

Article

Unlocking Lean Potential in SME Logistics and Supply Chains: A Study on Commitment, Tools, and Outcomes Through a Systematic Review and Survey Analysis

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Abstract

Background: Lean management is widely recognized as an effective approach to process optimization. However, its implementation in Small and Medium Enterprises (SMEs), particularly in logistics and supply chain contexts, remains challenging. Resource constraints and inconsistent organizational commitment often hinder effective implementation. This study examines Lean adoption, leadership commitment, and implementation outcomes in SME logistics and supply chains. **Methods:** A mixed-methods design was used, combining a systematic literature review guided by PRISMA and PEO frameworks, followed by a structured survey. A total of 780 valid responses from SME professionals were analyzed using descriptive statistics, correlation, regression, and reliability assessment. **Results:** Top and middle management commitment was identified as a significant predictor of perceived Lean implementation success. A measurable gap was observed between respondents' knowledge of Lean methods and their practical application, emphasizing the importance of strategic alignment, organizational culture, and employee engagement. **Conclusions:** The findings provide practical implications for strengthening Lean implementation in SMEs through enhanced managerial commitment and employee involvement. The study is limited by its focus on SMEs from a single country and the literature retrieved from one bibliographic database. Future research should include broader geographical coverage, multiple databases, and objective organizational performance indicators.

Keywords: logistics; supply chain; lean; SME; PRISMA; PEO framework



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1. Introduction

While Lean management has traditionally been associated with manufacturing systems, its application in logistics and supply chain management has received increasing importance, primarily with SMEs—Small and Medium Enterprises. SMEs frequently face challenges such as excess inventory, limited coordination and inefficient material flow across supply chain activities [1], all of which directly impact logistics performance. Lean principles provide a structured framework to address the inefficiencies through waste reduction, continuous improvement, and process standardization. In the context of logistics, Lean practices have been shown to improve process flow, reduce delays, and enhance operational efficiency [2].

Within logistics and supply chain ecosystems, Lean management contributes to the reduction of operational inefficiencies, minimizing inventory related waste, improving material flow, and enhancing coordination across interconnected organizational processes. Earlier studies have demonstrated that Lean-oriented logistics practices can improve delivery performance, operational responsiveness, and supply chain resilience particularly in resource-bound SME environments. Additionally, the integration of Lean principles into logistics and supply chain activities represent an increasingly important research area in both operational management and organizational research.

More recent research emphasizes that Lean implementation yields greater performance improvements when applied across supply chain processes instead of isolated operational areas. For instance, ref. [3] demonstrates that Lean-oriented supply chain practices significantly enhance organizational performance, highlighting their importance across logistics activities. Despite these developments, empirical research that focuses specifically on Lean implementation within SME logistics and supply chain systems, particularly in relation to practical application and leadership commitment, remains limited. SMEs represent a particularly important research context because they frequently operate under constrained managerial structures, reduced organizational capacity, and resource limitations, all of which may significantly influence the implementation and sustenance of Lean systems. The contribution of this study lies in examining the relationship between leadership commitment, perceived implementation success, and Lean tool utilization within SME supply chain and logistic environments. Furthermore, it builds upon prior work by the authors [4], extending the analysis from general Lean implementation to a more focused and detailed examination of Lean in logistics and supply chain processes.

Despite growing interest, limited empirical research links Lean implementation in SMEs to logistics and supply chain performance outcomes. This study aims to explore the influence of integrating Lean management practices into the logistics, supply chain and operations of Small and Medium Enterprises to achieve process optimization, reduce waste, enhance efficiency, and identify the critical factors that can impact successful implementation. To address the issues, it combines a structured literature review with empirical survey analysis in order to examine both theoretical and practical dimensions of Lean implementation within SME logistics and supply chain systems. By analyzing real-world information collected from companies and authentic literature on Lean exposure, involvement, perceived outcomes, etc., the focus is to identify both barriers and enablers for effective Lean transformation. Additionally, it also aims to evaluate the long-term benefits of Lean adoption and practices that can be directly linked to resilience and adaptability in dynamic environments.

The following research questions are formulated to structure a basis for this study:

RQ1—What barriers and challenges can prevent the effective adoption and implementation of Lean in Small and Medium Enterprises?

RQ2—What type of Lean tools and practices are accepted and frequently used within the SMEs?

RQ3—What are the perceived organizational benefits of Lean implementation in SMEs?

RQ4—How Lean principles can contribute to the adaptability and resilience of logistics and supply chain systems within SMEs?

To address these objectives, the study adopts a mixed-methods research design, which combines a systematic literature review with an empirical survey analysis. The systematic literature review was conducted following a predefined review protocol, including established search strategies, eligibility criteria, and reporting of transparent study selection procedures in accordance with the PRISMA 2020 guidelines. The review was complemented by a structured questionnaire survey targeting professionals working in

SMEs. A total of 780 valid responses were collected and analyzed using descriptive statistics, correlation analysis, regression analysis and reliability assessment. The achieved sample sizes for multivariate statistical analyses, providing a robust empirical basis for examining the relationships between Lean implementation, management commitment, and operational outcomes within SME logistics and supply chain ecosystems. The literature search strategy, eligibility criteria, and screening procedure were established before commencing the review. Following the database search, title and abstract screening was performed independently by the research team using predefined inclusion and exclusion criteria. Subsequently, a full-text eligibility assessment was carried out collaboratively by the authors, and any disagreements regarding study inclusion were resolved through discussion until consensus was achieved. Each included study was also qualitatively appraised with respect to its methodological transparency, research design, relevance to the research objectives and contribution to understanding Lean implementation within SMEs. Because the included studies comprise heterogeneous conceptual qualitative, quantitative and mixed-methods research, a formal certainty of evidence framework was not considered appropriate. Instead, the qualitative appraisal informed the synthesis and interpretation of the reviewed evidence.

Lean is technically a value-centric methodology, established to eliminate non-value-adding activities and improve process efficiency [5]. Traditionally embedded in manufacturing, Lean has gradually expanded into sectors such as healthcare, construction, and the service industry, depicting its utility in improving organizational workflows, processes, and customer satisfaction [6]. Core Lean methods such as JIT (Just-in-Time), Kanban, and TPM (Total Productive Maintenance) are frequently used to reduce inefficiencies and increase responsiveness to growing market needs.

SMEs, as critical contributors to global economies, play a key role in employment, innovation, and regional development. Despite their economic significance and value, SMEs often lack the technological and financial resources necessary to implement Lean practices at scale [7]. Many SMEs face difficulties in standardizing operations, automating processes, and sustaining long-term initiatives due to limited capital investment and a shortage of skilled workers [1]. These factors highlight the need for tailored Lean strategies that can address the unique operational conditions of SMEs while safeguarding alignment with broader supply chain objectives. Supply chain management is a critical domain that involves information, resources, and the coordination of the flow of goods from suppliers to end consumers [8]. The integration of Lean and supply chain can foster agility, operational efficiency, and waste reduction, eventually contributing to resilience and improved management [9]. Nevertheless, the successful implementation of Lean in SME supply chains requires addressing challenges related to demand variability, supplier collaboration, and logistics and transportation coordination.

The remainder of this paper is followed by the Materials and Methods, which includes the research design, data collection and analytical approach. Then it outlines the findings from systematic literature review, which are then followed by the findings from primary data analysis. All these elements are thoroughly connected in Section 4, whereas Section 5 concludes the study by summarizing key contributions, limitations, and future directions.

2. Materials and Methods

Methodology

This study employs a mixed-methods research design, combining both qualitative and quantitative approaches to investigate the role and effectiveness of Lean in Small and Medium Enterprises. A mixed-methods research design integrating qualitative and quantitative approaches was applied in order to examine Lean implementation and operational

outcomes within SMEs. The methodological framework combines a systematic literature review guided by PRISMA principles and the PEO framework along with a survey analysis.

A well-structured questionnaire served as the central research instrument, alongside the literature analyzed for the systematic review. This questionnaire was carefully constructed to elicit responses across multiple dimensions of Lean implementation, including knowledge, application, perceived outcomes, and organizational context. It was formulated to collect both open- and closed-ended questions, enabling numerical assessment as well as contextual insights.

The shortlisted study sample comprised 780 respondents closely affiliated with SMEs, including subordinates, team leaders/middle managers, and senior managers. This baseline dataset of 780 valid responses was derived from a total of 800 distributed questionnaires. Twenty returned questionnaires were excluded due to incomplete responses or logical inconsistencies, resulting in a final response rate of 97.5%. The survey employed a purposive nonprobability sampling approach targeting professionals with direct experience in Lean implementation within SMEs operating in Hungary, representing diverse sectors including services and manufacturing, reflecting the sectoral diversity of our study for Lean adoption within the SME landscape. Consequently, the final sample reflects the accessible study population and was considered sufficient for the descriptive, comparative, and regression-based analyses conducted in this research. Although the approach may limit the generalizability of the findings, it ensured the inclusion of complete and consistent responses suitable for the purpose of the analysis.

Data was collected via a comprehensive questionnaire, distributed digitally. It included a variety of Likert-scale questions; open-ended items; percent-based responses; multiple selections of responses for variables like benefits, risk, challenges, Lean methods, communication channels, etc. Prior to full execution, the research instrument underwent a pilot test to refine question clarity, structure, and relevance. This helped ensure usability and comprehension for a wide range of respondents.

