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Original Article

Operations Management Model for Automotive Service Workshops in Peru: Service Level Improvement through Lean Manufacturing and SLP

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Abstract *- Latin America's automotive repair SME sector faces persistent operational challenges that hinder its efficiency and competitiveness. Prior studies have explored Lean methodol ogies and Systematic Layout Planning (SLP) in large-scale industries, leaving a gap in adapting these tools for smaller automotive workshops. The discrepancies above are sought to be solved through the formulation and verification of an integrated operations management model that combines the Lean Manufacturing approach and SLP. It applied the 5S technique, layout optimization, and process standardization to minimize movements and delays. The verification step showed substantial improvement in the service level from 84.91% to 95.00%, along with a 32.99% improvement in the diagnostic time. These results demonstrate that the model can enhance service quality and operational efficiency and contribute to the academic literature and practice by providing a model usable by SMEs. Further research should assess the sustainability of the model and the use of digital monitoring systems.*

Keywords – *Continuous improvement, Process optimization, Waste reduction, Workflow efficiency, Automotive service SMEs.*

1. Introduction

The aftermarket service workshop industry, particularly for Small and Medium-sized Enterprises (SMEs), is fundamental to the economy as a whole, particularly in Latin America and Peru. This industry contributes considerably to job creation and is important for maintaining transport and urban mobility. According to a report from the International Labour Organization, SMEs account for roughly 90% of all businesses and create over 50% of employment worldwide [1]. The automotive industry in Latin America has increased steadily, with the need for repair and maintenance services rising along with the number of automobiles in circulation [2]. Similarly, in Peru, the increasing number of motor vehicles has concurrently increased the demand for automotive repair services, resulting in the growth of automotive repair workshops [3]. However, a significant number of workshops face severe operational difficulties as constraints on the ability to render quality service.

The problems that an automobile repair workshop faces are multifaceted and intricate. One of the major concerns is the level of service quality, which is quite deplorable due to inefficiencies caused by operators' non-productive movements in poorly designed work areas [4]. The design deficiency reduces a firm's functional capabilities and leads to procrastination in locating critical repair items, which is made worse by the disorganization of the workshop [5]. Besides, rework on work orders because of an inadequate division of labor in repair service processes increases standard costs and lowers the quality of service as perceived by the customer [6]. These issues not only jeopardize the economic welfare of the workshops but also further deteriorate the service experience of customers, which may ultimately lead to the loss of workshop patronage because of disloyalty and distrust [1].

Solving these issues is important for enhancing the competitiveness and sustainability of automotive repair workshops. Applying methodologies like Systematic Layout Planning (SLP) and Lean Manufacturing enables effective optimization of workshop processes. The Lean methodology, which focuses on waste elimination and gradual and continuous improvement, has been effective across many industries, including automotive. Conversely, SLP facilitates better planning of workshop layouts towards efficiency, reducing travel distances and better arranging workspaces [4]. Adopting these methodologies would improve operational performance and customer satisfaction with reduced waiting times and improved service quality [3].

Despite the importance of these subjects, gaps remain in the literature regarding the use of certain Lean Manufacturing and SLP tools for small-to-medium enterprises' automotive repair workshops. The existing literature focuses primarily on larger-scale companies or industries, which creates a gap in adapting these methodologies in smaller workshops. This research seeks to fill this gap by proposing an operations management model for the repair workshops incorporating Lean Manufacturing tools such as 5S, Standardized Work, and SLP. The approach is novel in that it seeks to integrate the concepts to provide a practical model to SME automobile repair shops to enhance their efficiency and service quality. This study is unique from other studies in that it aims to put Lean methodologies into practice in an automotive repair workshop, which will greatly aid in operational restructuring research. This study not only aims to contribute to the literature but also provides practical means to enhance competitiveness in the operational standardization and enhancement of quality service delivery to customers.

2. Literature Review

2.1. Lean Service Methodology in Automotive Repair SMEs

The use of the Lean Service method in automotive repair workshops of Small and Medium-sized Enterprises (SMEs) has been examined by various researchers. Such methodology revolves around the aspects of waste removal and continuous enhancement. It is vital for the competitiveness of SMEs within the automotive industry. Hu et al. [7] state that implementing Lean practices can improve SMEs' operational effectiveness, which is very important in their case as they are resource-constrained. Also, Sahoo [8] points out that the use of Lean in automobile components manufacturing has been associated with less non-value-added activities, improving customer satisfaction and reducing operating expenses.

