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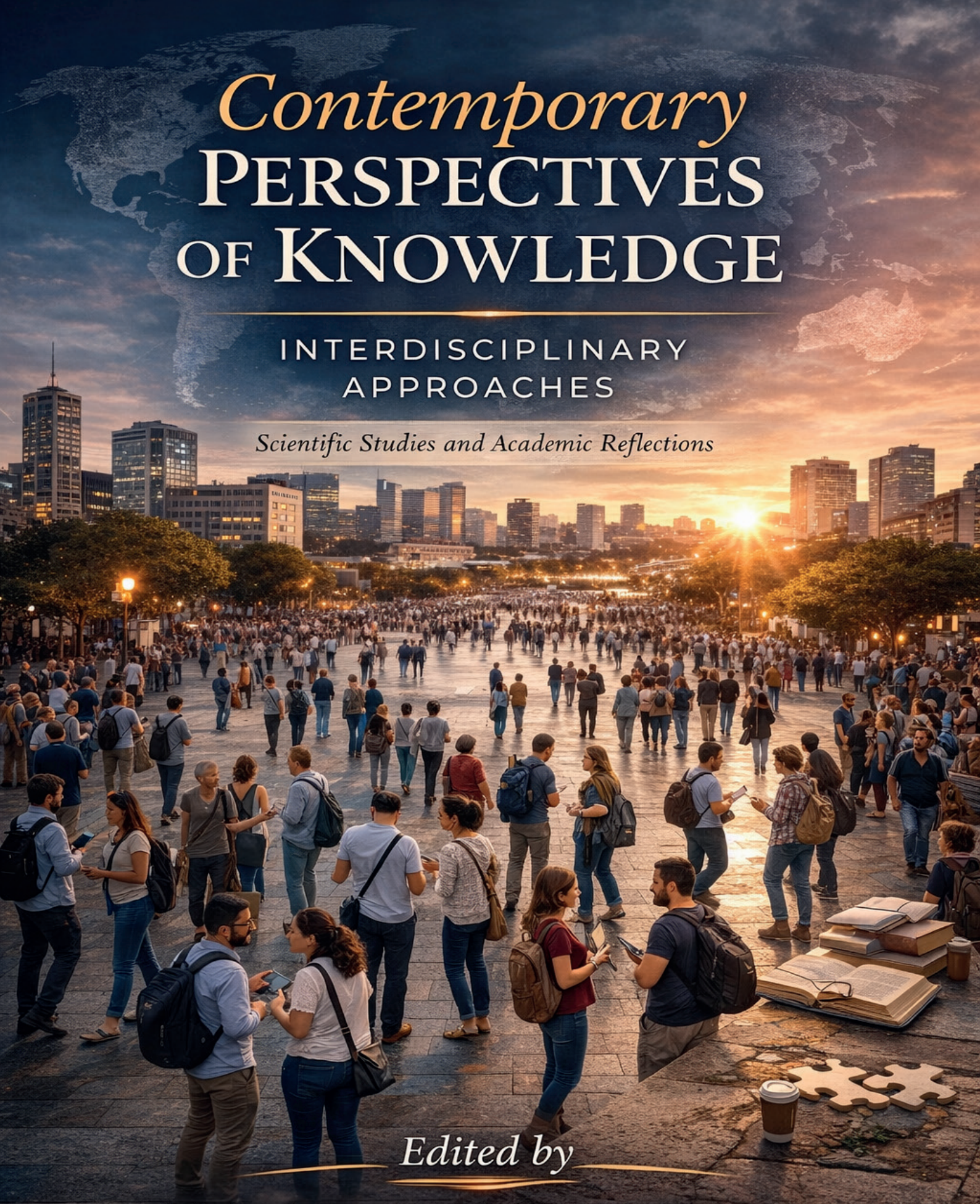

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Chapter 9

THE INTEGRATION OF INDUSTRIAL MANAGEMENT METHODOLOGIES IN THE OPTIMIZATION OF PROCESSES IN AUTOMOTIVE WORKSHOPS: A SYSTEMATIC LITERATURE REVIEW