Table 1 summarizes the operationalization of the principal constructs examined in this study. The questionnaire combined multiple question formats to capture both quantitative and qualitative information. Closed-ended multiple-choice questions were primarily used to collect demographic information and factual organizational characteristics. Five-point Likert-scale items measured respondents' perceptions of Lean implementation, management commitment, employee engagement, and implementation outcomes. In addition, open-ended questions were included to allow respondents to provide qualitative comments and practical observations, which were reviewed to support the interpretation of the quantitative findings.

Prior to the main data collection, the questionnaire was pilot-tested using a small group of 6 SME professionals representing the target population. The objective of the pilot study was to evaluate the clarity, logical structure, and comprehensibility of the questionnaire items, as well as the estimated completion time. Based on participant feedback, several questions were reworded to improve clarity and reduce ambiguity, minor modifications were made to the ordering of selected questions to improve the logical flow of the survey, and explanatory wording was added where necessary. No substantial changes were required to the underlying measurement constructs or the analytical framework.

Data analysis was conducted using Microsoft Excel 365 and IBM SPSS v23.0. Excel was primarily utilized for data preparation, descriptive statistics, visualization, and index calculations, whereas IBM SPSS was employed for inferential statistical procedures including correlation analysis, reliability testing, and multiple regression modeling. The internal consistency reliability was evaluated using Cronbach's alpha for constructs associated with Likert-scale questions in the questionnaire. The reliability assessment was carried out in

IBM SPSS using the sample of 780 valid responses. This sample size substantially exceeds commonly recommended minimum sample sizes for multivariate statistical analyses and survey-based organizational research. According to [10], larger sample sizes improve the stability of parameter estimates and increase the reliability of regression-based analyses. Furthermore, considering the number of variables included in the regression models, the achieved sample size provides sufficient statistical power for detecting meaningful relationships among the investigated constructs. While the initial portions of the instrument utilized categorical checklists to profile organizational demographics, subsequent evaluation items relied on ordinal 1–6 Likert-scale questions where 1 represents complete disagreement and 6 represents complete agreement. Instead of evaluating the survey as an undifferentiated instrument, items were operationally aggregated into theoretically grounded two distinct constructs to ensure analytical rigor.

1. Stakeholder and leadership commitment: This construct groups five distinct items that track vertical alignment and active role modeling across involvement and commitment of organizational hierarchies: senior management, middle management, blue collar/manual worker, white collar, and senior management example setting. This construct yielded a Cronbach's alpha of 0.871, signaling excellent internal consistency well above the standard academic benchmark of $\alpha \geq 0.70$.
2. Process maturity and operational transparency: This construct evaluates structural execution capabilities by combining core operational process indicators such as sufficiency of devoted training time, awareness of planned implementation, appropriate level of involvement, and data driven problem solving. This construct achieved a Cronbach's alpha of 0.760, establishing acceptable internal reliability for multivariate application.

Table 1. Operationalization of the survey instrument.

Survey Component	Objective	Question Type	Measurement/Analysis
Demographic characteristics	Describe the respondent profile (e.g., company size, position, industry, experience)	Multiple-choice	Descriptive statistics
Lean knowledge and awareness	Assess respondents' familiarity with Lean concepts and tools	Multiple-choice and Likert-scale	Frequency analysis and descriptive statistics
Lean implementation practices	Measure the extent to which Lean methods are applied within the organization	Likert-scale	Descriptive statistics, regression analysis, correlation analysis
Management commitment	Evaluate perceived support of top and middle management for Lean implementation	Likert-scale	Reliability analysis (Cronbach's α), regression analysis
Employee engagement	Assess employee participation in Lean initiatives	Likert-scale	Correlation and regression analysis
Perceived implementation outcomes	Evaluate respondents' perceptions of operational improvements resulting from Lean implementation	Likert-scale	Regression analysis and descriptive statistics
Challenges and additional observations	Collect respondents' experiences and recommendations regarding Lean implementation	Open-ended questions	Qualitative thematic review to support interpretation of quantitative findings

This multilayered approach allowed for both nuanced interpretation and broad pattern recognition across variables.

The following techniques were included but not limited to:

- Descriptive statistics to determine means, distribution, mid points, median and standard deviation;
- Cross tabulation to identify relationships between different variables;
- Frequency Analysis of different variables;
- Regression and comparative analysis to explore predictive trends.

The systematic literature review was conducted in accordance with the PRISMA 2020 reporting guidelines. Before the search was initiated, the eligibility criteria, search terms, database, time frame, document type, language restrictions and screening steps were identified. The main purpose of the review was to identify studies examining the relationship between Lean management, SMEs, logistics and supply chain systems.

The literature review is also structured around the PEO framework, which is a structured approach that is beneficial for formulating and categorizing keywords—particularly for the systematic reviews and qualitative studies. It further facilitates the development of a search query that is used to search for relevant literature in the databases. The following keywords were identified and segmented based on the PEO framework in Table 2.

Table 2. Keyword classification based on PEO Framework. Source—Author’s own creation.

Population	Exposure	Outcome
Supply Chain Management	Lean Management	Optimization
Operations	Lean Six Sigma	Process improvement
Small and Medium Enterprises	Lean thinking	Efficiency
	Continuous Improvement	Cost reduction
		Survey
		Customer Satisfaction

The literature search strategy was developed jointly by the authors. Following the database search, title and abstract screening was conducted independently by the authors using the predefined eligibility criteria. Full-text assessment was subsequently performed by the research team, and any disagreements regarding study inclusion were resolved through discussion until consensus was reached.

The search query or string was formulated with the facilitation of PEO framework and used in the SCOPUS database for data extraction. Scopus was selected due to its broad coverage of peer reviewed academic journals and articles across management, logistics, operations, and supply chain research domains.

(“Supply Chain Management” OR “Small and Medium Enterprises” OR “Operations”) AND (“Lean Management” OR “Lean thinking” OR “Continuous Improvement” OR “Lean Six Sigma”) AND (“Optimization” OR “Process Improvement” OR “Efficiency” OR “Cost Reduction” OR “Survey” OR “Customer Satisfaction”).

The literature review was conducted and reported in accordance with the PRISMA 2020 guidelines. The review protocol specified the research objectives, search strategy, eligibility criteria, screening procedure, and study selection process prior to data collection. PRISMA was used to ensure a transparent, systematic, and reproducible review process (PRISMA Checklist, see Table S1 in Supplementary Materials). Although the review protocol was not formally preregistered, the search strategy, inclusion criteria, exclusion criteria, and screening procedures were established before the literature search was conducted and were applied consistently throughout the review process. The eligibility criteria were

defined prior to screening. Studies were included if they addressed Lean management, SMEs, logistics, supply chain management, implementation practices, organizational performance, or related operational outcomes. Studies were excluded if they lacked relevance to the research questions, focused exclusively on large enterprises, addressed unrelated management concepts, or did not provide sufficient methodological or empirical content.

Database-level filters, including publication year, language, document type, and subject area restrictions, were applied during the identification phase. These records were therefore removed before manual screening and are reported separately in the PRISMA flow diagram. Manual screening was subsequently conducted through title and abstract review, followed by full-text eligibility assessment using predefined inclusion and exclusion criteria.

The screening process was conducted in two stages. First, titles and abstracts were reviewed against the predefined inclusion and exclusion criteria. Second, full-text assessment was performed for the remaining studies to determine their relevance to the objectives of this review with respect to methodological transparency, relevance to the research questions, research design, and publication quality. Screening decisions were conducted consistently according to the established criteria focusing on Lean management, SMEs, logistics, supply chain management, implementation factors, and organizational outcomes. To guarantee an exceptional standard of academic rigor, empirical reliability and data transparency, the final sample of 42 screened sources was strictly audited against the SCImago Journal Rank—SJR—and Clarivate Journal Citation Reports—JCR—tracking metrics. Of the 42 included items, 26 studies (62%) are published in premier top-tier Q1 journals, and 7 studies (16.7%) are positioned in Q2 journals. This indicates that 78.7% of the selected evidence base is anchored within elite, high-impact international publishing channels, including core operations, logistics and industrial frameworks. To prevent high tier selection bias and ensure comprehensive operational coverage, the remaining narrow portion of the dataset incorporates specialized sector-specific journals, 5 in Q3 and 1 in Q4. There was one that tracked industrial trade and 2 peer-reviewed academic monographs from leading publishers (Springer and Routledge). The selective integration of these practical, localized economic case studies is methodologically vital as they provide critical information regarding raw Lean-management hurdles and execution gaps.

In the eligibility phase, the full texts of the remaining articles were assessed. Exclusions at this stage were focused on documented reasons including insufficient connection to Lean implementation, lack of logistics and supply chain focus, absence of SME relevance or insufficient methodological relevance. The final set of studies was then included in the qualitative synthesis.

As reflected in Figure 1, the PRISMA flow diagram distinguishes between automated database filtering and manual screening decisions. Database filters were duly applied during the identification phase, whereas title/abstract and full-text assessment were conducted manually during the screening and eligibility phases. Reasons for exclusion were documented at the full-text eligibility stage.

Given the heterogeneous nature of the selected studies, a formal risk-of-bias tool was not applied. Nevertheless, the methodological quality of the studies was considered during the full-text assessment. Particular attention was given to the clarity of research objectives, methodological transparency, relevance to the research questions, and the adequacy of the reported findings. Studies with insufficient relevance or methodological detail were excluded during the eligibility assessment phase.

