IS5 – Exchange of information between shifts about orders,
- IS6 – There is no deputy for the workshop manager,
- IS7 – Non-standardized planning of repair times – depending on the experience of each worker,
- IS8 – Reserves in scheduling work for mechanics,
- IS9 – Duplication of effort due to the need to use two software tools,
- IS10 – Bad information flow between service advisor and warehouse operator.

Table 3. Classification of shortcomings by type of waste

Category of waste	Identified shortcomings potentially generating waste									
	IS1	IS2	IS3	IS4	IS5	IS6	IS7	IS8	IS9	IS10
W1	x	x	x	x	x	x	x	x		x
W2	x	x	x	x	x	x	x	x	x	x
W3		x	x		x	x				x
W4	x	x	x	x	x	x	x	x	x	x
W5	x	x	x			x	x	x		x
W6	x	x		x	x	x				x
W7	x	x	x			x	x	x	x	x
W8		x						x	x	x

24 measures were identified to address the root causes of the ten identified shortcomings (proposed measures – PM). While for some shortcomings, only one measure was found (IS1 proposed measure PM1-1), for others, five measures were found (IS6 proposed measure PM8-1 to PM8-5). A Significance matrix was used as a simple tool for system prioritization of the proposed measures, as shown in Table 4. Two criteria were used for prioritization: impact on sustainable performance improvement and requirements for implementation. Priority measures for implementation are those with a high impact and yet low implementation requirements.

Table 4. Significance matrix showing prioritization of proposed measures

		Summary of measures	
Impact	5, 4 – High	PM1-1, PM2-1, PM3-1, PM4-1, PM4-2, PM6-1, PM6-3, PM8-1, PM8-2, PM9-2, PM10-1	PM5-1, PM7-1, PM8-4, PM9-1, PM10-2
	1, 2, 3 – Low	PM3-2, PM5-2, PM6-2, PM8-3, PM8-5, PM10-3	PM3-2, PM5-1
Requirements for implementation		1 – Low	2 – High

4.2. Process mapping – BPMN application

To achieve the objective of this research, it was imperative to document the service advisors typical workday. Subsequently, the activities observed were classified into different categories: communication with the customer, mechanic, other service advisor, and storekeeper, pre-invoicing, invoicing, order work, ensuring service performance, operative, pauses, and substituting the storekeeper. These categories were then assessed according to the degree of waste and value-added and mapped out for their relationships and causal links throughout the order. This was achieved with the assistance of the specialized software Modelio, which utilizes BPMN methodology for creating process maps. The boundaries of the investigated process were defined at the input by the origin of a need for a service operation, namely the receipt of a customer request and the placing of an order, and the output by the fulfillment of the order and the return of the fixed car to the customer accompanied by invoicing for the carried-out service operations.

The methodology continually evolved during the course of the investigation due to newly discovered facts and connections. As a result, creating process maps was not a one-time activity but a continuous iterative process. During the creation of the maps, several adjustments were made regarding process analysis perspectives, the shift of boundaries of the studied processes, and the development of the overall logic of process and information flows recording. All of these factors led to the creation of process maps with high informative value for the set objectives. The focus was not on generic process maps intended to replace the standardized process diagram stipulated in corporate policies but rather on a highly specific perspective on processes related to individual orders designed to identify root causes of deficiencies and discover areas with potential for the improvement of sustainable performance of analyzed processes.