In contrast, Swarnakar and Vinodh [9] propose a Lean Six Sigma approach that has already been implemented in an automotive component manufacturing firm, arguing that the combination of Lean and Six Sigma concepts could be beneficial for Small and Medium Enterprises (SMEs) in the automobile repair industry. This business strategy not only pursues the reduction of expenditures but also seeks to improve the said quality, which is very important to stay competitive in an ever-changing market. Moreover, the research done by Dresch et al. [10] also points out that there are considerable gains for most small firms in applying Lean tools since these techniques tend to not only isolate inefficiencies but also instil a culture of proactive enhancement crucial for enduring success.

2.2. Work Standardization in Automotive Repair Workshops

At first, it may seem that the standardized work methodology stems from a single source, but this is not the case, as it has been highly researched in the field of process improvement concerning automotive repair workshops. The main goal of this methodology is to formulate consistent policies that enable a worker to accomplish work in a timely and proficient manner. As noted by Randhawa and Ahuja [11], work standardization enhances service quality but also lessens process variation, which is critical in any given work setting where accuracy and precision are needed. Also, Amaral et al. [12] mention that practicing standards in developing automotive products enables organizations to respond timely to market changes.

A study by Scharold [13] also suggests that standardizing Key Performance Indicators (KPIs) in automotive development can aid in performance assessment and facilitate the analysis of potential improvements. This is especially important for Small and Medium-sized Enterprises (SMEs), which tend to be resource-constrained and, therefore, unable to implement sophisticated quality management systems. This was further supported by Randhawa and Ahuja [14], who demonstrated that there is a significant enhancement of internal logistics processes in the automotive industry as a result of Standardized work and Plan-Do-Check-Act (PDCA) methodology being applied, which is later transferred to benefit repair shops.

2.3. Implementation of the 5S Methodology in Repair Workshops

The 5S system has effectively enhanced the efficiency of automotive repair workshops. As Bayo-Moriones et al. [15] suggest, implementing 5S in manufacturing plants improves operational performance, which I assume is equally applicable to automotive repair SMEs. Jiménez et al. [16] also extend the 5S system to 6S by incorporating occupational safety and claim that it is useful, especially in safety conscious workplaces.

Some emphasize other aspects of 5S. For example, Kanabar [17] notes that successful adoption of the system requires commitment from management and the participation of most employees, which can be difficult for SMEs. Nevertheless, reducing accidents and improving the work environment due to implementing 5S cannot be disputed. Furthermore, Randhawa and Ahuja argue that the 5S system not only increases operational efficiency but also enhances business excellence, which is crucial for the survival of SMEs in the automotive industry.

2.4. Systematic Layout Planning in Repair Workshops

Systematic layout planning is a methodology that can enhance the effectiveness of automotive repair workshops. This methodology entails structuring the workspace to eliminate unnecessary movements and optimizing workflow efficiency. Jaca et al. [18] point out that suitable layout plans can yield high productivity and customer satisfaction rates in manufacturing environments. This is useful for SMEs as they tend to work in confined spaces and need to utilize resources optimally.

Singh et al. [19] state that the concepts of layout planning for clinical laboratories may apply to automotive repair workshops, which are space restricted. Randhawa and Ahuja's

[20] research also showed that effective layout plans enable the adopting of other Lean approaches, such as 5S and Kaizen, and improve further operational performance. Hence, systematic layout planning is good practice and needs to be adopted to ensure the competitiveness of SMEs operating in the automotive industry.

