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Article

A multi-case study on a comprehensive model for sustainable lean implementation: integrating phases, practices, and critical success factors

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Abstract: This study proposes a comprehensive model for sustainable lean implementation by integrating three key dimensions: implementation phases, Lean Practices—Lean Technical Practices (LTP) and Lean Social Practices (LSP)—and critical success factors. A multiple-case study was conducted with 13 Brazilian organizations from different sectors that have applied lean for over five years. Data were collected through structured interviews, transcribed, and coded to identify behavioral patterns. Three approaches to lean sustainability were identified: (i) isolated continuous improvement actions focused on specific problems; (ii) structured continuous improvement programs incorporating practices such as 5S, Kaizen, and Six Sigma; and (iii) excellence programs in which lean is embedded into organizational management. Findings indicate that LSP, particularly leadership, training, and empowerment, play a more critical role in sustaining lean than LTP. Organizational, strategic, financial, process, and people-related factors also influence implementation. The study highlights the importance of a dedicated continuous improvement sector in sustaining lean initiatives. Unlike previous studies that examine phases, practices, and influencing factors separately, this research integrates these dimensions into a comprehensive model and introduces a maturity classification framework to support organizations in assessing their lean progression and identifying improvement opportunities. Furthermore, the model adopts a cyclical and adaptive perspective rather than a strictly sequential implementation approach. Although limited by its sample of 13 predominantly Brazilian organizations, the model provides practical guidance for developing sustainable lean strategies and strengthening a participative, people-centered culture of continuous improvement.
Keywords: Lean implementation, sustainability, phases, practices, factors, lean practices

1. Introduction

Lean, originally developed for manufacturing (Panigrahi et al., 2023; Basu and Dan, 2020; Cadden et al., 2020), was later expanded to sectors such as services (Baskir et al., 2023; Vadivel et al., 2022; Valdivia and Rivas, 2021) and healthcare (Reis et al., 2023; Vanichchinchai et al., 2023). Its philosophy aims to reduce costs and optimize resources through continuous process improvement, generating value for stakeholders (Costa and Godinho, 2016; Radnor et al., 2012).

In this study, lean sustainability is understood as the ability to maintain results over time, ensuring the continuity of improvements and promoting lasting organizational transformation (Zhang et al., 2020). This sustainability depends on the integration of phases, practices, and factors (Van Beers et al., 2022; Apostu et al., 2021), with Lean Technical Practices (LTP) and Lean Social Practices (LSP) being essential for its operationalization, under the influence of aspects such as culture, leadership, and resources (Reis et al., 2023; Reponen et al., 2021).

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Despite these advances, the literature still addresses these dimensions in a fragmented manner, focusing on specific phases, isolated stages, or technical tools (Mamoojee-Khatib et al., 2025; Marsilio et al., 2022; Hegedić et al., 2024). Thus, the need for studies that integrate these perspectives to promote lean sustainability is reinforced (Thomas and Suresh, 2024; McDermott et al., 2022; Drei et al., 2021; Hallam and Contreras, 2018; Mazzocato et al., 2010).

In this context, this study proposes an integrated hierarchical theoretical model based on the analysis of phases, practices, and factors influencing lean implementation. To this end, a Systematic Literature Review (SLR) was conducted in the Scopus, Emerald, PubMed, and Web of Science databases, covering 76 articles published between 2017 and 2025.

This study contributes to the literature by structurally integrating three dimensions that are often analyzed in isolation: implementation phases, lean practices, and influencing factors. Unlike previous approaches, the proposed model provides a structured view of these dimensions, highlighting their interrelationships throughout the implementation process. From a practical perspective, the model offers guidelines to support organizations in conducting more structured and sustainable lean initiatives, promoting alignment between strategy, practices, and organizational context.

The paper is structured into five sections beyond this brief introduction. The second section explores the concept of lean, implementation models, and influencing factors; the third describes the methodology, including the systematic literature review and multiple case studies; the fourth analyzes data from the organizations studied; the fifth discusses the results obtained; and finally, the sixth presents the study's conclusions.