The use of BPMN to identify the cause of shortcomings and waste and their impact in the mapped process will be presented. The basic characteristics of the created maps will be presented to illustrate how the results of the time study, questionnaires, interviews, and historical data analysis can be linked and visualized using the BPMN methodology. This approach helps better understand the relationships and connections between individual sub-processes and the accompanying information flows. Process maps will also enable clear recognition of the areas of responsibility of individual workers for problematic sub-processes.
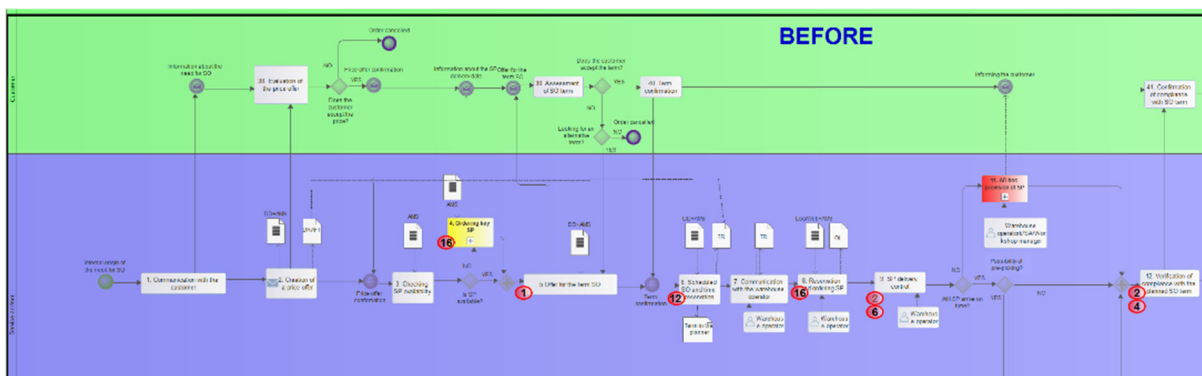

Fig. 2. Process map – Service operation order – Before phase

The process maps document the specific progression of the order from the initiation of the need for service operation to its fulfillment, as envisioned by the service advisor. The chief aim of the process maps was to methodically record the service advisor's actions pertaining to each service operation. The process maps comprise three primary swimming lanes that outline distinct responsibility areas: the customer, service advisor, and mechanic. Each sub-process on the map has a unique number for easy orientation. Processes that involve other workers are only briefly outlined. Red circles on the process maps indicate the place of origin of identified shortcomings and waste. Figure 2 represents only a fraction of the complete map, focusing on the BEFORE phase of the process. For all identified issues, their causes were found, and their places of origin were defined within process maps. This allowed for the relationships between the causes and consequences of each problem to be traced, leading to a better understanding of the overall process. Thanks to this identification, specific targeted solutions could be effectively designed without resorting to general, blanket measures without clear purpose or intent.

4.3. Example: Identified shortcoming 6 – Ad hoc provision of SP

Identified Shortcoming 6 – Ad-hoc Provision of SP was selected to present the implementation of the proposed methodology for identifying the location of the cause of the shortcoming within the mapped process. Firstly, the description of the problem and its cause is presented. Then, its consequence will be defined and finally, measures for its elimination will be proposed. Figure 3 shows a partial map of the ADhoc Provision of SP sub-process, which is inherently a completely unnecessary process and thus a clear example of waste-generating activity. It is a fairly complex sub-process that significantly interferes with the core work activities of the SA.
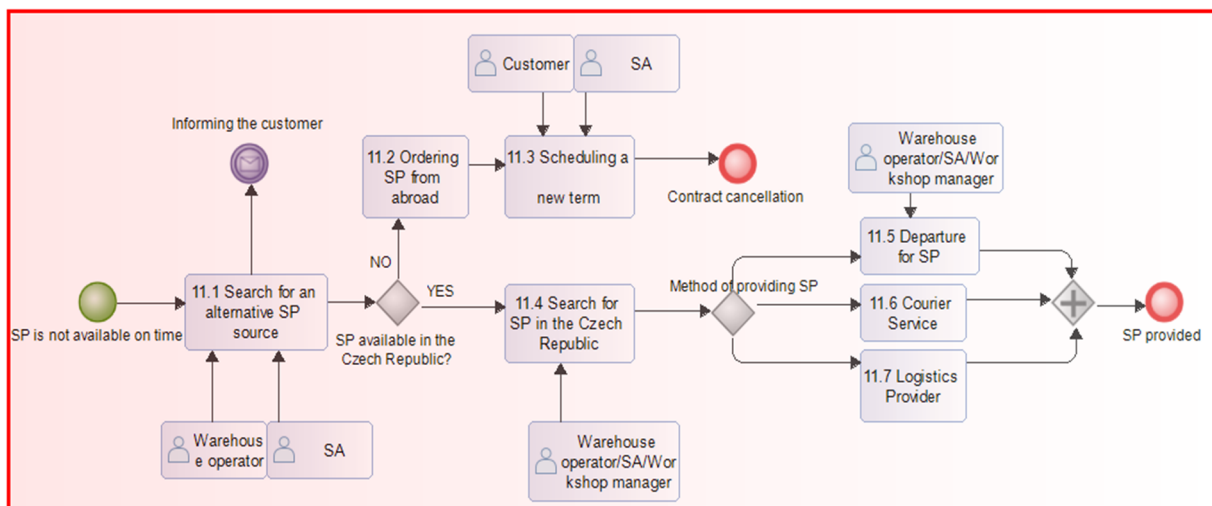
Fig. 3. Subprocess 11. ADhoc provision of SP