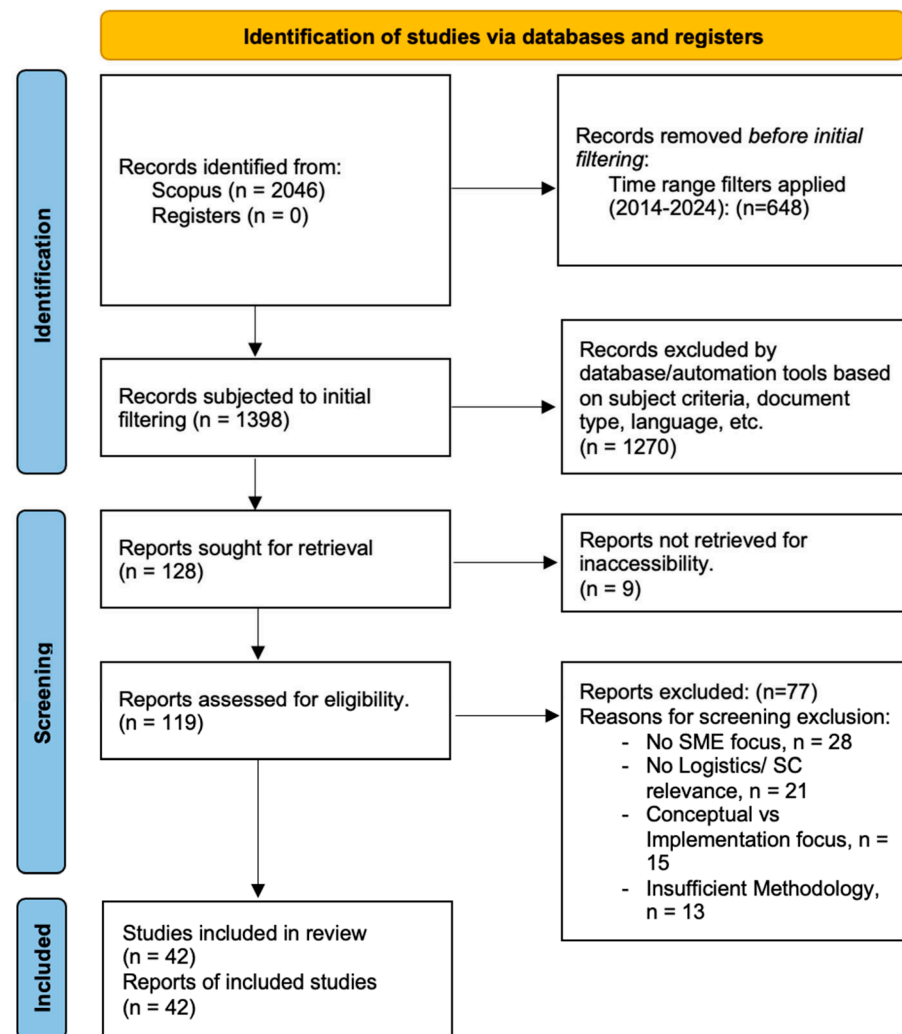


Figure 1. SLR (Systematic Literature Review) selection based on PRISMA framework, Source—Author's own creation.

The initial search yielded 2046 articles, which were further excluded or included in accordance with the PRISMA guidelines. The inclusion criteria for the period were applied at the beginning, limiting the articles to the 10-year period from 2014 to 2024 to ensure the latest trends and information were collected. This resulted in a reduction in the total count of articles to 1398. This step narrows search results by applying specific criteria to eliminate irrelevant material. Certain database and automated filtering was applied, resulting in the exclusion of 1270 records to obtain literature aligned with supply chains, SMEs, and Lean. This brought down the number of articles further to 128, of which 9 could not be retrieved due to full-text-platform unavailability. The procedure was then followed by a thorough title and abstract screening, where every article was screened focusing on its title and abstract. The final step of PRISMA reflected the in-depth analysis of each article and paper. A total of 77 reports were excluded based on the lack of SME focus, no logistics relevance, a gap of conceptual vs. implementation focus, and insufficient methodology. These significant benchmarks were the links between Lean, SMEs, logistics and supply chains. This inclusion procedure further confirmed the total of 42 articles finalized for the systematic review.

Several limitations associated with the review process should be acknowledged. First, the literature search was conducted using a single database, which may have excluded potentially relevant studies indexed elsewhere. Second, the review focused on English-

language publications and selected document types, which may have limited coverage. Third, the qualitative nature of the synthesis introduces a degree of interpretive judgment during study selection and analysis. These limitations should be considered when interpreting the findings.

3. Results

3.1. Thematic Analysis of Systematic Literature Review

One of the most widely accepted process improvement methodologies is Lean Management, proven to be an effective tool for organizations striving to maximize efficiency. Initially developed in the automotive industry, specifically at Toyota, Lean has evolved into a quite versatile methodology, extending its influence within several sectors and industries. The emphasis here is to dive deep into how Lean impacts Small and Medium Enterprises (SMEs), with a particular focus on supply chain and logistics. With its strong application to waste reduction, value creation, and efficiency, Lean is perceived as essential for SMEs that often operate with limited resources and need to enhance operations to remain competitive. Studies have highlighted that Lean has enabled the SMEs to improve quality, eliminate waste, enhance resilience, and minimize costs in fluctuating market conditions [11].

The implementation of lean management has demonstrated remarkable adaptability across industries such as manufacturing, healthcare, services, supply chain, and logistics, with each sector tailoring and refining Lean tools to address its specific operational challenges. In the manufacturing sector, Lean tools such as Total Productive Maintenance (TPM), Kaizen, and the use of various KPIs have been widely applied to reduce the production cycle times, promote continuous process improvements, and eliminate bottlenecks [12]. Research has indicated that the incorporation of TPM and Kaizen has significantly enhanced machine efficiency, lowered downtime, and fostered a culture of continuous improvement within the production lines. Additionally, the Lean approach has been found to facilitate agile decision-making by providing real-time data for performance metrics and levels of productivity, allowing SMEs to reach optimum efficiency [12].

Table 3 provides a structured synthesis of the 42 studies retained after the PRISMA screening process and used to inform the conceptual development of the study.

Table 3. Summary of studies included in the literature review.

No.	Study/ Journal Rank	Context/Industry	Methodology	Main Lean Focus	Key Insight Relevant to This Study
1.	[1] Q1	Family SMEs	Process mining study	Non-value-added activity reduction	SMEs face challenges identifying and removing waste.
2.	[2] Q1	Engineering services	Case study	Waste identification	Waste mapping remains central to Lean implementation.
3.	[3] Q1	Service/Manufacturing	Empirical survey	Lean–green supply chains	Lean practices contribute to operational performance improvements.
4.	[5] Q1	Service/Manufacturing	Empirical study	Leadership and team effectiveness	Leadership values strongly influence Lean team performance.
5.	[6] Q3	Direct-selling logistics	Case study	Logistics optimization	Lean improves logistics process efficiency.

Table 3. Cont.

No.	Study/ Journal Rank	Context/Industry	Methodology	Main Lean Focus	Key Insight Relevant to This Study
6.	[7] Q4	Fishery	Case study	Lean Six Sigma DMADV	Structured improvement methods enhance procurement performance.
7.	[8] Q1	Service/Manufacturing	Empirical study	Operational excellence	Lean contributes to sustainability and operational performance.
8.	[9] Q1	Manufacturing supply chains	Empirical survey	Supplier improvement priorities	Continuous improvement expectations extend across supply networks.
9.	[11] Q1	Aviation	Empirical study	Lean implementation status	Strategic commitment is necessary for sustainable Lean adoption.
10.	[12] Q1	Production systems	Framework development	KPI management	Performance indicators support continuous improvement.
11.	[13] Q2	Offshore engineering operations	Case study	Process optimization	Lean methods reduce process inefficiencies and improve workflow performance.
12.	[14] Q2	Service/Manufacturing	Fuzzy logic assessment	Lean activity prioritization	SMEs differ in adoption and perceived importance of Lean activities.
13.	[15] Trade	Education services	Case study	TQM success factors	Leadership commitment influences quality improvement outcomes.
14.	[16] Q3	Service/Manufacturing	Case study	OEE and performance improvement	Measurement systems support operational improvement initiatives.
15.	[17] Q2	Service/Manufacturing	Literature-based analysis	Lean Six Sigma and Industry 4.0 barriers	Resource limitations hinder digital–Lean integration.
16.	[18] Q1	Service/Manufacturing	Empirical survey	TQM and innovation	Organizational practices influence innovation capability.
17.	[19] Book	Cross-sector	Conceptual	Lean management	Lean success depends on organizational culture and leadership.
18.	[20] Q1	Operations	Conceptual framework	Lean and ergonomics integration	Human-centered implementation supports operational effectiveness.
19.	[21] Q1	Tourism management	Case study	Lean strategic management	Lean concepts can be transferred beyond manufacturing environments.
20.	[22] Q1	Engine manufacturing	Case study	Lean implementation	Process standardization supports productivity improvement.
21.	[23] Q1	Service/Manufacturing	Empirical study	Lean culture and capabilities	Lean culture supports long-term organizational development.

Table 3. Cont.