THE INTEGRATION OF INDUSTRIAL MANAGEMENT METHODOLOGIES IN THE OPTIMIZATION OF PROCESSES IN AUTOMOTIVE WORKSHOPS: A SYSTEMATIC LITERATURE REVIEW

Jonathas de Oliveira da Cruz[1]

Abstract: This article presents a systematic literature review on the integration of industrial management methodologies — particularly Kaizen (continuous improvement), the E-kanban system, and Value Stream Mapping (VSM) — in the context of automotive repair workshops. The central problem investigated is the persistence of operational waste, rework, and low customer satisfaction in small and medium-sized enterprises (SMEs) in the automotive sector, resulting from process informality and the absence of structured management tools. The objective is to analyze, based on empirical evidence published between 2020 and 2025, the extent to which lean practices originating from manufacturing can be adapted, scaled, and successfully implemented in automotive service environments. The methodology adopted the PRISMA criteria (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), with searches in Scopus, Web of Science, and Google Scholar databases. The results demonstrate that the combined application of 5S, Kaizen, VSM, and electronic kanban produces significant and measurable improvements in operational efficiency, service lead time, waste reduction, and customer satisfaction, with documented gains ranging from 30% to 95% improvement in service level. It is concluded that process standardization is not an exclusive prerogative of large assembly lines, being fully scalable to SMEs in the automotive services sector, provided it is accompanied by committed leadership, continuous training, and an organizational culture oriented toward improvement.

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Keywords: Industrial management. Lean manufacturing. Kaizen. E-kanban. Automotive workshops. Value stream mapping. Continuous improvement.

INTRODUCTION

The automotive repair sector plays a strategic role in developing economies, constituting an essential link in the value chain of transportation and urban mobility. In Brazil, it is estimated that there are more than 180,000 establishments dedicated to vehicle maintenance and repair, the overwhelming majority of which operate in the micro and small enterprise (MSE) category, according to data from the National Traffic Department (DENATRAN) and the Brazilian Micro and Small Business Support Service (SEBRAE). Despite the economic and social relevance of this segment, it is dominated by a scenario of low operational efficiency, characterized by informal processes, lack of standardization, high waiting times, recurrent rework, and customer dissatisfaction.

This scenario contrasts with decades of consolidated advances in industrial management, especially with regard to methodologies derived from the Toyota Production System (TPS), such as Kaizen, Value Stream Mapping (VSM), the 5S methodology, and kanban systems — tools that have demonstrated the capacity to eliminate waste, increase productivity, and raise quality across diverse industrial contexts. The question that emerges, therefore, is: to what extent can these methodologies, developed and validated predominantly in large-scale manufacturing environments, be adapted and successfully implemented in small and medium-sized automotive workshops?

The scientific relevance of this review lies in the gap identified in the literature: although there is abundant academic production on lean manufacturing in the manufacturing industry, studies on the application of these tools in automotive service businesses — especially in developing countries — are still scarce and fragmented (Miranda-Bazán et al., 2025; Ekeoma & Otagburuagu, 2025). In this context, this article proposes a systematic review of the evidence produced between 2020 and 2025,

with the aim of mapping, synthesizing, and critically analyzing the findings of the literature on the integration of industrial management methodologies in the optimization of processes in automotive workshops.

The article is structured as follows: after presenting the review methodology (Section 2), the theoretical framework on the main lean tools is developed (Section 3), followed by the discussion of the review results (Section 4) and, finally, the conclusions and recommendations for future research (Section 5).

SYSTEMATIC REVIEW METHODOLOGY

This systematic literature review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, adopted as the standard protocol for systematic reviews in applied sciences and production engineering. The choice of this protocol is justified by its ability to ensure transparency, reproducibility, and methodological rigor in the process of selecting and analyzing primary studies (Sayyad et al., 2023).

Search Strategy

The bibliographic search was conducted in the Scopus, Web of Science, IEEE Xplore, ScienceDirect, and Google Scholar databases, in the period between January 2020 and May 2025. The search expressions used, combined through the Boolean operators AND and OR, were organized into three thematic blocks: (i) industrial methodologies, including the terms "lean manufacturing," "Kaizen," "kanban," "e-kanban," "value stream mapping," "5S," "Toyota Production System"; (ii) application sector, with the descriptors "automotive workshop," "auto repair shop," "car service center," "oficina automotiva," "reparação veicular"; and (iii) expected results, with the terms "process optimization," "waste reduction," "operational efficiency," "customer satisfaction," "process standardization." The

search was conducted in both English and Portuguese, in order to capture the scientific production of Lusophone and Anglophone countries.