Cause: The identified waste source pertains to SA's ad hoc provision of Spare Parts (SP) from other services, occurring several times monthly. Typically, SA undertakes these trips, often on weekends, lasting approximately 2 to 6 hours per trip across various locations. This non-systematic flow of SP leads to traffic congestion issues and supply chain disruptions, particularly when new SP needs arise during repairs. During the process mapping, this deficiency was found to occur in two different cases within the process. The need for ad hoc SP provisioning arises at the BEFORE stage when the delivery of the required spare parts is checked the day before the service is performed. The same situation occurs in the DURING phase when the need for additional service actions and the associated need for additional spare parts arise during the execution of the service action. Both of these moments are captured in the process map, see Figure 4.
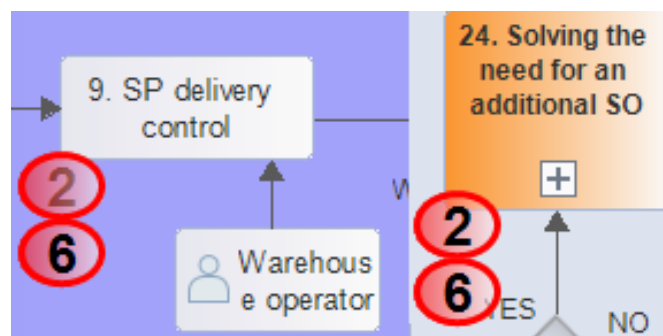

Fig. 4. Identified shortcoming 6 – Ad hoc provision of SP

Effect: SA estimates a monthly time expenditure of 10 to 15 hours from its personnel pool, incurring additional costs, obstructing workplace operations, and extending repair deadlines. Moreover, the organization faces risk of personnel being off-site without proper authorization, especially concerning travel documentation approval.

Solution:
- Implement a system for continuous monitoring and evaluation of supplier reliability, particularly in cases of SP non-delivery.
- Introduce a two-day buffer between the promised SP delivery date and the scheduled repair date to account for potential delays.
- Ensure expedited transport of SP between centers through the utilization of purchased express services, emphasizing appropriate service levels such as overnight transfers.

4.4. Expected impact on sustainable performance improvement

Adopting proposed measures enhances operational efficiency and positively influences sustainable performance in the three key dimensions: economic, environmental, and social. From an economic perspective, reducing waste results in cost savings and effective utilization of resources, ensuring long-term sustainability. Environmentally, optimized processes decrease resource usage and waste production, which aligns with the lean=green concept. Socially, the approach encourages transparency, standardization, and employee well-being, fostering a culture of ongoing enhancement. By embracing these principles, companies can improve their competitiveness and progress towards sustainability objectives, aligning with broader societal and environmental needs. The primary positive impacts on each of the three dimensions of sustainability are outlined below:

Economic Impact:
- The elimination of waste results in significant cost savings, contributing to the long-term viability of automotive aftersales processes.
- By removing non-value-added activities, the research ensures the efficient utilization of the highly skilled workforce, enhancing economic productivity.
- Application of quality management principles optimizes resource usage, leading to increased efficiency and improved order processing rates.
- Reduction in waste translates to time and monetary savings, further bolstering the economic sustainability of the processes.

Environmental Impact:
- The proposed measures reduce the environmental footprint of automotive aftersales processes, aligning with the lean=green principle.
- Streamlining processes and eliminating waste reduces resource consumption and waste generation, contributing to environmental sustainability.
- Time savings from process optimization directly translate into reduced input consumption and lower carbon emissions, fostering environmental responsibility.

Social Impact:
- Implementation of the research methodology enhances the social sustainability of service operations by prioritizing transparency and standardization.
- The focus on eliminating waste of highly skilled labor improves work efficiency and reduces the overwork rate, positively impacting the well-being of service advisors.
- Transparent processes and standardized activities ensure compliance with legal working hours and breaks, promoting a healthy work-life balance and overall social well-being.