2.5. The Kaizen Philosophy in Automotive Repair Workshops

Several Small and Medium Enterprises (SMEs) in the automotive repair industry have adopted the Kaizen philosophy, which focuses on continuous improvement to foster innovation and effectiveness. Waldhausen et al. [21] remark that applying Kaizen practices in surgical clinics has yielded better patient experience, which leads to the assumption that automotive workshops would benefit equally from these practices, as customer satisfaction is very important. In addition, Philipose et al. [22] suggest that organizing workspaces using the Kaizen methodology can improve service quality at a lower cost. Randhawa and Ahuja [23] emphasize that applying Kaizen can be a strategic business enabler for achieving excellence in manufacturing organizations, which is useful for automotive repair SMEs looking for competitive advantage. Yu et al. [24] argue that integrating Kaizen with other Lean improvement techniques may enhance continuous improvement gains. In conclusion, the Kaizen philosophy applies not only to automotive industry SMEs but also facilitates change towards operational efficiency and sustainable development.

3. Contribution

3.1. Proposed Model

Figure 1 showcases a model developed for an operation management strategy to improve efficiency within an automotive repair SME. The model incorporates Lean Manufacturing with Systematic Layout Planning (SLP) to enhance service quality while minimizing operational inefficiencies. The model was divided into the 5S methodology, layout design, and work process standardization. The first component that relied on the 5S methodology concerned the organization and cleanliness of the workplace by eliminating unnecessary movements and facilitating material search, which promoted the flow of daily activities. The second component, which was focused on SLP, enabled the examination and rearrangement of the physical layout of the workshop to make better use of space while minimizing travel times for workers. Finally, the third component was concerned with standardising key processes to ensure the consistency of actions and make it easier to train new personnel. In addition to correcting existing problems, the applied model was designed to encourage ongoing refinement through regular Kaizen events. This approach increased the workshops' capability to provide efficient, competitive services that satisfied customers; thus, long-term operational sustainability was ensured.

3.2. Model Components

The model being developed is based around a small and medium-sized enterprise focused on repairing vehicles in the automotive industry to improve servicing and address operational inefficiencies. This model applies Lean Manufacturing concepts and Systematic Layout Planning (SLP) methodology and aims to transform operations management into a resourceful activity within the repair shops. These philosophies are integrated to solve chronic issues of excessive travel distances, waiting times for materials, and non-standardized procedures, thus fostering an environment of continuous improvement. The figure below demonstrates the model designed with three fundamental parts that provide logic and a systems perspective at all model levels.

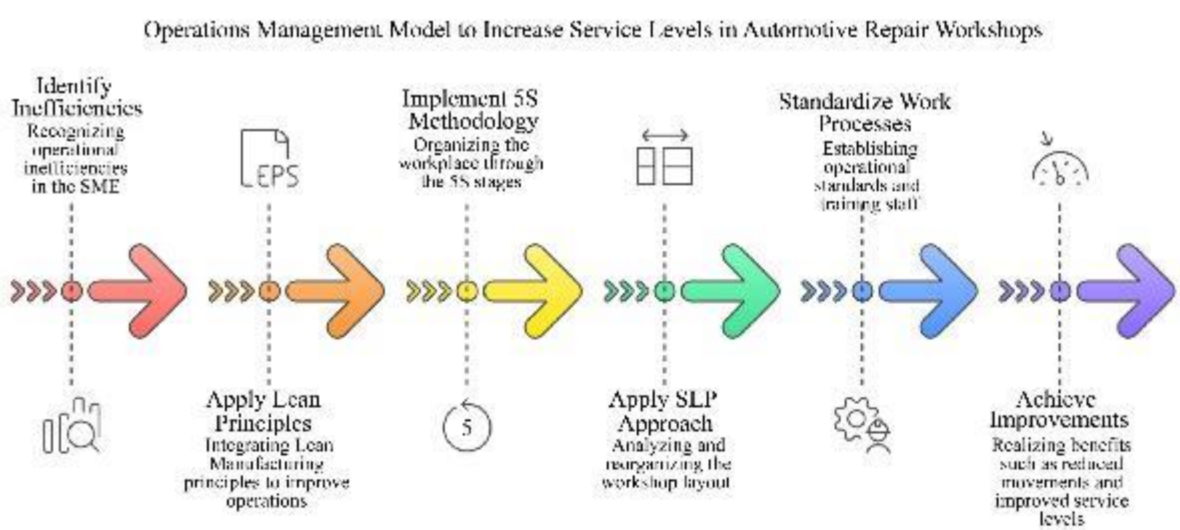

Fig. 1 Proposed model

3.2.1. Component 1: 5S Methodology

The 5S methodology was the initial stride toward achieving the model goal of developing a working environment that is clean, organized, and safe. This methodology was applied sequentially through five stages: Seiri or sorting, Seiton or set in order, Seiso or cleaning, Seiketsu or standardization, and Shitsuke or discipline. The preliminary audit determined needless components and specified their removal, thus diminishing unnecessary actions within the workshop. Afterwards, tools and materials were assigned locations to enable swift access and reduce time spent looking for supplies, followed by visual management systems