2. Theoretical Background

2.1 Models for Lean Implementation

Lean sustainability requires the integration of practices that are traditionally treated in isolation into a comprehensive organizational strategy (Lindsay et al., 2020). In this context, it is essential to consider the practices and factors that influence the different phases of implementation (Thomas and Suresh, 2024; Tlapa et al., 2020).

Lean implementation spans from the preparation stage to its incorporation as an organizational culture, with sustainability being achieved when this philosophy is fully internalized (Van Beers et al., 2022; Demirkesen and Bayhan, 2020). Throughout this process, Lean Technical Practices (LTP) and Lean Social Practices (LSP) stand out, focusing on continuous improvement and value creation (Reis et al., 2023; Zeng et al., 2015).

In addition, the success of implementation depends on factors such as commitment, training, and resource availability. Therefore, implementation models involve three perspectives: phases, practices, and factors.

2.2 Lean Implementation Phases

Lean implementation can be analyzed through five phases: (i) Preparation (P), (ii) Proof of Concept (PC), (iii) Expansion (E), (iv) Measurement (M), and (v) Adoption (A) of lean as an organizational culture. It is assumed that companies that effectively adopt lean move closer to what is referred to as lean sustainability.

The preparation phase involves initial activities such as training, capability development, and the engagement of leadership and teams, aiming to identify bottlenecks and prepare the organization (Marsilio et al., 2022; Huang et al., 2022). Subsequently, the proof of concept phase aims to validate practices and solutions through pilot projects, ensuring their suitability and preparing the organization for expansion (Van Beers et al., 2022).

In the expansion phase, improvements are disseminated across different areas, with knowledge sharing and strengthening of the continuous improvement culture (Bednarek, 2018; Zanon et al., 2020). The measurement phase focuses on monitoring performance indicators, enabling the evaluation and sustainability of results over time (Aquino et al., 2021).

Finally, in the adoption phase, lean is incorporated into the organizational culture, being widely applied and sustained through employee engagement and the consolidation of continuous improvement (Apostu et al., 2021).

2.3. Practices for Lean Implementation: Lean Technical and Social Practices

Practices were classified into Lean Technical Practices (LTP) and Lean Social Practices (LSP), according to the literature (Zeng et al., 2015). LTPs include tools such as VSM, PDCA, 5S, standardized work, kanban, visual management, KPIs, and kaizen, aimed at process mapping and improvement (Van Beers et al., 2022; Marsilio et al., 2022). LSPs, in turn, encompass practices such as leadership, training, and empowerment, related to work organization and people engagement (Huang et al., 2022; Vadivel et al., 2022).

Table 1. Practices, phases, and authors

Practices		Preparation	Proof of concept	Adoption
		Authors	Authors	Authors
Lean Technical Practices	VSM	A17	A1, A4, A9, A20	
	PDCA	A16, A36	A1, A3, A7, A17	
	5S	A11, A22	A5, A6, A7, A15	
	Kaizen		A5, A20, A30	A17, A18, A19, A33
Lean Social	Empowerment	A17, A20, A32	A1, A2, A19.	
	Training	A18	A4, A30, A31	A13
	Leadership	A18, A31, A32	A2, A8, A9, A10, A15	

Table 1 presents the practices across different implementation phases. It is important to note that there is no consensus in the literature regarding the number of phases; therefore, the table groups them into three stages for synthesis purposes, while this study adopts five phases, providing a more detailed analysis of the process.

2.4. Critical Success Factors for Lean Implementation

Regarding the critical factors for lean adoption, six main dimensions were identified: (i) organizational and people, (ii) suppliers and customers, (iii) processes and products, (iv) financial aspects, (v) strategy and lean knowledge, and (vi) governmental factors. Table II presents these factors, their subfactors, associated studies, and implementation phases. It is noteworthy that the organizational and people factor is directly related to Lean Social Practices (LSP), such as leadership, training, and empowerment.