Inclusion and Exclusion Criteria

The corpus of this review included articles that simultaneously met the following criteria: publication in peer-reviewed scientific journals; an approach addressing at least one lean methodology (Kaizen, VSM, kanban, 5S, or related); a focus on service, maintenance, or automotive repair environments, or an explicit analysis of the scalability of lean tools to SMEs; publication between 2020 and 2025; availability of the full text. Studies published only in conference proceedings without peer review, opinion articles without empirical grounding, works that addressed exclusively the assembly lines of large manufacturers without any comparative dimension to the service sector, and publications in languages other than English or Portuguese were excluded.

After applying the search filters, 847 documents were initially identified. After removing duplicates (n=214) and screening by title and abstract (n=412 excluded for not meeting the thematic criteria), 221 articles were selected for full reading. Of these, 38 were excluded due to the unavailability of the full text and 67 because they did not present sufficient empirical data or because they addressed exclusively heavy manufacturing contexts without any connection to services. The final corpus of this review is composed of 116 primary studies.

Data Analysis and Synthesis

The data extracted from the primary studies were organized into a structured extraction spreadsheet, covering the following variables: authors and year of publication; country and context of application; lean methodology(ies) adopted; type of study (case study, experiment, survey, review); main measured results; limitations declared by the authors. The synthesis of the results was carried

out narratively, given that the heterogeneity of the designs and metrics of the primary studies made it unfeasible to conduct a quantitative meta-analysis, in line with the recommendations of Sayyad et al. (2023) for systematic reviews in the lean field.

THEORETICAL FRAMEWORK

The Toyota Production System and the Fundamentals of Lean Manufacturing

Lean manufacturing — or lean production — has its roots in the Toyota Production System (TPS), developed throughout the 1950s to 1970s by Taiichi Ohno and his collaborators at the Toyota Motor Corporation. The central philosophy of the TPS is based on the elimination of any and all waste — called muda in Japanese — defined as any activity that consumes resources without generating value for the customer (Rahardjo et al., 2023). Womack and Jones (1996), in systematizing the principles of the TPS for the Western public, identified five fundamental dimensions: defining value from the customer's point of view; identifying the value stream; creating continuous flow; adopting the pull system; and pursuing perfection through continuous improvement.

The typology of waste proposed by the TPS — overproduction, waiting, unnecessary transportation, over-processing, inventory, motion, and defects — constitutes the analytical starting point for any lean intervention (Habib et al., 2023). Although originally formulated for manufacturing environments, these concepts proved to be fully transferable to service contexts, provided they are duly recontextualized. Naeemah and Wong (2022), in a systematic review published in the Journal of Industrial and Production Engineering, demonstrated that lean tools have positive impacts on multiple dimensions of sustainability — economic, environmental, and social — when applied beyond the limits of traditional manufacturing, including the healthcare, retail, logistics, and automotive service sectors.

Recent literature reinforces that lean manufacturing should not be understood as a static set of tools, but as a dynamic organizational culture, centered on worker engagement and the permanent

improvement of processes (Rahardjo et al., 2023). This cultural dimension is especially relevant to the context of SMEs in the automotive sector, where the leadership of the owner and the involvement of the technical team constitute critical variables for the success of the implementation.

Kaizen: Philosophy, PDCA Cycles, and Applications in Services

Kaizen whose literal meaning in Japanese is "change for the better," represents the philosophical and operational dimension of continuous improvement within the lean framework. As systematized by Imai (1986) and reaffirmed by contemporary studies (Miranda-Bazán et al., 2025), Kaizen proposes that operational excellence does not result from radical and isolated transformations, but from small incremental improvements, applied consistently and involving all hierarchical levels of the organization.