The cleaning procedure was simplified by integrating it as a routine process, and the workshop's look and operational safety were improved by removing possible hazards. The discipline instilled during the final phase ensured that the staff embraced a culture of continuous improvement. The standardization of these procedures provided sustainability over time with ease.

3.2.2. Component 2: Systematic Layout Planning (SLP)

The second component of the model concerned the physical reorganization of the workshop using the Systematic Layout Planning (SLP) technique. This technique permitted an understanding of the flow of materials, personnel, and processes within the given space so that travel times and operational costs could be lowered. The initial analysis involved the construction of a relational activity chart that shows the most common movements between the different working areas of the workshop. With a better understanding of relations between activities, a proposal for space reorganization was created to improve the use of available space and minimize excessive movements. The redesign enhanced the visibility and accessibility of workstations to enable effective supervision and coordination of activities. Moreover, particular areas for storing materials were defined, which improved inventory control and minimized material selection errors.

3.2.3. Component 3: Work Standardization

Work standardization, the last component in the model, aimed at ensuring that operational activities were carried out similarly and consistently.

A thorough analysis of processes was performed to determine Non-Value-Adding (NVA) steps, processes, or activities and develop standard operating procedures for every subtask. Staff members were trained and provided visual manuals to guarantee proper interpretation and application of the procedures. The definition of standard times allowed for improved operational planning by eliminating bottlenecks and enhancing flow. Compliance with standards was checked through regular audits to evaluate the fulfilment of standard requirements and the potential for improvement. In this process, the active participation of staff was crucial, allowing them to feel more responsible for the workshop's objectives and, hence, more committed to it.

3.2.4. Integration and Continuous Improvement

The implementation included continuous improvement processes driven by Kaizen events to integrate the three components. These events provided an opportunity at intervals to measure the model's performance and make changes as needed.

Integrating the 5S system, redesigning the layout, and standardizing the work processes greatly improved the service levels, which was observed by greater customer satisfaction and decreased financial losses due to the inefficiency of operations. The sequence of implementation of the model is provided in Figure 1, which supports the need for a comprehensive systematic approach to achieving durable improvement over a long period.

The model is useful in the existing body of knowledge in operations management in the automotive industry for providing a blueprint to repair shops that desire to enhance their business competitiveness by adopting Lean strategies.

3.3. Model Indicators

Operational efficiency and effectiveness measurement for improving service levels in automotive repair workshops were analysed through the performance of the operations management model integrating Lean tools and Systematic Layout Planning (SLP). This model made it possible to precisely control operations, identify inefficient processes in a timely manner, and refine them constantly.

The assimilation of Lean and SLP assisted in rearranging organizational space and work patterns by minimizing non-value-added activities and maximizing resource value. Such an approach enabled the use of deeper analysis for making decisions relating to enhancing service delivery, process stability, and competitiveness at automotive repair SMEs.

3.3.1. Search Time Percentage

This indicator measures the percentage of time spent searching for parts compared to the total operation time. Reducing search time improves overall efficiency and reduces delays in service delivery.

$$\text{Search Time (\%)} = \left(\frac{\text{Time spent searching}}{\text{Total operation time}}\right) \times 100$$

3.3.2. Diagnostic Time Percentage

This indicator tracks the proportion of time used for the diagnostic process relative to the total operation time. A reduction reflects streamlined diagnostics and enhances operational flow.

$$\text{Diagnostic Time (\%)} = \left(\frac{\text{Diagnostic time}}{\text{Total operation time}}\right) \times 100$$

3.3.3. Transfer Time Percentage

This indicator represents the percentage of time spent in transfers within the workshop. Lower values indicate a more efficient layout and reduce unnecessary movement.