Table 2. Factors influencing lean implementation

Factors / Subfactors		Studies	Phases				
			P	PC	E	M	A
Organizational and People	Lack of training; poor communication; lack of skills and opportunities; resistance to change; employee motivation and engagement; teamwork; lack of structured implementation; strategic planning; top management commitment.	A11, A12, A14, A23, A24, A26, A27, A28, A29, A30, A33, A35, A37, A38, A39, A40, A41, A42, A43	X	X	X	X	X
Suppliers and Customers	Supplier management; customer relationship management; supply chain performance.	A21, A23, A27, A28, A33					X
Process and Product	Process control; product development; standardization; efficiency improvement; quality management.	A24, A28, A33, A35, A37, A39, A40		X		X	X
Financial	Lack of financial resources; cost reduction; financial performance pressure.	A11, A21, A24, A25, A26, A39, A40, A41, A42	X				X
Strategy and Lean Knowledge	Lack of strategic alignment; lack of lean knowledge; difficulty measuring benefits.	A21, A24, A38	X	X	X	X	X
Governmental Influences	Lack of government support; regulatory pressure.	A26					X

Organizational and people management factors, such as leadership commitment, engagement, training, resistance to change, and strategic clarity, are critical for lean adoption (Basu and Dan, 2020; Cadden et al., 2020). The relationship with suppliers and customers also contributes to supply chain efficiency and the sustainability of initiatives (Hassani et al., 2020).

Process and product management involves control, standardization, and flow improvement, impacting efficiency and quality, while financial aspects refer to resource constraints and the need to demonstrate results (Reponen et al., 2021). Strategy and lean knowledge reinforce the importance of organizational alignment and continuous capability development, while governmental factors may influence implementation through incentives or restrictions.

Thus, the integration of phases, practices, and factors is essential to reduce barriers and promote sustainable results in the long term.

3. Research Methodology

This research was motivated by a gap identified in the SLR, which analyzed 76 articles published between 2017 and 2025 in the Scopus, Emerald, PubMed, and Web of Science databases, focusing on phases, practices, and factors influencing lean sustainability.

Based on these findings, a multiple case study was conducted with 13 Brazilian organizations that have been using lean for more than five years, aiming to analyze implementation models. This method is characterized as an empirical investigation within a real-life context (Yin, 2015).

Data collection took place between September 2023 and February 2024 through a questionnaire consisting of 19 open-ended questions. The interviews were conducted via videoconference, recorded, transcribed, and analyzed.

Table 3. The interviewees

Interview	Organization	Employees	Sector	Position	Lean Experience	Lean Duration
1	Commerce and Services	5.000	Controlling	Process Analyst	2 years	5 years
2	Pharmaceutical Manufacturing	64.000	Quality	Quality Director	13 years	14 years
3	Machine manufacturing	60.000	Production	Production supervisor	14 years	15 years
4	Vehicle manufacturing	35.000	Quality	Quality manager	10 years	10 years
5	Mining	250	Performance	Performance Analyst	13 years	4 months
6	Mining	215.000	Operational excellence	Operational Excellence Analyst	10 years	12 years
7	Waste solutions	200	Strategy and Performance	Process and Indicators Analyst	6 years	3 years
8	Refractories Industry	20.000	Continuous Improvement	Lean specialist	19 years	7 years
9	Oilfield equipment manufacturer	28.000	Process improvement	Process Improvement Coordinator	15 years	2 years
10	Hospital health	150	Hospital consultancy	Physician and hospital consultant	12 years	11 years
11	Manufacturing of materials and services for construction	4.000	Quality	SGI Analyst	7 years	15 years
12	Financial services	80.000	Agile	Agility Consultant	6 years	6 years
13	Pharmaceuticals	70.000	Operation	Continuous improvement manager	5 years	17 years

The analysis of the interviews followed a structured process, beginning with the tabulation of information regarding lean implementation in the organizations. The stages applied in each company were highlighted by the interviewees, and the responses were coded. After coding, the information was standardized to facilitate comparison across organizations.