No.	Study/ Journal Rank	Context/Industry	Methodology	Main Lean Focus	Key Insight Relevant to This Study
22.	[24] Q1	Maintenance services	Measurement framework	Lean implementation assessment	Lean maturity requires systematic evaluation mechanisms.
23.	[25] Q1	Healthcare supply chains	Empirical study	Lean supply chains	Leadership and stakeholder support affect implementation success.
24.	[26] Q1	Manufacturing	Conceptual/ empirical	Lean and Industry 4.0 integration	Digital readiness influences Lean transformation outcomes.
25.	[27] Q1	Service/Manufacturing	Case study	Learning organization	Organizational learning supports continuous improvement.
26.	[28] Q2	Manufacturing	Case study	Lean Six Sigma	Waste reduction improves operational efficiency.
27.	[29] Q1	SMEs	Empirical survey	TQM deployment	Management systems support profitability and performance.
28.	[30] Q1	Service/Manufacturing	Framework study	Lean and ERP integration	Technology can facilitate process improvement efforts.
29.	[31] Q1	SMEs	Empirical study	Organizational learning	Learning capability influences process improvement success.
30.	[32] Q2	Manufacturing	Case study	Lean production	Lean positively affects operational performance.
31.	[33] Q1	Construction	Empirical study	Proactive management	Coordination improves supply chain performance.
32.	[34] Q1	Service/Manufacturing	Conceptual review	Error management	Organizational learning from failures supports improvement.
33.	[35] Book	Cross-sector organizations	Edited volume	Lean management	Lean implementation requires organizational alignment.
34.	[36] Q1	Remanufacturing	Empirical study	Lean barriers and benefits	Implementation obstacles remain common despite benefits.
35.	[37] Q3	Automotive manufacturing	Framework/case study	Lean Six Sigma	Structured improvement enhances competitiveness.
36.	[38] Q2	Kitchenware manufacturing	Case study	Lean and energy efficiency	Lean can support both efficiency and sustainability objectives.
37.	[39] Q3	Ocean freight logistics	Case study	Value stream mapping	VSM identifies inefficiencies in logistics operations.
38.	[40] Q1	Public sector operations	Empirical study	Lean practices and performance	Lean practices correlate with improved organizational outcomes.
39.	[41] Q1	Service/Manufacturing	Framework study	Lean Six Sigma 4.0 barriers	Resource and capability constraints hinder implementation.

Table 3. *Cont.*

No.	Study/ Journal Rank	Context/Industry	Methodology	Main Lean Focus	Key Insight Relevant to This Study
40.	[42] Q3	Multi-sector review	Systematic review	Six Sigma applications	Continuous improvement methods produce performance gains.
41.	[43] Q2	Manufacturing	Case study	Lean Six Sigma tools	Practical tool deployment improves process performance.
42.	[44] Q1	Road transportation and logistics	Methodological study	Lean transportation	Lean principles improve transportation efficiency and routing performance.

Moreover, the service sector is also witnessing extensive adoption of Lean tools such as 5S, Just-in-Time (JIT), and continuous flow, which have played a critical role in enhancing process efficiency, customer satisfaction, and overall service delivery [31]. SMEs operating in the service industry benefit from Lean practices by eliminating bottlenecks, unnecessary steps, streamlining workflows, and ensuring quicker response time to customers. Studies have highlighted that Lean serves not only as a tool for improving efficiency but also as a catalyst for establishing dynamic capabilities, ensuring that SMEs become more agile and adaptable to the fluctuations in market conditions [23]. If the aspect of supply chain and logistics is considered, this area is also benefiting from Lean methodologies, specifically in optimizing transportation routes and reducing operational costs. The application of these principles in road transportation in general has led to notable improvements in time management, fuel conservation, and efficiency [44].

It is important to note how the percentage of validations is calculated and understood in Tables 4–6. These percentages show how frequently a specific tool, success factor, or limitation/challenge appeared across our final selection of 42 articles. Because a single study or article often discusses and validates more than one Lean tool or success factor at the same time, these categories are not mutually exclusive. Therefore, the total sum of these percentages across the tables is not meant to add up to exactly 100%. Instead, this approach allows us to look at each variable or factor independently to see how prominently it features on its own within the existing SME logistics literature.

Table 4. Lean tools—SLR. Source—Author’s own creation.

Lean Tools and Key Features			
Lean Tool	Key Feature	Validation from Literature	% of Validations
Value Stream Mapping	Visualizes and improves the entire process flow	High	30%
5S	Enhances workplace organization	High	25%
Kaizen	Promotes continuous improvement	High	20%
Kanban	Improves inventory and workflow efficiency	Medium–High	18%
Total Productive Maintenance	Maintains equipment efficiency	Medium–High	15%
Just-in-Time	Reduces inventory waste	Medium	12%
Standardized Work	Ensures consistency and quality	Medium	10%
Root Cause Analysis	Identifies and resolves root problems	Medium	8%

Table 5. Success Factors—SLR. Source—Author’s own creation.

Critical Success Factors for Lean Implementation			
Success Factor	Description	Importance Level	% of Validations
Leadership	Emphasized as the most crucial factor	High	32%
Continuous Improvement	Key element for sustainability in Lean processes	High	28%
Stakeholder Engagement	Crucial for collaborative practices	Moderate–High	20%
Employee Training	Necessary to bridge skill gaps	Moderate–High	15%
Technology Integration	Facilitates smoother Lean transitions	Moderate	12%

Table 6. Challenges—SLR. Source—Author’s own creation.

Challenges in Lean Implementation			
Challenge	Description	Significance Level	% of Validations
Limited Resources	Insufficient financial, human, and technological resources	High	28%
Lack of Skilled Workforce	Limited expertise in Lean principles and tools	High	25%
High Demand Variability	Demand fluctuations causing inefficiencies in supply chains	High	20%
Limited Digitalization	Challenges in integrating technologies such as ERP and IoT	High	15%
Economic Constraints	Pressure for immediate cost reduction limiting long-term Lean adoption	High	12%

Percentages reflect the independent frequency rate ($Vp = [Nv/42] \times 100\%$) across the 42 final included papers and are non-mutually exclusive. As mentioned in Table 4, Lean tools such as 5S and Value Stream Mapping have been instrumental in identifying issues and inefficiencies in the supply chain, leading to improved delivery times and better inventory management [44]. Also, SMEs that have implemented Kanban and JIT systems have reduced inventory holding costs while ensuring a continuous supply of materials, thereby fostering overall efficiency [36]. In the healthcare sector, Lean management has also been successfully integrated into medical supply chains and hospital management systems, contributing towards improved resource utilization, stronger supplier coordination, and better demand forecasting. Research has suggested that Lean tools are playing a pivotal role in optimizing patient care services and cost reductions by ensuring a smooth and efficient flow of medical supplies, along with minimizing wastes [25].

Table 5 shows a clear picture of the critical success factors that are reflected by the review of literature. Percentages reflect independent frequency occurrence within the paper pool. Despite the advantages, the positive implementation of Lean management is dependent on several critical factors. One of the most crucial elements is leadership commitment, where strong leadership is critical for driving Lean adoption and sustaining the improvement initiatives over time [20]. Research suggests that leaders must create a supportive organizational culture that can encourage employees to participate in Lean practices actively. In the absence of this factor, the motivation to adopt and sustain Lean initiatives tends to diminish, leading to unsuccessful implementation. Then, it can be observed from data that employee training and engagement also play a pivotal role in Lean adoption. Since Lean practices heavily rely on employees’ ability to address and identify inefficiencies, organizations should invest in continuous training programs [17]. Research suggests that SMEs that engage in regular training sessions are more successful in

the integration of Lean tools such as 5S, JIT, Kaizen, etc., into their daily operations, which in turn has a direct impact on process optimization.

Some data indicate that Lean transformation often fails when organizations solely focus on the tools of Lean without addressing leadership behaviors and cultural enablers [35]. This model provides a complementary perspective by advocating that leadership behaviors, rather than just process optimization, drive sustainable Lean success. Studies have shown that companies integrating Lean with strong leadership and continuous improvement culture achieve better operational resilience and efficiency as compared to those that are applying Lean solely as a cost-cutting initiative [19].

With the widespread adoption of Industry 4.0, Lean has been integrated increasingly with digital tools such as Overall Equipment Effectiveness (OEE), AI-driven automation, and Enterprise Resource Planning systems [26]. These types of technological advancements have significantly improved data visibility, decision-making, and operational efficiency for SMEs. Although research suggests that while digital transformation aligns quite well with the Lean principles, their adoption requires substantial investment both in terms of skills and structure, which can pose a financial challenge. Another significant aspect of Lean implementation is the contribution towards sustainability. Lean methodologies are known to complement environmental sustainability by reducing consumption of energy, material wastes, and idle times [21]. Studies in the food processing sector demonstrated that Lean practices contribute not only towards cost reduction but also to the ecological benefits by controlling carbon footprint and material waste [21].

The synthesis of information reflected in Table 6 sheds light on some of the commonly encountered challenges and limitations that are faced with Lean adoption and sustainability. Percentages reflect independent frequency occurrence within the paper pool. SMEs normally lack the required capital to invest in digital tools, infrastructure upgrades, and Lean training programs, which are essential at this time for the effective implementation of Lean [32]. The high costs that are associated with digital transformation and workforce development create additional challenges for SMEs to sustain Lean initiatives in the long term [32]. Also, employee resistance to change is another common limitation. Many workers are hesitant to embrace Lean methodology because they fear it may increase workload or because they lack understanding.

