QUALITY PAPER

An empirical study on Lean and its impact on sustainability in services

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Abstract

Purpose – Lean implementation has become popular over the past three decades in the industry and is becoming more prevalent in, service organizations. The objective of this study is to evaluate the impact of social and technical Lean practices on sustainable performance (i.e. economic, environmental and social) in service organizations.

Design/methodology/approach – The methodology includes the analysis of global results obtained from 139 managers from the service sector.

Findings – The results demonstrate that Lean practices have a positive effect on the three perspectives of sustainable performance, regardless of the company size and duration of Lean implementation. Furthermore, both social and technical Lean practices have a similar impact on environmental and economic performance, but their impact on social performance differs, since social Lean practices have a stronger impact on social performance.

Practical implications – This study has a significant contribution to Lean practitioners in service sectors, as it demonstrates that efforts to apply Lean practices can benefit economic results as well as environmental and social performance.

Originality/value – Majority of existing studies focused on the isolated impact of Lean on one of the triple bottom line performance aspects and with a scarcity of studies within the context of services. The intersection of these three strategic areas – Lean, sustainability and services – has not been extensively addressed. There is also a lack of studies that observe sustainability in environmental, social and economic performance, mainly in the service sector.

Keywords Lean practices, Socio-technical system, Sustainability, Performance

Paper type Research paper

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1. Introduction

In recent years, academics and practitioners have widely recognized the benefits of implementing Lean for the service industry (Caiado *et al.*, 2018). The Lean implementation in service organizations is mentioned as Lean service and the first reports on the theme date back to the late 1990s and early 2000s (Tortorella *et al.*, 2021). Therefore, Lean service is a recent concept compared to Lean Manufacturing (Hadid and Mansouri, 2014; Gupta and Sharma, 2018), which has been the focus of interest of operations management for over four decades (Petrusch *et al.*, 2018). Lean service, like Lean Manufacturing, seeks to eliminate waste from service processes to improve value for the customer (Hadid *et al.*, 2016; Hadid, 2019).

The inherent differences between services and manufacturing make it important to study a phenomenon such as Lean in a specific context (Gupta and Sharma, 2018). Services permeate all aspects of a modern economy (Lins *et al.*, 2021). In addition to its importance for the economy, service companies face customer demands for better quality service, and managerial demands for cost reduction (Lins *et al.*, 2021). On the other hand, Lean has been increasingly used to improve efficiency and reduce waste in both service and production firms (Hussain *et al.*, 2019). Furthermore, companies in the service sector are adopting Lean to achieve economic, social and environmental aspects of sustainable performance (Morell-Santandreu *et al.*, 2021).

Lean service can be understood as a socio-technical system (STS) and should be implemented as such (Hadid *et al.*, 2016; Malik and Abdallah, 2020). STS assumes that organizations comprise two components: technical and social (Abdallah *et al.*, 2019; Hadid and Mansouri, 2014; Hadid *et al.*, 2016). The social aspects comprise training, reward and recognition, employee involvement and continuous improvement, while the technical aspect includes continuous flow, work standardization, visual control and Total Productive Maintenance (TPM) (Alsmadi *et al.*, 2012; Hadid *et al.*, 2016. Past studies have failed to sufficiently address the importance of social factors for successful Lean implementations as the emphasis is mostly on the technical aspect (Malik and Abdallah, 2020).

However, research exploring the potential of Lean management in services in general and for specific service sectors is still scarce (Syltevik *et al.*, 2018). Although there are several studies proposing models for Lean assessment in the manufacturing context, there is a lack of models implementing and assessing Lean in the service context (Carlborg *et al.*, 2013; Danese *et al.*, 2018). There is an even greater lack of research aimed at evaluating the impact of Lean on the sustainability of service companies and chains in terms of triple bottom line (economic, environmental and social) aspects (Caiado *et al.*, 2018; Hussain *et al.*, 2019; Awad *et al.*, 2022). Today, achieving sustainability in terms of economic, environmental and social performance is an important part of many service organizations' business goals and strategies (Lagrosen and Lagrosen, 2019; Hussain *et al.*, 2019). To attain sustainability, it is clearly stressed that economic, social and environmental performance are needed to be equally utilized as metrics (Anuar *et al.*, 2018, Hines *et al.*, 2020). However, the majority of existing studies focused on the isolated impact of Lean on one of the triple bottom line performance aspects and with a scarcity of studies within the context of services (Hussain *et al.*, 2019). The intersection of these three strategic areas – Lean, sustainability and services – has not been extensively addressed (Caiado *et al.*, 2018).