4. Data Analysis

The analysis of the collected data was divided into three topics: implementation phases, practices used, and factors affecting implementation.

4.1 Implementation Phases of the Three Identified Groups

The data analysis allowed the identification of three lean implementation groups, reflecting different levels of maturity and sustainability.

The first group (E1, E5, E10, and E12) is characterized by isolated continuous improvement actions, with a reactive use of lean to solve specific problems, without a formal structure, indicating a low level of maturity. The second group (E3, E7, and E9) adopts structured programs, such as 5S, kaizen, and Six Sigma, demonstrating greater systematization; however, practices remain limited to specific areas, representing an intermediate level.

The third group (E2, E4, E6, E8, E11, and E13) represents the most advanced stage, in which lean is incorporated into operational excellence programs, with organization-wide scope, integration across departments, and strategic alignment. In this case, lean broadly guides processes and practices, fostering cultural transformation and long-term sustainability.

Although there is no uniform sequence of phases, practices such as training, strategic alignment, and the expansion of improvements are common across the groups. The differences lie in the level of structuring and scope: Group 1 operates in a fragmented manner, Group 2 institutionalizes practices in specific areas, and Group 3 adopts an integrated and sustainable approach.

4.2 Practices Used Across Implementation Phases

Table 4 presents an analysis of the implementation stages carried out by each participating organization, highlighting the practices adopted in relation to Lean Social Practices (LSP) and Lean Technical Practices (LTP), classified according to the groups of organizations.

Table 4. Lean practices adopted by the three groups

	Practices	Group 1	Group 2	Group 3	Average General
LSP	Training	30,8%	23%	46,2%	100%
	Leadership	30,8%	15,4%	46,2%	92,4%
	Empowerment	30,8%	15,4%	38,5%	84,7%
	Engagement	30,8%	15,4%	38,5%	84,7%
LTP	Kaizen	30,8%	23%	46,2%	100%
	VSM	15,4%	0%	38,4%	53,8%
	PDCA	7,7%	15,4%	46,1%	69,2%
	A3	7,7%	7,7%	30,8%	46,2%
	Visual management	0%	7,7%	23,1%	30,8%
	Six Sigma	0%	7,7%	23,1%	30,8%
	5S	7,7%	15,4%	38,4%	61,5%
	5 whys	7,7%	7,7%	23,1%	38,5%
	5W2H	7,7%	7,7%	7,7%	23,1%
	KPIs	23,05%	7,7%	23,05%	53,8%
	Ishikawa	0%	0%	23,1%	23,1%
	DMAIC	0%	7,7%	15,4%	23,1%

The analysis of Table IV reveals a strong adoption of LSP, particularly training (100%), leadership (92.4%), and engagement and empowerment (84.7%), which are essential for team development and employee involvement.

Regarding LTP, kaizen was adopted by all organizations (100%), followed by PDCA (69.2%), 5S (61.5%), and VSM and KPIs (53.8%). More advanced practices, such as kamishibai, kata, and hoshin kanri, were identified only in Group 3 organizations (7.7%), indicating higher maturity.

The integration between LSP and LTP reflects alignment between continuous improvement and organizational culture, contributing to operational excellence. It was also observed that LSP play a more significant role than LTP in achieving lean sustainability.

4.3 Factors Affecting Lean Implementation

Table 5 presents the factors identified from the collected data, organizing the groups of organizations and the elements that impact lean implementation.