5. Results: Proposed General Methodology

In this chapter, the general methodology that was developed and tested during the case study will be presented. The first step is to conduct the time study. At the beginning of any analytical process, the aim, purpose, scope and depth of the research activities must be clarified. Due to the limited capabilities of the observers, it was not possible to carry out this analysis on a broad scale and simultaneously on all company processes. Therefore, in this initial phase, it was necessary to realize what a priority for the company is, what the motivation for process mapping is, and whether the section or object of research that has been chosen is really the most important one to start with. Figure 5 shows a schematic of the proposed methodology.

In the given schematic procedure, all successive steps are divided into four phases, namely the preparation phase, the implementation phase, the evaluation phase, and the realization phase. After collecting the data and identifying the shortcomings that may cause waste, the important classification steps follow. Specifically, it is the classification of identified shortcomings according to their impact on the sustainable performance of the process and according to their nature, which is important to determine the most significant waste. The following is a classification of identified shortcomings by type of waste, which is important to find the root causes and appropriate measures to eliminate them.
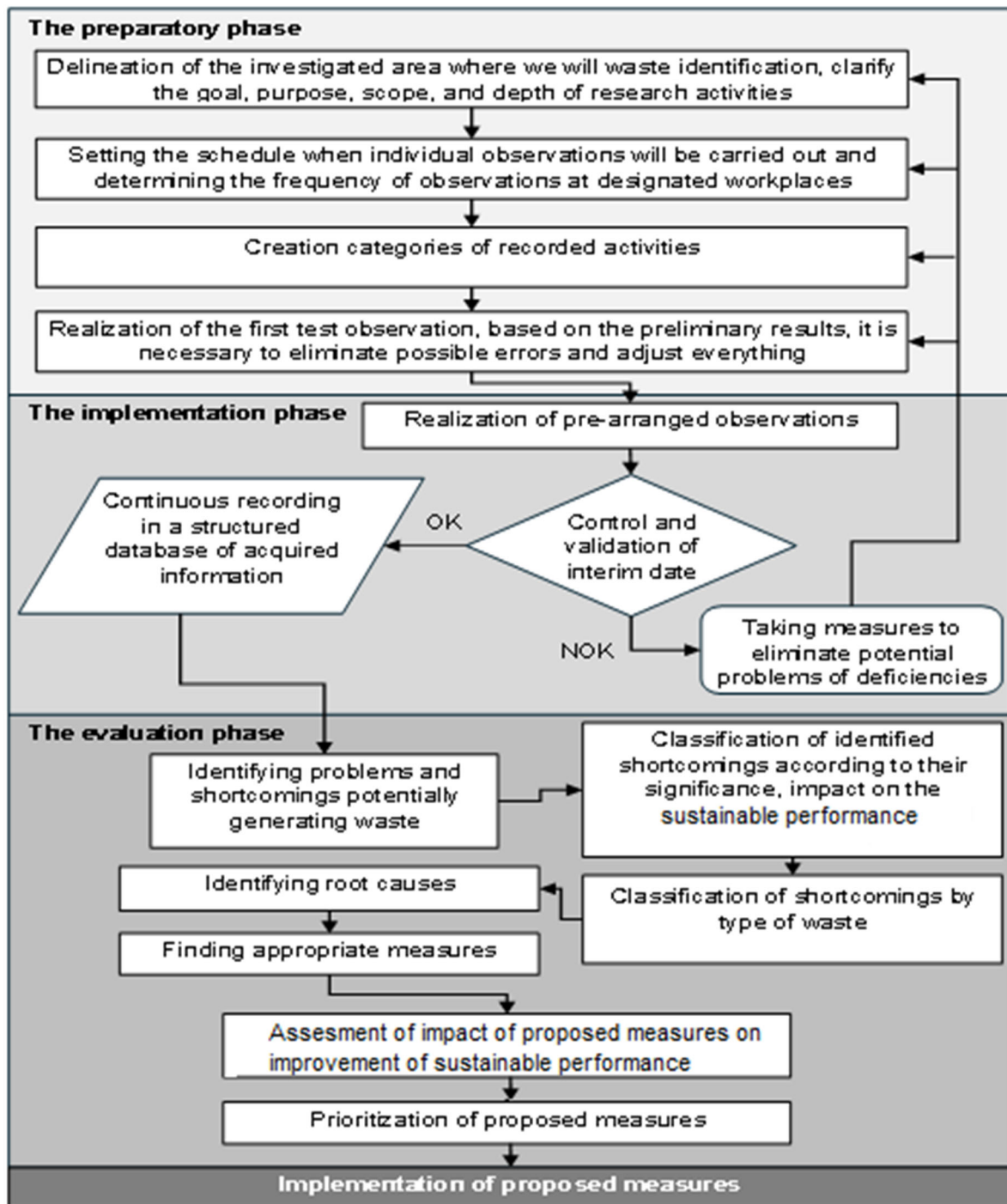
Fig. 5. Proposed methodology for utilization of lean principles in sustainable performance improvement