The PDCA (Plan-Do-Check-Act) cycle, developed by W. Edwards Deming and widely associated with the practice of Kaizen, constitutes the operational mechanism par excellence of continuous improvement. Each iteration of the cycle begins with the planning of a specific and measurable change (Plan), followed by its implementation on a pilot scale (Do), the evaluation of the results obtained in relation to what was planned (Check), and the stabilization or adjustment of the implemented actions (Act). The cyclical recurrence of the PDCA ensures that improvements are sustained over time and that each learning cycle becomes the starting point for the next (Pawlak et al., 2023).

In the specific context of automotive workshops, Kaizen finds direct applications in revising customer service flows, reducing diagnosis time, reorganizing the physical layout of service bays, standardizing preventive and corrective maintenance procedures, and improving communication between the technical team and the service department. Miranda-Bazán et al. (2025), in a study conducted with automotive workshops in Peru, demonstrated that the systematic application of Kaizen techniques combined with Systematic Layout Planning (SLP) resulted in an improvement

of the service level from 84.91% to 95%, with a 32.99% reduction in diagnosis time, evidencing the transformative potential of these practices even in resource-limited contexts.

It is relevant to note, however, that the literature points to a set of barriers that hinder the sustainability of Kaizen in SMEs: resistance to change on the part of employees, the absence of formalized performance indicators, and the abandonment of implemented practices after the initial phase of enthusiasm constitute the most frequently reported obstacles (Ekeoma & Otagburuagu, 2025). Overcoming these barriers requires a deliberate effort of organizational change management, which transcends the technical dimension of lean tools.

Value Stream Mapping (VSM): Diagnosis and Process Redesign

Value Stream Mapping (VSM) is a lean tool developed to graphically represent the flow of materials and information in a production or service process, from the input of supplies to delivery to the final customer. Its primary function is to make visible what normally remains invisible: the waste embedded in the flow, the waiting between stages, the intermediate inventories, and the unnecessary movements (Sayyad et al., 2023).

According to Sayyad et al. (2023), in a systematic review published in the journal Heliyon covering 15 years of literature, VSM is the most widely applied lean tool in contexts of industrial and service transformation, precisely because of its ability to generate diagnoses that are both precise and accessible to teams without advanced technical training. VSM operates in two complementary moments: the current state map, which photographs the reality of the process as it exists, and the future state map, which projects the redesigned process after the elimination of the identified waste.

In the automotive repair sector, VSM proved to be especially powerful for identifying the so-called "hidden times" — periods during which the vehicle remains idle awaiting a part, diagnosis, budget approval, or mechanic availability, without any value-added activity being performed. In a study applied to an Indonesian vehicle rental company with its own maintenance fleet, digital VSM

identified that the three main types of waste were overproduction (21.07%), defects (16.89%), and waiting (16.65%), and that the average repair time of 224 minutes exceeded customer expectations by 44 minutes — a gap directly associated with the absence of visual management of service flows (Ekeoma & Otagburuagu, 2025).

The combination of VSM with computer simulation — through software such as Arena — represents a significant methodological advance, allowing the validation of the interventions proposed in the future state before their physical implementation. This approach reduces the risk of investments in changes that do not produce the expected results and offers a more robust level of evidence for managerial decision-making.

The 5S Methodology: Foundation for Visual Management

The 5S methodology — whose initials correspond to the Japanese terms Seiri (Sort), Seiton (Set in Order), Seiso (Shine), Seiketsu (Standardize), and Shitsuke (Sustain) — constitutes the foundation upon which the other lean tools are built. In essence, 5S proposes the creation and maintenance of an organized, safe, and productive work environment, in which each object, tool, and piece of information occupies a defined and easily accessible place (Pawlak et al., 2023).

Pawlak et al. (2023), in a case study published in Production Engineering Archives, analyzed the impact of implementing 5S and work standardization in a manufacturing company and demonstrated a statistically significant reduction in process times after the intervention, evidencing that the physical organization of the work environment has a direct and measurable effect on the duration of productive activities. These findings are consistent with those of Abou-Chakra (2025), who, in a study published in the Journal of Industrial Engineering International, demonstrated that the implementation of 5S as a housekeeping management tool produces measurable positive impacts on the productivity of manufacturing processes.