Table 5. Factors influencing lean implementation

Factors	Subfactors			Group 1	Group 2	Group 3	Average General
Organizational and People (OP)	People's mentality			7,7%	15,4%	15,4%	12,8%
	Resistance to change			30,8%	23%	46,2%	33,3%
	Lack of training			7,7%	7,7%	15,4%	12,8%
	Lack of support from leadership			7,7%	15,4%	15,4%	12,8%
	Culture resistance			7,7%	7,7%	30,8%	15,4%
	Scope	Implemented sectors	All sectors	50%	66,7%	66,7%	61,1%
			Specific sectors	50%	33,3%	33,3%	38,9%
		Department responsible for implementation	Strategy and Performance Sector	25%	33,3%	0%	19,5%
			Continuous Improvement Sector	75%	66,7%	0%	47,2%
			Operational excellence sector	0%	0%	100%	33,3%
		Department responsible for training	Internal sector	50%	100%	50%	66,7%
			External consulting and internal sector	25%	0%	33,3%	19,4%
			External consultancy	25%	0%	16,7%	13,9%
	Involvement	Hierarchical level of those responsible for the management	Sector collaborators	75%	100%	66,7%	80,6%
			Industry leadership	0%	0%	16,65%	5,6%
			Lean industry expert	25%	0%	16,65%	13,8%
		Criteria for employee training	All trained	50%	0%	50%	33,3%
			Selection for training	50%	100%	50%	66,7%
		Alignment of lean program goals	All collaborators	75%	66,7%	83,4%	75%
			Specific sector collaborators	25%	33,3%	16,6%	25%
Financial (F)	Financial release after analysis			0%	0%	15,4%	5,1%
	Lack of resource			0%	15,4%	15,4%	10,3%
	Financial measurement of the Project		Yes	33,3%	100%	100%	77,8%
			No	66,7%	0%	0%	22,2%
Strategy and Lean Knowledge (EC)	Lack of lean knowledge			7,7%	7,7%	15,4%	10,3%
	Lack of strategy			7,7%	0%	7,7%	5,3%
	Strategy for results	Indicators		75%	66,7%	83,4%	75%
		Audit		0%	33,3%	0%	11,1%
		Meetings		25%	0%	16,6%	13,9%
	Project engagement indicator	Engagement		50%	0%	33,3%	27,8%
		Kaizen record		25%	100%	16,7%	47,2%
		Adherence to the project		0%	0%	16,7%	5,6%
		It does not have		25%	0%	33,3%	19,4%
Organizational Structure (OS)	The need for a sector focused on continuous improvement			30,8%	23%	46,2%	33,3%

The analysis revealed factors and subfactors that are still underexplored in the literature, highlighting gaps between theory and practice. Within the organizational and people factor, the scope of implementation and team involvement stand out. In the financial factor, the measurement of project outcomes emerged as a key aspect. In the strategy and lean knowledge factor, strategies for sustaining results and engagement indicators were identified. Additionally, the organizational structure factor is noteworthy, particularly the existence of a dedicated unit for lean implementation.

The results indicate that 61.1% of organizations implement lean across all sectors, while 38.9% focus on specific areas. Responsibility for implementation is predominantly assigned to continuous improvement (47.2%), operational excellence (33.3%), and strategy and performance (19.5%) departments, which perform similar functions. There is also strong participation from operational employees (80.6%), indicating a decentralized and empowerment-based approach.

Regarding training, 66.7% of organizations have an internal training structure, while the remainder adopt external or hybrid approaches. Alignment of goals with all employees occurs in 75% of organizations, reinforcing the importance of broad engagement. To sustain results, 75% use performance indicators, complemented by meetings and audits.

The analysis also shows that 77.8% of organizations conduct financial measurement of projects, especially for high-impact initiatives. However, financial limitations and difficulties in measurement remain significant barriers.

Finally, all organizations reported organizational challenges, particularly resistance to change, cultural barriers, and lack of leadership support, as well as gaps in strategy and lean knowledge. These findings indicate that lean sustainability depends on the alignment of structural, strategic, and human dimensions, supported by dedicated organizational structures and formal performance monitoring mechanisms.