To overcome this issue, SMEs must develop appropriate change management strategies and, where possible, provide incentives to workers to encourage their participation with Lean [13]. Unlike larger corporations, smaller firms mostly have to rely on external consultants, which can add to the economic burden [29]. Several evolving trends form the future of Lean management for SMEs. The integration of Lean with Industry 4.0 technologies such as artificial intelligence, automation, and digital twins is expected to revolutionize Lean adoption in response to increasing agility and operations optimization [41]. Additionally, the combination of circular economy principles with Lean is becoming more evident and prominent, as organizations seek to optimize their utilization of resources while minimizing environmental impact [42].

3.2. Survey Analysis

In the following section, the survey and its responses will be empirically analyzed. There are different themes and segments through which the analysis has been conducted in order to get a clear picture.

3.2.1. Exposure and Involvement

This analysis examines certain levels of involvement of respondents with Lean practices across different roles in the organization.

The values mentioned in Table 7 represent the unweighted arithmetic mean of percentages reported across the three corporate roles. For instance, the average score for the “actively” row is computed as $42 + 33 + 60/3 = 45$. Subordinates report the highest level of active engagement (60%). This is the largest proportion of actively engaged participants, the ones who regularly use Lean tools in daily work as indicated by Figure 2, as compared to the middle managers/team leaders with 42% involvement, followed by the senior managers with only 33% interaction with Lean activities. This attribute suggests that Lean tools are more frequently applied at the operational level, where employee interaction is quite direct.

Table 7. Exposure and involvement. Source—Author’s own creation.

Role vs. Involvement	Middle Manager, Team Leader	Senior Manager (Management)	Subordinate, Employee	Avg. Score
actively: I regularly use some Lean tool/method in my daily work	42	33	60	45
ad hoc: I occasionally participate in Lean activities, but not routinely, not as part of my daily work	33	22	39	31.3
I am not involved at all.	23	20	29	24
I have received a basic education, but I do not participate in anything else.	22	25	43	30
I occasionally receive information about Lean, but only for informational purposes.	32	41	42	38.3
very actively: I am a Lean expert/responsible/trainer/decision-maker	51	31	54	45.3

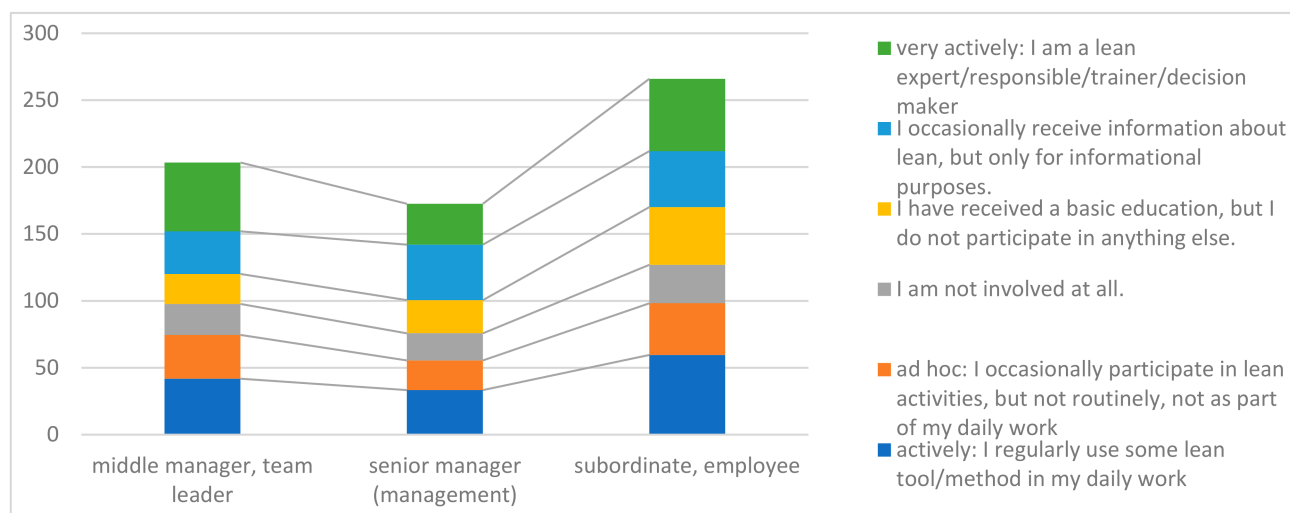


Figure 2. Exposure and involvement. Source—Author’s own creation.

A higher percentage of middle managers (33%) and senior managers (22%) fall into a more ad hoc participation in Lean activities, indicating that their interaction is occasional and not regular.

The very active category (Lean experts, trainers, decision-makers) is the highest among middle managers (51%) and subordinates (54%), while only 31% of senior managers fall into this category. This suggests that middle managers and employees are more likely to

develop Lean expertise. A total of 41% of senior managers show higher exposure to Lean; this implies that, while they are not directly engaging in Lean activities, they are aware of the methodology and tools associated with Lean. In general, almost 36% of respondents have indicated only basic knowledge of Lean and do not participate in any such activities related to it. Whereas, almost 29% of the subordinates reported no involvement at all, the highest among the three role groups, which could imply a lack of integration of Lean into certain job roles and departments at the operational level.

3.2.2. Used Methods

The Lean tools under consideration were selected through a very meticulous process. It combined a mixture of the tools that emerged from the systematic literature review and the ones that can be found in majority of enterprises. This approach ensured relevance, theoretical grounding, and practical application for the SME environment. To evaluate how widely each tool is utilized within the surveyed organizations, a relative frequency score was computed for each method listed in Table 6. This frequency represents the total number of respondents who have personally encountered or applied a given tool divided by the total number of valid study responses. For example, for the 5s methodology, which stood out as the most used method, was calculated in the following way.

$$\text{Score} = \frac{\text{Total positive counts of tool application}}{\text{Total valid dataset respondents}} = \frac{576}{780} = 0.738 \approx 0.74.$$

All the tools underwent frequency analysis, and the average scores were assigned, as reflected in Table 8.

Table 8. Frequency of Lean Method usage. Source—Author’s own creation.

Lean Method	Frequency of Usage
5S	0.74
Idea collection system (suggestion system)	0.48
Qualification matrix	0.41
Kanban (line replenishment, material/information request, card indication of activity start/status)	0.40
PDCA (plan-do-check-act cycle)	0.36
Kaizen event/workshop/workshop	0.36
5 whys method	0.36
Fishbone/Ishikawa diagram	0.35
Standardization/standardization	0.34
The 5 Lean principles	0.33
Daily management (short status discussions)	0.33
Visual management	0.26
One-piece flow/production	0.26
OEE (Overall Equipment Efficiency)	0.26
JIT (just-in-time) (production/activity started on time/only on demand)	0.25
TPM (Total Maintenance Effectiveness)	0.23
Supermarket	0.23
Andon	0.22
7 or 8 losses	0.20
Pull (pull system)	0.20
VSM (value stream/process mapping)	0.19
SMED (Quick Changeover Development)	0.18
Muda–Mura–Muri	0.12
TPS housing/Toyota housing	0.09
TWI—Training Within Industry	0.08
jidoka (intelligent automation)	0.08
Hoshin–Kanri (strategy breakdown and action planning)	0.06
4 + 1 basic rule (Toyota DNA)	0.02

The analysis indicates varying adoption levels of Lean Methodologies, with 5S being the most frequently used in SMEs, reflecting a strong focus on workplace organization. The Idea Collection and Qualification Matrix indicates skills management and active employee involvement. We can see moderate adoption of Kanban, PDCA, and Kaizen, suggesting a commitment to workflow management and process improvement by some of the SMEs. OEE, one-piece flow, and JIT reflect that Lean flow principles are present in the system, but they are not fully integrated. Advanced Lean strategies such as Muda–Mura–Muri, Jidoka, and Hoshin–Kanri are minimally applied, indicating a limited focus on automation, strategic alignment, and waste elimination.

3.2.3. Knowledge Shift

The knowledge shift analysis reviews the difference between the Lean methods that were known before and the Lean methods that were applied in the organization. Notably, most of the values of this difference were negative, indicating that most of the senior managers and team leaders were already familiar with more Lean methods than they encountered during the implementation within the organization in which they were working.

Some of the key observations from the analysis provided in Table 9 and Figure 3 explains that:

- Between the comparison of middle and senior managers, they later exhibited a greater shift in knowledge in Small and Medium Enterprises, indicating that while they had a vast prior knowledge of Lean, the practical implication within the enterprises remain limited.
- Small companies showed the highest levels of knowledge shift within the senior managers (−5.46), implying that more theoretical knowledge was there than the actual application.
- It was observed that medium and large companies had smaller gaps of knowledge and it ranged from −3.13 to −4.48, indication and quite balanced application of Lean methods.
- Very large organizations here—where the employee count was more than 1000—presented an interesting trend, where senior managers showed the least knowledge shift of −1.57, possibly because of the focus on strategic roles rather than operational execution.

This analysis suggests that SMEs should enhance practical application opportunities and ensure that Lean methods receive the same level of importance as the operational tools in use.

Table 9. Knowledge shift. Source—Author’s own creation.