$$\text{Transfer Time (\%)} = \left(\frac{\text{Transfer time}}{\text{Total operation time}}\right) \times 100$$

3.3.4. Service Level Percentage

This indicator evaluates the proportion of completed services compared to the total requested services. A higher percentage reflects improved service delivery and customer satisfaction.

$$\text{\% Service Level} = \left(\frac{\text{Successful Deliveries}}{\text{Total Deliveries}}\right) \times 100$$

4. Validation

4.1. Validation Scenario

The validation scenario was carried out in a case study within the automotive sector, specifically a Small and Medium-sized Enterprise (SME) located in Lima, with operations also in Arequipa, Peru. This company specializes in vehicle rental, repair, and maintenance services, including mobile workshops for corporate clients. The main facility in Lima accounted for 75.3% of its total last year. Its core services included preventive maintenance, corrective maintenance, and vehicle repair, the latter being the focus of this study. The case study faced challenges related to a low service level in the vehicle repair process, resulting in significant delivery delays and financial penalties. The initial diagnosis identified key issues such as unnecessary movements within the workshop, delays in locating repair materials, and non-standardized procedures, which directly affected its operational performance.

4.2. Initial Diagnosis

The diagnosis in the case study revealed that the low service level in the vehicle repair process was primarily associated with three key factors. The first factor was related to unproductive times, which accounted for 43.88% of the problem. This was caused by unnecessary movements within the workshop, representing 43.10%, and delays in locating repair materials, contributing 26.1%. The second factor, explaining 36.53% of the issue, was the rework of work orders caused by a lack of standardization and insufficient staff training, accounting for 21.70% of the total. Finally, the third factor was linked to other organizational issues, such as a shortage of dispatch personnel and the management of limited credit lines, representing 19.60% of the problem. These factors led to a technical gap of 10.90% compared to the sector's optimal service level, which should reach at least 95%, while the case study achieved only 84.91%. This situation resulted in annual financial losses of $393,973, equivalent to 2.19% of the projected revenue, due to delays in delivering repaired vehicles.

4.3. Validation Design

The proposed operations management model, integrating Lean tools and Systematic Layout Planning (SLP), was validated through a pilot process in a small automotive repair workshop. The validation spanned four months, focusing on enhancing service levels by reducing inefficiencies. The model had 3 key strategies: using 5S to assist in workplace order, optimizing workflow using SLP to reduce movement, and instituting standards that would aid in minimizing vehicle repair delays. The validation of the model was done from the "data evidential base," and it proved to be successful because, during the validation period, there was an improvement in most of the key indicators while the overall service level was increased to comply with the requirements, thus achieving effectiveness in operations and customer satisfaction.

The proposed one for the case study was better developed regarding the problematic aspects of the vehicle repair process. This model aimed to enhance service levels by applying Lean methodology combined with Systematic Layout Planning (SLP). While designing the solutions, the analysis of the gaps included finding root causes, choosing the relevant gap-closing tools, and employing ordered solutions to guarantee the expected value-checked outcomes. The next parts present breakdowns of each part of the proposed solution and the logic for their selection.

4.3.1. Root Cause Identification and Tool Selection

The first stage of articulation in the solution design process concentrated on understanding the reasons that caused a deficiency in vehicle servicing. This study identified three major problems: excessive walking within the workshop, slow retrieval processes for repair parts, and gaps in training. These issues hampered the effectiveness and quality of the operations.

In light of these challenges, three main strategies known to be effective in situations were incorporated: 5S, Systematic Layout Planning (SLP), and standardization of processes. Every strategy was made for a particular part of the problem to address all of them in operational enhancement.

4.3.2. Implementation of the 5S Methodology

The 5S methodology was put in place to enhance orderliness in the workplace while also tackling the issue of unnecessary expenditures. To begin with, an audit of the workshop was conducted, which uncovered neglected storage spaces and unsuitable processes. The five stages of the 5S methodology, which are Sort (Seiri), Set in Order (Seiton), Shine (Seiso), Standardize (Seiketsu), and Sustain (Shitsuke), were successively conducted within a period of 83 days.