4.4 Analysis of Lean Sustainability Across Organizations

The data analysis indicates different levels of lean sustainability among the organizations, with Group 3 being the most advanced, followed by Group 2 and, finally, Group 1. It was observed that organizations with operational

excellence programs demonstrate a greater ability to sustain lean compared to those adopting continuous improvement programs or isolated actions.

In addition, aspects such as the scope of implementation, definition of responsibilities, training structure, and goal alignment contribute to differentiating sustainability levels across organizations.

Lean sustainability level →

	Group 1 - isolated actions			**Group 2 - Continuous improvement program**			**Group 3 - Excellence program**		
Implemented sectors	SS (E5 e E10)	AS (E1 e **E12**)		SS (E9)	AS (**E3** e E7)		SS (E8 e E13)	AS (**E2**, E4, E6, E11)	
Responsible for driving	LS	LES (E10)	EMP (E1, E5 e **E12**)	LS	LES	EMP (**E3**-E9)	LS (E4)	LES (E6)	LES (**E2**, E8, E11, E13)
Responsible for training	ES (E10)	IS e ES (E1)	IS (E5 e **E12**)	ES	IS e ES	IS (**E3**, E7 e E9)	ES (E8)	IS e ES (E4 e E11)	IS (**E2**, E6 e E13)
Goal alignment	SS (E5)		A (E1, E10 e **E12**)	SS (E7)		A (**E3** e E9)	SS (E8)		A (**E2**, E4, E6, E11 e E13)
LTP practices	Kanban, obeya, OKRs, queuing theory, quick changeover system, BSC, GPD			Taguchi			Kamishibai, kata, hoshi kanri, cost deployment, ECRs, routine management, 3Ms, design print, DMADV, quick kaizen, Pareto, opportunity card		
Factors	Fear of the unknown								

Caption: SS - Specific sectors; AS - All sectors; LS - Leadership; EMP - Employees; LES - Lean specialists; IS - Internal sector; ES - External sector; A - All

Level of sustainability - The further to the right, the greater the sustainability

Fig.1 Lean sustainability level

Figure 1 summarizes this model by positioning the groups according to their maturity levels. Group 1 presents a low level of maturity and is characterized by isolated and fragmented actions. Organizations in this group require greater strategic alignment and support mechanisms to strengthen Lean implementation.

Group 2 presents an intermediate level of maturity, with structured initiatives and continuous improvement programs that are still restricted to specific areas. These organizations demonstrate high employee involvement and internal training structures that support the continuity of initiatives. However, limitations remain regarding the uniform application of Lean practices across the organization.

Group 3 represents the highest level of Lean sustainability, incorporating the methodology throughout the organization through excellence programs that foster high performance and sustained organizational transformation. Organizations in this group stand out for the widespread dissemination and consolidation of Lean principles and practices.

Thus, lean sustainability is associated with the scope of implementation, people engagement, and strategic alignment.

5. Discussion

Although there are studies addressing lean perspectives, there is still a gap in the integration of phases, practices, and factors for effective implementation (Thomas and Suresh, 2024; Rosa et al., 2021). In this regard, the need for a structured model to guide sustainable implementation becomes evident.

As contributions, this research: (i) identifies lean sustainability groups; (ii) recognizes practices (LSP and LTP) and factors that are still underexplored in the literature; and (iii) proposes an integrated model for sustainable lean implementation.

5.1 Identification of Groups with Different Levels of Lean Sustainability Maturity

The analysis identified three levels of lean sustainability: (i) isolated actions, (ii) structured continuous improvement programs, such as kaizen and 5S, and (iii) integration into operational excellence, with comprehensive management. Lean sustainability refers to its long-term consolidation through organizational transformation (Zhang et al., 2020).

Organizations adopting isolated approaches face difficulties in sustaining results due to the lack of standardization, continuous evaluation, and leadership alignment (Besel, 2013). In contrast, companies with structured programs tend to achieve greater sustainability, while isolated initiatives present limited gains.