Knowledge Shift	Where Is Your Position/Job in the Corporate Organization?	
	Middle Manager, Team Leader	Senior Manager (Management)
Company Size		
Large	−4.13	−5.19
Medium	−3.13	−4.35
Medium—Large	−3.74	−4.48
Small	−2.97	−5.46
Very Large	−3.90	−1.57
Grand Total	−3.71	−4.68

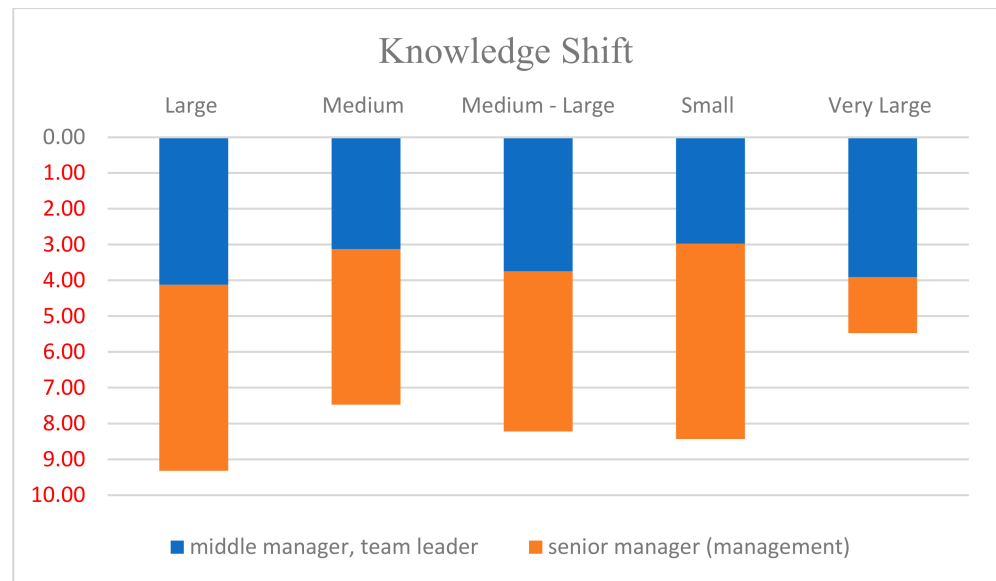


Figure 3. Knowledge shift Correlation. Source—Author’s own creation.

3.2.4. Potential Benefits of Lean in SMEs

As represented in Table 10, the evaluation of perceived benefits from the implementation of Lean highlights several key areas where employees have experienced positive change. The most widely acknowledged benefit, according to 23.37% of employees, is that Lean enables them to work with a more transparent process, suggesting that Lean improves visibility and clarity within the workflows.

Table 10. Potential benefits of Lean. Source—Author’s own creation.

Benefit	Score	Percentage % (Out of Nc = 2615 Choices)
I work with more transparent processes	611	23.37
Learn new things	371	14.19
My work becomes easier	299	11.44
Teamwork improves	251	9.60
I make fewer mistakes; the quality will be better	242	9.26
Distribution of work in the team becomes more even	192	7.35
Problems at work are decreasing	182	6.96
Workplace will be safer/healthier/more ergonomic	169	6.47
Amount of workload (e.g., overtime) decreases	108	4.13
My job becomes more stable	105	4.02
I experience less stress at work	83	3.18
My income is increasing	1	0.04

Other key benefits included “Learning new things” (14.19%) and “My work has become easier” (11.44%), suggesting that Lean fosters continuous learning and improves efficiency.

“Teamwork improvement” (9.60%) and “Fewer mistakes leading to better quality” (9.26%) further imply how Lean strengthens overall work quality and collaboration. Nonetheless, benefits that relate to direct financial impact for the employees, “My Income is Increasing” (0.04%), appear to be highly negligible and were the least recognized benefit of all.

Additionally, “Stress Reduction” (3.18%) and “Job Stability” (4.02%) also scored lower, suggesting that while Lean improves operations, its impact on long-term job security and

stress levels is not significant. The findings imply that Lean is valued primarily for its role in fostering learning, encouraging teamwork, and enhancing and improving the overall work processes and operations, rather than for its financial incentives or stress reduction effects that are directly related to the employees.

3.2.5. Employee Perceptions of Lean-Related Risks

As part of a broader investigation into the implementation of Lean within SMEs, additional descriptive analysis was conducted to understand the risks employees perceive and the adverse outcomes. These insights can complement an overview, offering a basic human-centric perspective on the consequences of Lean implementation in SMEs. Data were collected from respondents who identified one or more challenges encountered following interaction with Lean.

The results summarized in Figure 4 indicate the percentage of respondents implying each type of risk. The most evident issue, highlighted by 27.4% of respondents, was stress and conflict. This suggests that if Lean practices are poorly implemented or not supported by an adequate change-management culture, they can increase psychological strain and interpersonal challenges within the workforce. Fluctuations or emigration (13.57%) and additional costs (13.09%) were also noticeable, suggesting that organizational instability and unforeseen financial obstacles can arise during Lean transitions. A reasonable proportion of employees (12.68%) indicated that unpaid extra work directed towards customers was an issue, suggesting potential disparities in workload and compensation. Additionally, responses indicating unequal workload distribution (11.04%) and teamwork deterioration (4.70%) reflect a perception of potential disruption to fairness and collaboration, which are factors normally crucial to sustaining Lean in resource-constrained SME environments. A loss of trust in managers/owners (5.52%) increases the risk of psychological safety when Lean practices and methodology are imposed from the top-down without adequate employee engagement and the sharing of values. A few respondents tagged job loss (3.00%) and wage tension (2.18%) as additional risks. It can reveal underlying fears about the methodology when it is associated with cost-cutting tools rather than value-creating strategies, leading to reduced job security and dissatisfaction with compensation.

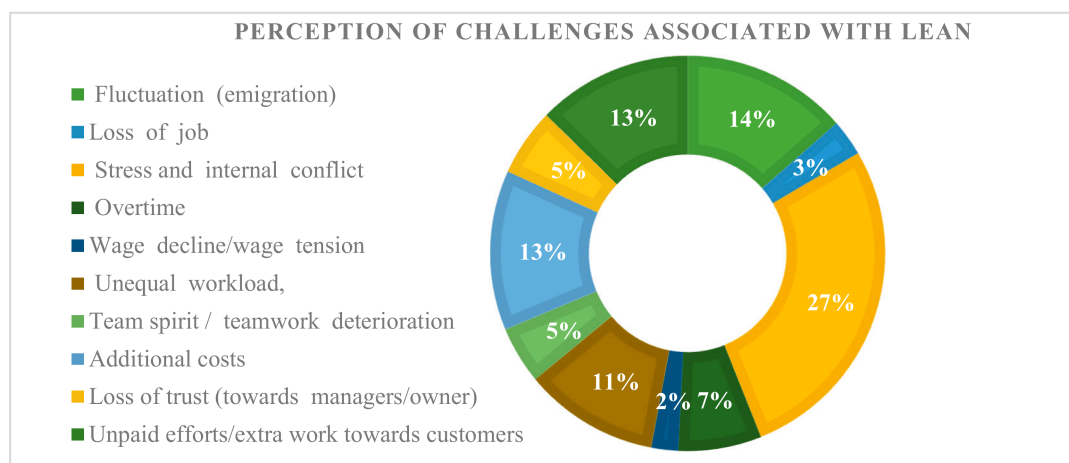


Figure 4. Perception of challenges. Source—Author’s own creation.

These findings imply that Lean implementation is not without significant organizational and human challenges. While the major aim of Lean is to enhance operational efficiency, this analysis highlights the importance of adopting a holistic and people-oriented approach, confirming that such transformation initiatives are coupled with proper training, equitable workloads, transparent communication, and appropriate employee involvement

and engagement. The presence of psychological risks in general suggests that Lean strategies must be tailored to the organizational culture and capabilities of SMEs, as resource constraints and flat hierarchies often amplify the impact of change.

3.2.6. Average Opinion Score vs. Positive Results of Lean

This analysis assesses how the involvement of Lean % of respondents correlates with their perception of Lean's positive impact.

Figure 5 reflects that higher involvement with the methodology leads to a more positive perception. Respondents who dedicated a larger percentage of their work to Lean activities reported a significantly stronger agreement with the statement that Lean brings positive results. The average score for the least involved (0–10%) is 4.21, while those highly involved (86–100%) report a higher score of 4.73. The difference is not that much, but we can see the indication of this correlation. The general average opinion score also increases with Lean Involvement, moving from 3.18 to 4.29. This evidently implies that respondents who work more extensively with Lean not only view its application more favorably, but also have a more positive overall opinion on related workplace attributes. The interesting point is that the opinion score rises steadily, but a noticeable change occurs after the 50% mark. From 26 to 50% (3.77) to 51 to 66% (3.85), and then from 67 to 85% (4.13), we can see a clear shift towards more positive perspectives. This depicts a moderate level of Lean involvement; above 50% might be ideal before employees fully experience and assimilate the positive effects. Employees who spent most of their time in Lean activities (67–100%) show the strongest agreement with the positive outcomes of Lean (4.50 to 4.73). This data provides a direct positive correlation between perceived effectiveness and Lean involvement. It also reinforces the idea that Lean is most effective through direct application rather than passive observation.