During the Sort phase, any workspace items likely not to be put into use were captured and removed. While waiting for removal, relocation, or repair, items were tagged with red labels, which resulted in 70 items being either relocated or reorganized. The workspace moving towards the new ideal state was devoid of clutter, and the tall materials needed most were easily accessible.

In the Set in Order phase, the remaining items were organized by their order of usage. Using the criteria, materials were grouped and rearranged so that the optimal storage places could be assigned to them. The new storage locations placed in the logical order significantly reduced the time required to locate the materials, reducing repair time.

During the Shine phase, maintenance of orders and cleanliness was emphasized. Enhanced cleaning procedures and instructions were provided to personnel to ensure correct methodology implementation. The workshop was observed to be equipped with various graphics that showed the needed specifications.

The Standardize step was designed to routinize the changes accomplished in the prior steps. Training sessions were held for all employees to ensure they understood the new standards and procedures.

Subsequently, a culture of continuous improvement was created in the Sustain phase. Routine checks and other follow-up actions were planned to ensure compliance with the 5S rules and find other ways to improve the system.
As part of the classification and disposal of unnecessary items within the warehouse, the application of the red tag is shown in Figure 2. This is done in line with the 5S method, where obsolete or unused materials are tagged with red and are set aside for evaluation and removal. This process enhances organizational order and optimizes valuable operational space.

Fig. 2 Red tag application in warehouse

The 2S (Sort and Set in Order) method is applied in the warehouse, as shown in Figure 3. In the 'Before' picture, there is an untidy space containing randomly placed bits and pieces, which, in turn, is transformed into an ordered space with an improved storage system and subsequently enhanced accessibility and efficiency of the workspace in the 'After' picture.

Fig. 3 2S Implementation in warehouse organization

In the radar chart shown in Figure 4, the evaluation of the implementation of the 5S methodology is presented. Performance levels are measured and compared on a scale of (1S to 5S) pre and post-intervention, together with the target objective. After the 5S methodology intervention, results showed improvement post-implementation across the board but were especially notable in 2S and 4S, which denotes better organization, order, and standardization in the workplace.

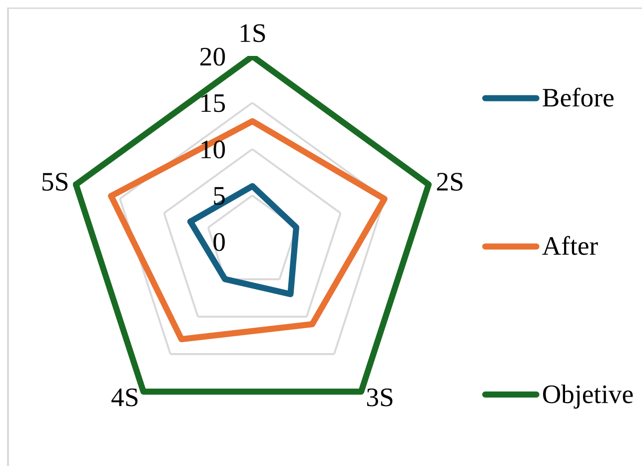

Fig. 4 5S Performance evaluation

4.3.3. Systematic Layout Planning (SLP)

The second part of the solution was the use of Systematic Layout Planning (SLP) for workshop layout optimization. Assessment of the existing layout suggested large gaps between key workstations, which resulted in excessive movement and time wastage.

In order to comprehend the flows between distinct zones of the workshop, a relational activity diagram was constructed. Considering these factors, travel distances and workflow efficiency were incorporated into the new layout design. Calculating the distance-effort matrix demonstrated that the total effort decreased from 110,083,500 kg-m to 100,660,500 kg-m, validating the new layout's claims.

The newly developed layout also aided in the free flow of vehicles through the various stages of the repair process, causing a reduction in the duration necessary for each stage and decreasing congestion.

Not only did these changes improve operational effectiveness, but they also increased the degree of safety and organization in the workplace. The optimized workshop layout designed through Systematic Layout Planning (SLP) is illustrated in Figure 5. To decrease distances, the redesign relocated crucial zones such as vehicle inspection, storing area, and workstations. Using SLP leads to an organized and productive workshop by increasing work efficiency and minimizing travel distances and unused space.