More mature organizations stand out for their broad implementation, internal capability development, and strategic alignment, fostering engagement. Thus, lean sustainability is associated with its structured and continuous integration within the organization.

5.2 Identification of LSP and LTP Practices and Underexplored Factors in the Literature

The analysis revealed a greater adoption of Lean Social Practices (LSP), such as training, leadership, empowerment, and engagement, which are essential to create a supportive environment and sustain long-term changes (Huang et al., 2022; Vadivel et al., 2022; Akmal et al., 2021). In contrast, Lean Technical Practices (LTP) showed lower adoption, indicating dependence on the level of maturity and organizational capabilities.

More advanced practices, such as kata, kamishibai, and hoshin kanri, were identified in more mature organizations, contributing to lean sustainability, although they remain underexplored in the literature.

In addition, a critical factor that is still insufficiently addressed in the literature was identified: the existence of a continuous improvement department. This unit proves essential for structuring, coordinating, and sustaining improvement projects, ensuring that lean initiatives are not carried out in isolation but rather in an integrated manner aligned with organizational objectives.

5.3. Lean Sustainability Model

This model aims to structure the sustainable implementation of lean based on the integration of phases, practices, and factors identified in the literature. Sustainability is achieved when lean promotes a cultural transformation within the organization, moving beyond isolated improvement initiatives.

The lean implementation process consists of five phases, as illustrated in Figure 2.

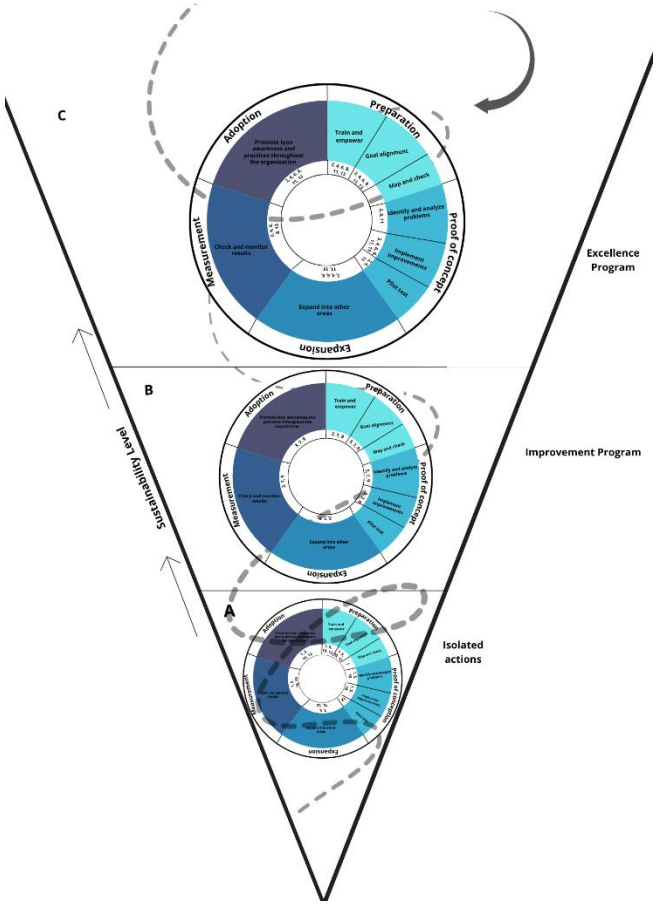

Fig. 2 Lean sustainability model

Based on the SLR, a hierarchical model was proposed that integrates phases, practices, and factors, highlighting lean implementation as an interdependent system in which effectiveness results from the interaction between technical, social, and contextual dimensions. Unlike previous studies, the model explicitly presents these interrelationships throughout the phases and incorporates contextual factors as transversal elements, contributing to a more consistent and sustainable implementation.