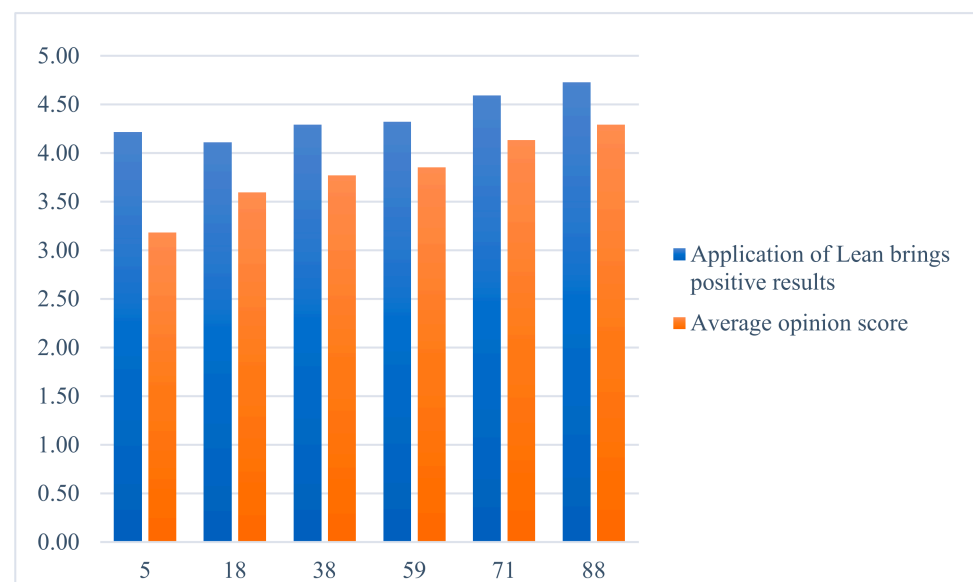


Figure 5. Average opinion vs. positive results. Source—Author's own creation.

3.2.7. Regression Analysis—Positive Results vs. Commitment of Top and Middle Management

A multiple regression analysis was conducted to examine the factors influencing perceived positive outcomes of Lean application. "Application of Lean brings positive results" was kept as the dependent variable, whereas independent variables included 'Practical application is only important in selective areas', 'Commitment of top management to Lean', and 'Commitment of middle management to Lean'.

ANOVA—Analysis of Variance

The value of 55.65 under the F-statistic with a significance level of 1.75×10^{-32} indicates that the regression model is statistically significant, meaning that at least one of the predictors significantly contributes to explaining the variation in the dependent variable. The overall multiple regression model demonstrated a robust fit, yielding an *R-squared* value of 0.421 and an adjusted *R square* of 0.418. This indicates that approximately 41.8% of the total variance in the perceived outcomes of Lean application can be directly explained by the three independent variables evaluated in this model.

Coefficients and Interpretation

As reflected in Table 11 and Figure 6, the intercept value of 3.026 indicates that when all the independent variables or predictors are equal to zero, the predicted value for the dependent variable, or “Perceived positive results from Lean” in this scenario, is 3.026. This provides a standardized baseline level of positive results from Lean when the predictors have no influence.

Table 11. Regression values. Source—Author’s own creation.

Variable	Coefficient	Standard Error	T-Stat	p-Value	95% Confidence Interval	Effect Direction
Intercept	3.026	0.141	21.39	1.22×10^{-79}	[2.748, 3.303]	
Practical application is only important in selective areas	−0.104	0.026	−4.04	5.83×10^{-5}	[−0.154, −0.053]	Significant +ve
Commitment of Top Management to Lean	0.254	0.039	6.47	1.75×10^{-10}	[0.177, 0.331]	Significant +ve
Commitment of Middle Management to Lean	0.157	0.042	3.71	0.0002	[0.074, 0.240]	Significant +ve

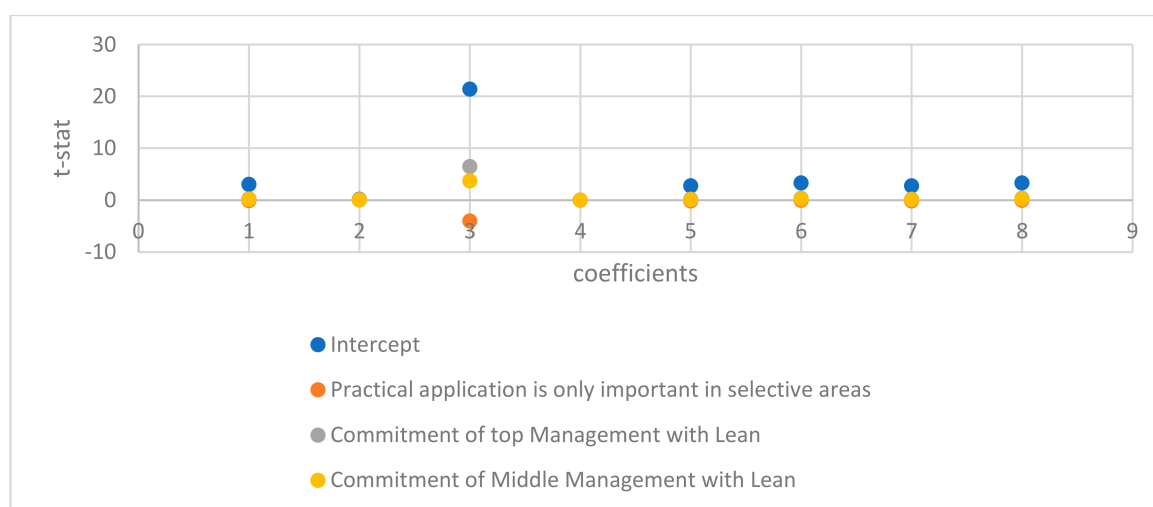


Figure 6. Regression scatter plot. Source—Author’s own creation.

For the first independent variable, the coefficient for “practical application is only important in selective areas” is −0.104, suggesting that for every one unit increase in

the belief that practical application in selective areas is essential, the predicted value, in contrast with “application of Lean brings positive results,” will decrease by 0.104 units. This indicates that individuals who believe Lean should be applied selectively tend to perceive fewer positive outcomes from Lean initiatives. The p -value of 5.83×10^{-5} indicates that this predictor relationship is statistically significant.

The coefficient for commitment of top and senior management to Lean is 0.254, representing that for every one unit increase in the top management’s commitment to Lean, the predicted value of “application of Lean brings positive results” may increase by 0.254 units. This indicates that greater commitment from top or senior management is associated with a higher perception of Lean’s positive results. The p -value of 1.75×10^{-10} endorses that this relationship is statistically significant. The coefficient for commitment to Lean is 0.157 for the data set, meaning that for every 1-unit increase in middle management’s commitment to Lean, the predicted value of the dependent variable will increase by 0.157 units. This indicates that stronger commitment from middle management contributes positively to the perceived success of Lean implementation. The p -value 0.0002 again indicates that this relationship between the variables is also statistically significant.

The findings of this regression analysis indicate that management commitment significantly influences a positive perception of Lean benefits among the workforces. From the values, we can see that commitment from top/senior management is a strong positive predictor of perceived Lean success, with a statistically significant relationship. Similarly, the commitment of middle management also has a positive impact, though it is somewhat less influential than that of top/senior management. Whereas, the opinion that practical application is only important in select areas is negatively associated with perceptions of Lean’s benefits, suggesting that a broader, comprehensive approach across the whole organization can lead to better Lean outcomes and effectiveness.

The strong influence of top and middle management commitment identified in this study is consistent with previous research emphasizing leadership as a critical success factor in Lean implementation. Prior studies have shown that managerial support facilitates resource allocation, organizational alignment, and employee engagement, thereby increasing the likelihood of successful Lean adoption. The present findings extend this evidence to SME logistics and supply chain environments, where resource limitations often increase the importance of leadership commitment.

The results further support the view that SMEs face unique implementation challenges compared with larger organizations. Resource constraints, limited specialist expertise, and less-formalized management systems may restrict the effective adoption of Lean practices. This observation is consistent with the prior SME-focused Lean literature and reinforces the need for implementation approaches tailored to smaller organizational settings.

4. Discussion

It can be observed that the results of this study have produced meaningful insights into the application of Lean management practices within the context of SMEs, particularly in relation to the supply chain. It endorses that while Lean tools and principles are widely accepted and acknowledged, their consistent assimilation across different organizational levels of SMEs remains uneven. This is often influenced by resource limitations, improper knowledge and training, inconsistencies in leadership, and a culture for Lean adoption, especially when compared to large enterprises. Findings suggest that awareness and knowledge of Lean tools such as 5S, Kaizen, and Value stream mapping, etc., exist across different hierarchies, but actual day-to-day usage is concentrated among a smaller group of employees with direct operational responsibilities. While methods such as 5S contribute to localized efficiency improvements, their impact remains constrained when not aligned

with broader logistics and coordination strategies. This observation is consistent with prior research indicating that Lean practices deliver greater performance when implemented across supply chain process rather than isolated areas [2]. Furthermore, recent studies emphasize that integrated Lean approaches within supply chains significantly enhance organizational performance, particularly in manufacturing and logistics environments [3].

The perceived benefits of Lean management, as reported by the respondents, revolve around work simplification, transparent processes, enhanced collaboration, and a reduction in errors. However, it was quite evident that personal benefits such as stress mitigation, income increase, etc., were less frequently observed. Moreover, research shows that Lean involvement correlates with a positive perception, with participants with higher levels of exposure and participation tending to view Lean implementation more favorably. The correlation between direct involvement and perceived success also helps answer the RQ4 regarding how Lean principles can contribute to the adaptability and resilience of logistics and supply chain systems. This resilience cannot be simply achieved by forcing the ad hoc use of a single tool like 5s or a suggestion system. Instead, true adaptability depends on a concept known as process maturity. When 1–6 Likert-scale items were statistically validated using Cronbach's alpha, the areas assessing devoted training time, implementation tracking steps, middle manager coordination and fact-based problem solving were grouped into a reliable process maturity scale where alpha was 0.760. When an SME invests in building high process maturity, it creates a flexible and adaptable operational environment. For instance, starting improvements from real facts and localized data ensures that when a logistics disruption or unexpected delay occurs, managers can make rapid, objective, and accurate changes to transportation or inventory schedules rather than panicking or guessing. This data-driven and transparent approach insulates the SME's supply chain operations from sudden shocks. This familiarity with this methodology breeds commitment and sustained engagement, which may lead to stronger internalization of Lean values. Therefore, RQ4 is addressed not only conceptually through the literature review but also empirically through the observed relationships between leadership commitment, implementation success, and operational maturity. While the survey did not directly measure resilience performance, the identified organizational characteristics provide indirect evidence of resilience-enhancing capabilities within SME logistics and supply chain environments.