The methodology developed improves operational efficiency and highlights its positive effects on sustainability across three key dimensions: economic, environmental, and social. In terms of economics, eliminating waste leads to cost reduction and the effective use of resources, ensuring long-term sustainability. Removing non-value-added tasks ensures the optimal utilization of a highly skilled workforce, thereby boosting economic productivity. Quality management principles enhance resource allocation, resulting in higher efficiency and better order processing rates. The decrease in waste leads to both time and cost savings, further strengthening the economic sustainability of the processes.

From an environmental standpoint, the suggested strategies reduce the environmental impact of automotive aftersales procedures, aligning with the lean-green philosophy. Streamlining processes and waste reduction contribute to lower resource consumption and waste generation, promoting environmental sustainability. Time saved through process optimization directly translates to reduced input usage and decreased carbon emissions, promoting environmental responsibility.

Looking at it from a social angle, the methodology promotes transparency, standardization, and employee welfare, fostering a culture of continuous enhancement. Implementing this research methodology improves the social sustainability of service operations by emphasizing transparency and standardization. By focusing on eliminating waste from highly skilled labor, work efficiency is improved, and overwork rates are reduced, positively affecting the welfare of service advisors. Transparent processes and standardized tasks ensure compliance with legal working hours and breaks, promoting a healthy work-life balance and overall social well-being.

By adopting these principles, organizations can boost their competitiveness and progress towards sustainability objectives, aligning with broader societal and environmental priorities. Through highlighting these positive outcomes, the study showcases its contribution to overarching sustainability objectives, encompassing economic prosperity, environmental stewardship, and social welfare within the automotive aftersales sector.

6. Conclusion

In the current dynamic business landscape, characterized by sustainability pressures, labor shortages, and escalating input costs, efficiency, and continuous improvement are critical in the automotive aftersales industry. This paper has presented a methodology for utilizing lean principles in sustainable performance improvement to identify and eliminate waste in aftersales service processes, aligning with the demand for sustainability across economic, environmental, and social dimensions.

A case study of an automotive company's aftersales service processes has demonstrated the critical role of high-quality aftersales service in ensuring the competitiveness and long-term prosperity of the automotive industry. The study has shown that achieving service excellence necessitates the strict identification and elimination of waste and process shortcomings.

The methodology presented is divided into two key stages. The first stage involves the creation of a comprehensive process map, which defines sub-processes, key documents, software applications, personnel responsibilities, and causal links. The second stage is the strategic identification and addressing of barriers, waste, and deficiencies within the current state of processes. This is achieved by effectively linking these deficiencies within the process map to define their origins and impacts.

The resulting process map is the foundation for proposing actions to eliminate waste and shortcomings and achieve desired process states. The methodology's generalization, presented via a flowchart outlining successful improvement phases and sub-steps, ensures its scalability and adaptability for widespread application in industrial process improvement activities.

The detailed analysis of service processes presented in this paper demonstrates how the methodology enables organizations to navigate the turbulent business landscape, building both short-term efficiency gains and long-term sustainability and competitiveness.

In conclusion, this paper emphasizes the chief importance of continuous improvement and sustainability in automotive aftersales processes. Through the developed methodology, specific shortcomings have been identified and addressed, contributing substantively to economic, environmental, and social sustainability. To ensure the long-term viability and prosperity of the automotive industry, continued research and the implementation of sustainable practices must be pursued with constant effort. By adhering to these principles, organizations can enhance their competitiveness and progress towards broader sustainability objectives, making significant contributions to economic prosperity, environmental stewardship, and social welfare within the automotive aftersales sector and beyond.

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