Lean implementation occurs across five phases. The preparation phase involves process mapping, goal setting, structuring continuous improvement, project prioritization, and team training. The proof of concept phase consists of applying and validating improvements, followed by standardization and dissemination. The expansion phase promotes the diffusion of practices and the development of capabilities. The measurement phase focuses on monitoring results through performance indicators. Finally, the adoption as a culture phase consolidates lean within the organization through audits, dissemination of results, and continuous reinforcement of the philosophy.

6. Conclusion

This study aims to propose a lean implementation model, providing guidance for organizations to adopt this philosophy in a sustainable manner, based on the transformation of organizational culture. The study seeks to add value to processes, support the development of strategies to engage stakeholders, and strengthen academic research on the topic.

This research presents three main contributions to lean implementation: (i) the identification of lean sustainability groups, (ii) the recognition of practices (LSP and LTP) and factors that are still underexplored in the literature, and (iii) the proposal of a lean implementation model. Three groups of organizations were identified, ranging

from isolated actions to operational excellence programs. The study highlights the relevance of LSP, the need for a continuous improvement department, and the development of a sustainability model for lean implementation in organizations.

From a practical perspective, this study provides guidelines for lean implementation, emphasizing its practical and strategic application. The proposed model serves as a guide for companies at different stages of lean adoption, supporting decision-makers in developing sustainable strategies. Furthermore, it offers insights for the development of benchmarking structures to assess and improve lean maturity within organizations. By emphasizing the importance of leadership and engagement, the study promotes a more participatory and people-centered approach, strengthening the culture of continuous improvement, increasing employee satisfaction, and enhancing organizational resilience.

This research is limited to 13 organizations, predominantly Brazilian, which may restrict the generalization of the findings. For future research, it is recommended to increase the number of interviews, including organizations from different sectors and with varying levels of lean sustainability.

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APPENDIX I

Code	Reference	Journal
A1	Bajjou et al., (2025)	Engineering, Construction and Architectural Management
A2	Gatell et al., (2024)	Total Quality Management & Business Excellence
A3	Van zyl-cillié et al., (2024)	BMC Health Services Research
A4	Parameswaran et al., (2024)	Smart and Sustainable Built Environment
A5	Hegedić et al., (2024)	Sustainability
A6	Polat et al., (2024)	Engineering, Construction and Architectural Management
A7	Ayfokru et al., (2023)	Advances in Civil Engineering
A8	Nicholas (2023)	Total Quality Management & Business Excellence
A9	Sandoval et al., (2023)	Journal of Engineering Science and Technology Review
A10	Vanichchinchai (2023)	Business Process Management Journal
A11	Allen (2022)	Journal of Innovation and Entrepreneurship

A12	Bhadu et al., (2022)	International Journal of Productivity and Performance Management
A13	Chuman-Bobadilla et al., (2022)	In Proceedings of the 3rd International Conference on Industrial Engineering and Industrial Management
A14	Doeleman et al., (2022)	Journal of Strategy and Management
A15	Marsilio et al., (2022)	BMC Health Services Research
A16	Pozzi et al., (2022)	International Journal of Production Research
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A18	Akmal et al., (2021)	International Journal of Lean Six Sigma
A19	Apostu et al., (2021)	International Journal of Lean Six Sigma
A20	Ciannella e Santos (2021)	Social Responsibility Journal
A21	Gaiardelli e Songini (2021)	International Journal of Productivity and Performance Management
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A23	Ramadas e Satish (2021)	International Journal of Lean Six Sigma
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A25	Reponen et al. (2021)	BMC Health Services Research
A26	Singh, Singh e Khamba (2021)	Journal of Science and Technology Policy Management
A27	Sharma, Sohani e Yadav (2021)	Journal of Engineering, Design and Technology
A28	Basu e Dan (2020)	International Journal of Lean Six Sigma
A29	Bhamu et al., (2020)	Springer
A30	Cadden et al., (2020)	International Journal of Production Economics

A31	Castro-Chara et al., (2020)	IOP Conference Series: Materials Science and Engineering
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