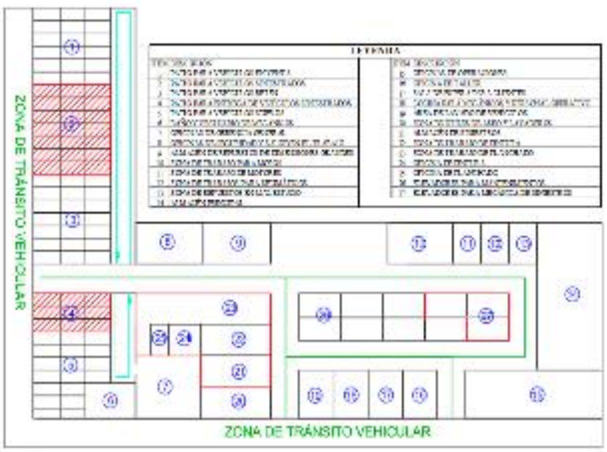

Fig. 5 Optimized automotive repair workshop layout with SLP

4.3.4. Work Standardization

The last focus of the solution was to work on the art of standardization so that key processes are performed consistently and efficiently. The diagnostic process was tagged for enhancement because it had the highest difference in execution times. A thorough time study determined the time a person should spend on each diagnostic activity. The findings showed that the average time spent on diagnosing would decrease from 4.77 hours to 3.20 hours if non-value-adding activities were removed and workflows enhanced.

A Standard Operating Procedure (SOP) manual was prepared to capture the standardized process. This manual provided detailed descriptions of each activity to eliminate ambiguity and ensure uniformity. Workshops were organized to train the staff on the new procedures and strongly stress the need to comply with the standards set forth.

As a follow-up to the efforts to establish standards, a follow-up was done using evaluation sheets. Supervisors conducted regular assessments to ensure compliance and provide feedback for continuous improvement. This approach not only reduced diagnostic times but also improved the accuracy and reliability of the process.

Applying the 5S methodology reduced search times and improved organization, while SLP optimized the layout and minimized unnecessary movements. Work standardization ensured consistent and efficient execution of diagnostic activities.

Figure 6 presents the standard work evaluation sheet because of the implementation the Lean tool: Standardized Work in the vehicle diagnosis process. It details key activities, duration, and compliance status, highlighting critical and significant activities with visual symbols to prioritize quality control and operator safety. The flowchart provides a clear sequence of tasks, ensuring process standardization and improving operational efficiency. The total time required to complete the process was 3.10 hours, achieving greater accuracy and reducing variability in operations.

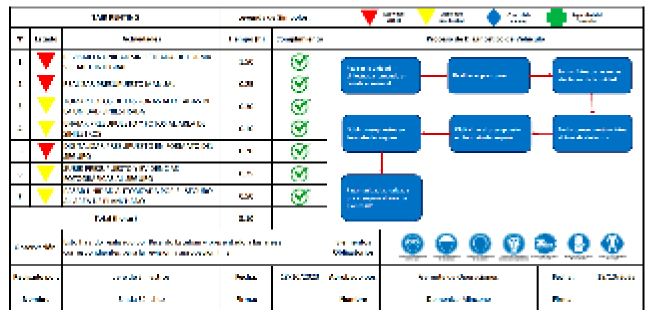

Fig. 6 Standard work evaluation sheet for the vehicle diagnosis process

4.4. Results

Table 1 compares key indicators before and after implementing the operations management model based on Lean tools and Systematic Layout Planning (SLP) in the case study, a small automotive repair workshop. The search time percentage was reduced from 19.84% to 16.42%, representing an improvement of 17.24%. Similarly, the diagnostic time percentage decreased from 4.82% to 3.23%, reflecting a 32.99% improvement. The transfer time percentage also showed a significant reduction, from 7.74% to 6.25%, achieving a 19.25% improvement. Finally, the service level increased from 84.91% to 95.00%, exceeding the expected industry standard with an improvement of 11.88%. These results highlight the effectiveness of the proposed model in optimizing operational processes and enhancing the workshop's overall performance.