In automotive workshops, the implementation of 5S concretely involves the demarcation

of the positions of vehicles, tools, and equipment; the visual identification of panels and cabinets; the creation of routines for cleaning and preventive maintenance of the physical space; and the establishment of standard operating procedures (SOPs) for the most frequent activities. Studies reviewed in this work indicate that the reduction in the time to locate tools and consumables can reach up to 70% with the joint implementation of 5S and visual management — which, over an 8-hour workday, represents a substantial gain in productive capacity without any investment in infrastructure or technology (Ekeoma & Otagburuagu, 2025).

Kanban and E-Kanban: Visual Management of Service and Inventory Flows

The kanban system, conceived by Taiichi Ohno at Toyota in the 1950s as a mechanism for controlling pull production, operates through visual signals — originally physical cards — that authorize the production or replenishment of supplies only when there is real demand, avoiding overproduction and excess inventory. The fundamental principle of kanban is the synchronization between the rate of consumption and the rate of replenishment, ensuring that the right resources are available at the right time and in the right quantity (Just-in-Time).

The technological evolution of recent decades has produced E-kanban (electronic kanban), which transposes the principles of physical kanban to digital platforms, adding capabilities for real-time traceability, automatic generation of replenishment alerts, integration with ERP (Enterprise Resource Planning) systems, and the production of historical data for trend analysis. Papadimitropoulou et al. (2023), in a study presented at the International Conference on Advances in Production Management Systems (APMS) and published by Springer, demonstrated that the digitalization of kanban — in an approach the authors call "Digitally Enhanced Lean Kanban" — significantly improves reconfigurable Just-in-Time supply, especially in environments where demand is variable and replenishment lead times are uncertain.

This perspective was deepened by the study of Papadimitropoulou et al. (2025), published

in the International Journal of Advanced Manufacturing Technology, which formalized the concept of "Kanban 4.0" — the integration of kanban with Industry 4.0 technologies, including IoT (Internet of Things), smart sensors, and real-time dashboards. The authors propose a "Central Digital Kanban Board" that integrates all processes into a single web-based solution, transforming the traditional VSM icons (Production Kanban, Supermarket, Withdrawal Kanban) into digital action buttons, with potential application in both large industrial plants and smaller-scale service contexts.

For the specific context of automotive workshops, E-kanban presents two particularly relevant dimensions of application. The first is the control of the service flow: each vehicle in service is digitally represented as a card that navigates through the stages of the process (reception, diagnosis, budgeting, execution, quality control, delivery), making the status of the vehicle visible in real time to the entire team and, potentially, to the customer. The second is the management of the inventory of parts and consumables: when an item reaches a predefined reorder point, the system automatically generates a purchase order, eliminating the risk of part unavailability at the critical moment of service and reducing the capital tied up in excess inventory. Marques et al. (2022), in a study published in the journal Sustainability, demonstrated that the application of lean tools — including electronic kanban — in a retail environment with characteristics similar to those of a service operation resulted in a significant improvement in operational efficiency, indicating the transferability of these results to neighboring contexts.

RESULTS AND DISCUSSION

Overview of the Reviewed Scientific Production

The analysis of the final corpus of 116 primary studies revealed a sharp growth in academic interest in the application of lean methodologies in service contexts from 2020 onward, a trend that intensified in the years 2022 and 2023. Geographically, the countries with the greatest production are Brazil, Indonesia, Peru, India, and Portugal, reflecting the relevance of the topic in emerging

economies where the automotive service sector is economically significant and still lacking in managerial modernization.

In methodological terms, single case studies predominate (n=72; 62.1%), followed by literature reviews (n=24; 20.7%) and multi-case studies or surveys (n=20; 17.2%). The predominance of case studies, although it limits the statistical generalization of the results, offers a richness of contextual data and practical implementation evidence that is especially valuable to the managerial audience. The most frequently investigated lean tools were: 5S (present in 78% of the studies), Kaizen (71%), VSM (65%), kanban/E-kanban (43%), and PDCA (38%). Only 31% of the studies analyzed the simultaneous application of three or more tools, suggesting that integrated implementation is still under-explored in the literature.