Results also underscore the importance of continuous training and cross-functional engagement at so many levels to promote resilience and responsiveness in supply chain systems. This link between training and resilience is further backed up by our knowledge shift analysis, also reflected in Table 7, which provides an interesting statistical look at the internal gaps within these organizations. As noted in the results, the grand total differences for both middle managers (−3.71) and senior managers (−4.68) are distinctly negative across all enterprise sizes. This means that leaders already possess with them a vast pool of theoretical Lean knowledge, but the actual everyday application of their knowledge is very limited. When a crisis happens, this gap can make the supply chains rigid on multiple levels. If employees only know the theory but lack the practical daily habits of Lean tools, they cannot pivot workflows quickly when supplier lines or shipping schedules face unexpected issues.

Despite growing interest in Lean adoption within SMEs, several research gaps remain. To begin with, context-specific barriers for Lean integration, such as sectoral differences, cultural resistance, or digital readiness, require deeper investigation. Moreover, the long-term effects of Lean on SME and supply chain adaptability—specifically in unpredictable or crisis situations—remain insufficiently explored. Additionally, more empirical studies are needed that are up to the task of examining how Lean maturity evolves over time in SMEs and which organizational enablers best support its sustainability.

Although supply chain resilience was not measured directly through dedicated resilience indicators, several findings provide indirect evidence regarding resilience-related capabilities. The statistical results demonstrate that organizations exhibiting stronger management commitment and higher levels of Lean implementation also report greater implementation success. From an operational perspective, these factors are associated with process standardization, continuous improvement, organizational learning, and faster adaptation to changing conditions. Furthermore, the observed knowledge-to-practice gap suggests that resilience capabilities may depend not only on awareness of Lean principles but also on their effective operational integration. Consequently, the findings indicate that organizations with higher Lean maturity are likely to possess stronger adaptive capabilities, which are commonly recognized as key dimensions of supply chain resilience.

A generalized picture of the key findings from this mixed-methods analysis can be seen in Table 12. Survey respondents identified clear organizational benefits, and Lean was associated with enhancements in operational transparency, process efficiency, teamwork, and quality outcomes in SMEs. They are supported by a mean benefit perception score of 3.91, indicating general agreement on the positive impact. Although leadership commitment has been widely recognized as a prerequisite for successful Lean implementation, the present findings suggest that its influence may vary across organizational levels within SMEs. While senior management commitment demonstrated a significant positive relationship with perceived Lean success, middle management commitment also emerged as a critical factor influencing implementation outcomes. This finding supports previous research emphasizing the importance of leadership engagement while extending existing knowledge by illustrating how managerial commitment contributes to the translation of Lean knowledge into operational practice within SME logistics and supply chain environments. The observed knowledge-to-practice gap further suggests that an awareness of Lean principles alone is insufficient without sustained managerial support, employee involvement, and structured implementation mechanisms.

Considering the limitations—the current research focuses on participants in one geographic region, primarily Hungary. While the sample size of 780 respondents provides a substantial basis for analysis, it is still limited when considering the broader population of SMEs across different countries and sectors. Additionally, because this study utilized a nonprobability sampling approach focused on SMEs operating within a specific national context, the findings should be interpreted with appropriate caution. While the results provide valuable insights into Lean implementation, logistics practices, and supply chain-related outcomes within SMEs, they may not be fully generalizable to organizations operating in different geographic, industrial, or institutional environments. Another limitation of the study is that supply chain resilience was examined indirectly through Lean implementation characteristics rather than through dedicated resilience performance indicators. There is also a potential for inherent bias, as participants may have offered socially desirable responses or interpreted Lean-related terminology differently, which could skew the results. Though efforts were made to validate and cross-check responses, the nature of perpetual and opinion-based data always carries the risk of subjectivity. Regarding the systematic literature review, reliance on a single database and a 10-year publication window may have limited or excluded relevant or foundational studies.

From a practical perspective, the findings suggest that SME managers should prioritize leadership engagement, employee training, and organizational alignment when implementing Lean initiatives. For policymakers and business support organizations, the results indicate the importance of developing targeted programs that strengthen Lean capabilities among SMEs operating in logistics and supply chain environments. Looking ahead, future research aims to expand the scope by incorporating financial performance

into lean implementation and by exploring the integration of ESG and ESRS reporting frameworks. A much broader, multi-country dataset will also be pursued to provide comparative insights across different regions and industries. The same will be implemented for the SLR part, where the research will be expanded to other databases and timelines to formulate a comprehensive analysis. Compared to previous work by the authors [4], this study provides a more focused contribution by linking lean practices directly to logistics and supply chain performance, offering a more applied perspective for SMEs.

Table 12. Integrated synthesis of key findings—Author’s own creation.

Research Question/Core Element	Key Empirical Findings & Statistical Indicators	Practical & Strategic Implications
RQ1: Lean Tools Deployment and Process Mapping	5S is the clear starting point across the studied firms (Dominant Index score: 0.74), followed by Idea Collection Systems and Qualification Matrices. On the other hand, long-term strategic frameworks like Hoshin-Kanri and the 4 + 1 Basic Rule show very low adoption levels.	Small businesses tend to prioritize quick, floor-level operational tools. To improve performance and integrate with broader supply chain networks, managers need to look past isolated tools and adopt Lean as a holistic, long-term strategy.
RQ2 & RQ3: Leadership Alignment and Implementation Barriers	The main hurdles facing these firms are employee resistance, tight budgets, and insufficient training. The deeper issue is an internal execution bottleneck: senior executives (-4.68) and middle managers (-3.71) know the theory but fail to apply it. The regression model shows that top management ($\beta = 0.254$) and middle management ($\beta = 0.157$) are vital for success, while a fragmented, “selective only” approach hurts progress ($\beta = -0.104$).	SMEs must stop applying Lean in isolated patches. Owners and executives should design company wide rollouts, explicitly empower middle managers to adopt Lean daily operations, and focus on practical, continuous training rather than abstract classroom concepts.
RQ3 (Cont.): Perceived Outcomes and Organisation Performance	Respondents tied Lean adoption directly to faster workflows, clearer processes, fewer defects, better teamwork, and stronger overall business performance.	Lean improves both day-to-day metrics and long-term competitiveness. When treated as an integrated system backed by solid leadership, it gives resource-constrained small firms a sustainable competitive edge.
RQ4: Logistics Adaptability, Visibility and Supply Chain Resilience	Lean practices directly clear up information flow, speed up how quickly problems are spotted, and open up communication channels. In a mature process environment ($\alpha = 0.760$), leadership support acts as the anchor that transforms messy workflows into clean, visible data streams.	Evidence from survey and regression analysis indicates that management commitment and implementation maturity are positively associated with perceived Lean success. These organizational capabilities support process standardization, adaptability, and continuous improvement, which are frequently identified in the literature as core dimensions of supply chain resilience.

5. Conclusions

This study aims to investigate how lean management practices are adopted in Small and Medium Enterprises (SMEs), with a particular focus on supply chain optimization. The

results addressed key questions around the challenges, practical usage, organizational benefits, and broader implications of lean for adaptability and resilience. One of the primary findings is the barriers to lean adoption in SMEs, including limited financial and human resources, inconsistent employee involvement, and weak leadership commitment. These attributes prevent lean from moving beyond apparent or short-term initiatives, specifically in a resource-constrained environment. A focused regression analysis confirmed that commitment from top/senior management (coefficient = 0.254, $p < 0.001$) and middle management (coefficient = 0.157, $p < 0.001$) can significantly contribute to the positive perception of benefits of Lean. Additionally, the belief that Lean should apply only to select areas negatively correlated with perceived success, indicating the importance of holistic, organization-wide integration. Moreover, Lean plays a crucial role in supply chain resilience, as highlighted by both the literature and survey results, fostering transparent work processes, flexibility, improved responsiveness, and faster process cycles. It was found that Lean principles, when integrated beyond tool-level application, can enhance flexibility and responsiveness in SME supply chains. This study contributes to both practical and academic knowledge by mapping where SMEs currently stand in their Lean journey and identifying which areas require further consideration. From a practical standpoint, the study demonstrates that for Lean to serve as an operational shield against logistics disruptions, SMEs should not be limited to the selective tool application that currently limits the agility. Rather than treating lean as a localized cost-cutting exercise, managers should utilize the operational frameworks that are validated to standardize workflows, secure cross-hierarchical leadership involvement, and employ data-driven daily management cycles; doing so bridges the implementation gap, allowing firms to deploy their theoretical knowledge to actively stabilize the supply line and optimize cross sectoral logistics performance. Future research will expand on this foundation by integrating financial metrics and cross-country comparisons, and by exploring the integration of ESG and ESRS to align with long-term sustainable businesses.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/logistics10080174/s1>, Table S1: PRISMA 2020 Checklist. Ref. [45] is cited in Supplementary Materials.

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