5. Discussion

The implementation of Lean methodologies alongside Systematic Layout Planning (SLP) in Small and Medium-sized Enterprises (SMEs) has been previously discussed along with the outcomes of this study, and Hu et al. note that Lean SMEs, especially in resource-constrained settings, can yield significant operational improvements, which parallels the reduction of non-productive times examined within this study. In the same way, Randhawa and Ahuja proved that enhancing workplace organization and cleanliness with the 5S methodology equally improved safety and staff morale, which were major drivers in redesigning the automotive repair workshop in this study. Also, Jaca et al. presented cases where proper planning of workspace geometries improved materials flows and reduced transfer times, which this study achieved through the implementation of SLP. This study seeks to fill the existing gap in the literature addressing automotive repair workshops by incorporating the mentioned methodologies.

5.1. Study Limitations

Even though this study achieved favourable outcomes, it has a few shortcomings that should be acknowledged. First, the study was conducted in a single automotive SME based in Lima, making it impossible to extrapolate the results to the rest of the country or other industries. Also, the validation period of the model was only four months, which makes it impossible to evaluate the long-term effects of the refinements done to the model. Perhaps the most important limitation is using historical data and direct observation as the only methods to assess the performance, which is bound to present inaccuracies and biases in measuring the DOE.

Lastly, there are no provisions in the model for the use of digital technologies for the real-time control and supervision of the processes so that the operational productivity could be enhanced even more.

5.2. Practical Implications

This study offers findings that may benefit managers and practitioners in the automotive industry. The Lean and SLP model serves as a guiding tool towards better service delivery and decreased operational inefficiencies. Using 5S and standardization of work methods improves work organisation, enhancing productivity and workplace conditions. On the contrary, systematic layout planning illustrates the need to improve space productivity when resources are limited, better coordination of work activities and reduced transfer times between workstations is achieved. This investigation underlines the need to adopt strategies to achieve a culture of continuous improvement by engaging employees in the change search.

Table 1. Results of the pilot

No.	Indicator	As-Is	To-Be	Results	Variation (%)
1	Search Time Percentage	19.84%	16.00%	16.42%	-17.24%
2	Diagnostic Time Percentage	4.82%	3.00%	3.23%	-32.99%
3	Transfer Time Percentage	7.74%	6.00%	6.25%	-19.25%
4	Service Level Percentage	84.91%	96.00%	95.00%	11.88%

5.3. Future Works

Further studies ought to emphasize confirming the suggested model across various SMEs in several regions in order to expand its usability and evaluate its relevance in different operational settings. More research would help understand how the changes are sustained over time and how they influence competitiveness in business. In addition, using digital tools like real-time monitors and advanced analytics could strengthen the data-driven decision-making process and be a valuable addition. Incorporating Lean Manufacturing with other progressive approaches like Lean Six Sigma Could Yield better results for the automotive repair industry.

6. Conclusion

The implementation of Lean Manufacturing and Systematic Layout Planning (SLP) in the proposed integrated model led to substantial improvements in the operational performance of an automotive repair SME. In this case, unnecessary movements were minimized, key processes were simplified, and workshop layouts were optimized, which resulted in an increase in service levels from 84.91% to 95.00% and a 32.99% decrease in time spent on diagnostics. Applying 5S and standard work methods enhanced safety and organization, while SLP reduced travel time and improved transfer time percentage by 19.25%. This research mitigates a notable chance in the literature concerning the implementation of Lean and SLP methodologies in automotive repair SMEs, which have not been addressed in previous works. The model's value lies within offering a defined model to improve operational efficiency, reduce lead time, and increase customer satisfaction. Such models can be especially helpful for smaller workshops that strive to remain operational and compliant with industrial standards in a competitive business environment.

The scope of this study goes beyond the operational changes achieved. It offers a template for replication by SMEs flexible enough to fit different industries with comparable problems. Lean methodologies and spatial optimization techniques show how multiple tools must be used to solve operational inefficiencies. Other SMEs that desire to enhance service levels while decreasing operational expenditure can base their strategy on this approach. Further studies should investigate the implementation of this model in dissimilar SMEs located in various regions and sectors to test its thrust. The longitudinal studies could help elucidate the efficacy of the improvements over an extended period. Adding sophisticated digital technologies for real-time monitoring and the predictive analysis of the changes could strengthen the model's effectiveness while providing a sound basis for decision-making and fostering constant improvement.

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