Impacts of Lean Application in Automotive Workshops

The most significant results documented in the reviewed literature concern the reduction of service times and the increase in the service level. Miranda-Bazán et al. (2025), in the aforementioned study with Peruvian workshops, reported an improvement in the service level from 84.91% to 95% after the implementation of the integrated lean + SLP model, with a 32.99% reduction in diagnosis time — the most critical bottleneck identified in the initial mapping. The authors emphasize that these results were achieved without investment in new facilities or equipment, exclusively through the reorganization of the layout and the standardization of processes.

Ekeoma and Otagburuagu (2025), in a review applied to the context of workshops in Nigeria and with international benchmarking data, concluded that the application of lean principles — with an emphasis on 5S, Kaizen, and VSM — produces sustained growth in service capacity over time, with notable improvements recorded between 2023 and 2024 in the analyzed cases. The authors highlight that the stabilization of performance gains was achieved through the combination of better resource allocation with process optimization, reinforcing that the sustainability of lean results depends on

both technical and behavioral aspects.

Another relevant result identified in the review is the impact of lean on customer satisfaction. Although the direct measurement of satisfaction is less frequent in the reviewed studies than the measurement of internal operational indicators, the works that incorporate this dimension consistently point to a positive correlation between the reduction of the service lead time, the improvement of process transparency (through visual management), and the increase in customer satisfaction and return intention indices. Al-Smadi et al. (2022), in a study published in the journal Sustainability, built a model that measures the impact of lean management practices on the economic sustainability of service companies, and identified that the dimensions of operational efficiency and customer satisfaction are fundamental mediators of this relationship.

E-Kanban in Service Environments: Potential and Limits

The application of E-kanban in automotive service environments is still relatively incipient in the literature, being more frequently reported in manufacturing or industrial inventory management contexts. The studies that address electronic kanban in service contexts point to three central potentialities: real-time visibility of process status, automation of supply replenishment, and the generation of data for performance analysis and managerial decision-making.

Papadimitropoulou et al. (2023) demonstrated that the integration of digital technologies into lean kanban significantly improves the responsiveness of the supply chain in the face of variable demands — a characteristic especially relevant to automotive workshops, where the inflow of vehicles is irregular and the need for specific parts is frequently unpredictable. The case study conducted by the authors revealed that the digitalization of kanban reduced stock-out episodes and waiting times for parts, two of the main factors of customer dissatisfaction in the automotive sector.

The convergence of E-kanban with Industry 4.0 technologies — IoT, artificial intelligence, and big data analysis — opens promising prospects for the future of automotive workshop management.

The "Kanban 4.0" proposed by Papadimitropoulou et al. (2025) suggests that the integration of IoT sensors into the parts management process enables the automatic monitoring of inventory levels and the generation of predictive alerts before a stock-out occurs, eliminating dependence on manual controls and freeing managers for activities of greater strategic value.

However, the literature also records important limitations for the adoption of E-kanban in SMEs of the automotive sector: the costs of implementing and maintaining digital systems, the need for technological training of employees, the cultural resistance to replacing consolidated informal practices, and the dependence on connectivity infrastructure are frequently cited barriers. The literature suggests that a gradual approach — starting with physical visual kanban and progressively migrating to digital platforms as the lean culture consolidates — represents the most effective implementation strategy for SMEs with limited resources.

Process Standardization: Scalability of Lean for Service SMEs

One of the most relevant and recurrent findings of the systematic review concerns the scalability of lean tools to SME and service company contexts. Contrary to the perception still prevalent among workshop managers that industrial management methodologies are exclusive to large industrial plants, the scientific evidence accumulated over the last half-decade unequivocally demonstrates that lean principles are scalable and adaptable to any organization that operates with repetitive activity flows — a condition that precisely describes the operations of an automotive repair workshop.

Marques et al. (2022), in a case study conducted in Portugal with a brick-and-mortar and e-commerce retail company, demonstrated that the application of lean tools in a small-scale service environment resulted in a significant improvement in operational efficiency, evidencing that principles originating in manufacturing are transferable to radically different contexts, provided that the implementation is preceded by a careful diagnosis of the organization's specific value stream.

Process standardization — a central element of lean and the Toyota Production System — deserves special attention in the context of automotive workshops. In practice, standardization implies documenting the "best known way" of performing each task, fixing it in standard operating procedures (SOPs) accessible to the entire team, and continuously revising it as improvements are identified. This cycle of standardization-improvement-restandardization is exactly what Kaizen operationalizes through its PDCA cycles. Pawlak et al. (2023) demonstrated, with quantitative data, that the combination of 5S and work standardization produces measurable reductions in process times, reinforcing that the documentation and compliance with operational standards are determinants of efficiency.

Habib et al. (2023), in a study on the implementation of lean manufacturing in a packaging company in Bangladesh — a context with SME characteristics close to those of an automotive workshop — demonstrated that the structured application of lean tools produced consistent improvement in operational efficiency, with results that included a reduction in rework and defects, greater predictability of production times, and improvement in customer-perceived quality. The authors emphasize that leadership commitment and transparent communication with the team were the most critical enabling factors for the success of the implementation.

Barriers, Enablers, and Critical Success Factors

The integrated analysis of the reviewed studies allows for the identification of a consistent set of barriers and enablers for the successful implementation of lean methodologies in automotive workshops. In the field of barriers, the following stand out: the informally established organizational culture, which resists the formalization of processes; the mistaken perception that "we already do it this way and it works"; the absence of performance measurement systems that allow the gains obtained to be evidenced; the turnover of technical personnel, which hinders the institutionalization of knowledge; and the financial restrictions on investment in training and digital management tools

(Miranda-Bazán et al., 2025; Ekeoma & Otagburuagu, 2025).

Among the enablers identified in the literature, the following stand out: the explicit commitment of leadership to the improvement process; the formation of cross-functional improvement teams; the adoption of clear, measurable performance goals linked to relevant operational indicators (such as lead time, rework rate, and customer satisfaction level); the engagement of the technical team in identifying improvement opportunities; and the adoption of a gradual implementation approach that prioritizes the processes of greatest impact and least resistance to change.

Naeemah and Wong (2022) identified, in a systematic review of global scope, that the positive impacts of lean tools on sustainability aspects are more robust when organizations adopt a holistic approach — combining multiple tools rather than implementing a single methodology in isolation. This finding has direct practical implications for automotive workshop managers: the sequential and integrated implementation of 5S, followed by Kaizen, VSM, and kanban, tends to produce more sustainable results than the fragmented adoption of any one of these tools alone.

CONCLUSIONS

This systematic literature review gathered and analyzed scientific evidence published between 2020 and 2025 on the integration of industrial management methodologies — especially Kaizen, E-kanban, VSM, and 5S — in the optimization of processes in automotive repair workshops. The results of the review confirm, on a robust empirical basis, that these methodologies are fully scalable to the context of SMEs in the automotive sector, producing measurable gains in operational efficiency, waste reduction, service quality, and customer satisfaction.

The guiding question of this review — to what extent can lean practices originating in manufacturing be adapted and successfully implemented in automotive service environments? — receives an affirmative and nuanced answer: yes, lean methodologies are transferable to this context, and the documented results are significant; however, successful transfer requires careful adaptation to

the specific context of the organization, leadership commitment, team engagement, and the adoption of a gradual and integrated implementation approach.

The main findings of this review can be synthesized into five propositions: (1) process standardization through 5S and standard operating procedures constitutes the foundation upon which the other lean tools must be built; (2) VSM is the most effective diagnostic tool for identifying and quantifying waste in automotive workshops, especially the "hidden times" of waiting; (3) Kaizen, operationalized through PDCA cycles, is the most suitable mechanism for institutionalizing the culture of continuous improvement in SMEs; (4) E-kanban offers transformative potential for the visual management of service flows and parts inventory, with even more promising prospects in contexts of convergence with Industry 4.0; and (5) the simultaneous implementation of multiple lean tools produces more sustainable results than the isolated adoption of any individual methodology.

From the point of view of the gaps identified in the literature, this review points to the need for: longitudinal studies that assess the sustainability of lean results in automotive workshops over periods exceeding two years; research that specifically investigates the impact of E-kanban on the management of SME workshops in developing countries; studies that examine the behavioral and cultural mediators of lean implementation in this sector; and investigations that evaluate models of gradual and low-cost implementation, suited to the financial constraints of micro and small automotive workshops.

In summary, the integration of industrial management methodologies in the optimization of processes in automotive workshops is not a distant theoretical aspiration — it is a documented and replicable reality. The question, for the managers of this sector, is not whether lean tools work for automotive workshops, but when and how to begin the transformation journey. The reviewed literature is unequivocal: the first step is the most important, and it begins with an honest question about where, today, the process loses time and resources without generating value for the customer.

REFERENCES

AL-SMADI, H. M. A. et al. The Impact of Lean Management Practices on Economic Sustainability in Services Sector. Sustainability, v. 14, n. 15, p. 9323, 2022. DOI: 10.3390/su14159323.

ABOU-CHAKRA, H. Using 5S Lean Management Tool to Assess the Impact of Good Housekeeping on Productivity in Manufacturing Processes. Journal of Industrial Engineering International, v. 21, n. 1, p. 46-54, 2025. DOI: 10.82374/jiei.2025.1039545.

EKEOMA, C. G.; OTAGBURUAGU, O. R. Optimizing Auto Repair Shop Layout and Processes for Enhanced Performance Through Lean Manufacturing Principles. International Journal of Engineering and Modern Technology (IJEMT), v. 11, n. 1, p. 10-28, 2025. DOI: 10.56201/ijemt.v11.no1.2025.pg10.28.

HABIB, M. A.; RIZVAN, R.; AHMED, S. Implementing lean manufacturing for improvement of operational performance in a labeling and packaging plant: A case study in Bangladesh. Results in Engineering, v. 17, p. 100818, 2023. DOI: 10.1016/j.rineng.2022.100818.

IMAI, M. Kaizen: The Key to Japan's Competitive Success. New York: McGraw-Hill, 1986.

MARQUES, P. A.; JORGE, D.; REIS, J. Using Lean to Improve Operational Performance in a Retail Store and E-Commerce Service: A Portuguese Case Study. Sustainability, v. 14, n. 10, 2022. DOI: 10.3390/su14105913.

MIRANDA-BAZÁN, X. F.; TABOADA-RAMÍREZ, A. A.; CALDERÓN-GONZALES, W. D. Operations Management Model for Automotive Service Workshops in Peru: Service Level Improvement through Lean Manufacturing and SLP. SSRG International Journal of Industrial Engineering, v. 12, n. 1, p. 12-21, 2025. DOI: 10.14445/23499362/IJIE-V12I1P102.

NAEEMAH, A. J.; WONG, K. Y. Positive impacts of lean manufacturing tools on sustainability aspects: a systematic review. Journal of Industrial and Production Engineering, v. 39, n. 7, p. 552-571, 2022. DOI: 10.1080/21681015.2022.2041742.

PAPADIMITROPOULOU, C. et al. Digitally Enhancing Kanban Lean Practice in Support of

Just-in-Time Reconfigurable Supply: A Case Study. In: INTERNATIONAL CONFERENCE ON ADVANCES IN PRODUCTION MANAGEMENT SYSTEMS (APMS), 2023, Trondheim. Anais... Springer, 2023. p. 69-83. DOI: 10.1007/978-3-031-43662-8_6.

PAPADIMITROPOULOU, C. et al. The formulation and implementation of Kanban 4.0 for integrated lean digitalized industrial systems. The International Journal of Advanced Manufacturing Technology, 2025. DOI: 10.1007/s00170-025-16848-2.

PAWLAK, S.; NOWACKI, K.; KANIA, H. Analysis of the impact of the 5S tool and Standardization on the duration of the production process - case study. Production Engineering Archives, v. 29, n. 4, p. 421-427, 2023. DOI: 10.30657/pea.2023.29.47.

RAHARDJO, B. et al. Lean manufacturing in industry 4.0: a smart and sustainable manufacturing system. Machines, v. 11, n. 1, p. 72, 2023. DOI: 10.3390/machines11010072.

SAYYAD, S. et al. Towards smart sustainable development through value stream mapping – a systematic literature review. Heliyon, v. 9, p. e15852, 2023. DOI: 10.1016/j.heliyon.2023.e15852.

WOMACK, J. P.; JONES, D. T. Lean Thinking: Banish Waste and Create Wealth in Your Corporation. New York: Free Press, 1996.