There is also a lack of studies that observe sustainability in environmental, social and economic performance, mainly in the service sector (Anuar *et al.*, 2018; Hussain *et al.*, 2019; Caiado *et al.*, 2018; Lizarelli *et al.*, 2022). Therefore, the objective of this paper is to assess the impacts of Lean's social and technical practices on economic, social and environmental performance and service companies around the world.

To achieve the proposed objective, this paper is organized as follows. Section 2 presents a review of relevant literature on Lean service and on the relationship between Lean and the three dimensions of sustainability, as well as the study hypotheses. Section 3 presents the research method, while the results are presented in Section 4. Section 5 presents the conclusion of the work, implications, limitations and directions for future research.

2. Literature review and research hypotheses

2.1 Lean service

Lean has been primarily applied to improve manufacturing processes (Alsmadi *et al.*, 2012; Gupta and Sharma, 2018), and the benefits through Lean for these organizations have led to the spread of its application to other industry sectors, such as the service sector (Suárez-Barraza *et al.*, 2012; Caiado *et al.*, 2018). Lean provides a framework with principles, tools and practices to organize and improve processes, identify the value delivered to the customer and continuously increase efficiency and quality (Malmbrandt and Åhlström, 2013; Petrusch and Vaccaro, 2019). Service organizations are putting efforts to improve service quality, productivity and profitability by incorporating Lean principles (Vadivel *et al.*, 2022).

The absence of adequate tools that accurately measure productivity and its improvement has led to the use of the Lean service, along with the emergence of topics such as service wastes into the service industry. Lean service can assist in the identification of waste, by applying Lean production concepts to service operations (Sum *et al.*, 2019). In this way, Lean Service can be seen as a strategic approach that places customers as a central focus and invests in mechanisms for employee engagement at the team and individual level (Caiado *et al.*, 2018).

The idea of transferring production concepts from manufacturing to services is not new (Petrusch *et al.*, 2018). When Womack and Jones (1996) formally introduced the concept of Lean thinking, through the five principles (value, value stream, flow, pull and perfection), a bridge was established that enabled the transfer of concepts of manufacturing to non-manufacturing processes (Hadid and Mansouri, 2014; Petrusch *et al.*, 2018). This expanded the applicability of the Lean system to the service sector, which later spread throughout to all types of service industries (Hadid and Mansouri, 2014; Petrusch *et al.*, 2018; Hadid, 2019). Gradually, Lean implementation has shown its popularity in healthcare, education, public services, hospitality, financial and information technology industries (Vadivel *et al.*, 2022; Tortorella *et al.*, 2021).

2.2 Social and technical Lean practices

For service organizations to achieve the best possible benefits through Lean implementation, it has to be seen as a socio-technical system (STS) (Hadid *et al.*, 2016). The STS model considers each organization to be composed of a social subsystem of people and structural components and a technical sub-system of technology and production process elements (Centauri *et al.*, 2018).

The two distinctive sides of Lean, i.e. social and technical sides can work independently and together to improve the firm's performance (Hadid and Mansouri, 2014; Malik and Abdallah, 2020). Therefore, it is important for researchers to measure the level of adoption of social (soft) and technical (hard) practices to precisely capture the effectiveness of Lean service in advancing the firm's performance (Hadid and Mansouri, 2014).

On the Lean technical practices side, different practices play different roles in achieving the goal of increasing value-adding activities and decreasing non-value-adding ones in service companies (Hadid and Mansouri, 2014). A full understanding of the contribution of each set of practices, as well as their inter-relationship, is essential for managers to achieve the desired results (Hadid and Mansouri, 2014). Lean social practices emphasize human resources and refer to human-related activities such as employee engagement and employee involvement (Vadivel *et al.*, 2022).

2.3 Lean and sustainability

Driving companies toward sustainability will require changes in their performance considering the triple bottom line (Elkington, 1998). The triple bottom line focuses on economic prosperity, environmental quality and social equity (Elkington, 1998). Sustainable operations integrate the profit and efficiency orientation with broader considerations of the company's internal and external stakeholders and its environmental impact (Kleindorfer *et al.*, 2005). The environmental perspective concerns environmentally sustainable practices, which seek to minimize the environmental impact of human action, the ecological footprint, energy consumption and waste production. The social perspective deals with fair and beneficial practices for the community, in which the organization generates an interdependence between all parties involved. The economic perspective refers to economic value and financial performance (Pederneiras *et al.*, 2021). A sustainable organization adopts practices which respond to the social, environment and economic impact (Klein *et al.*, 2023).

There is a premise about a causal relationship between the adoption of Lean practices and sustainability based on the triple bottom line concept, for both manufacturing and service companies (Kleindorfer *et al.*, 2005; Klein *et al.*, 2023). Lean application in services can lead to the reduction of waste, which can reduce the environmental impact, increase efficiency and reduce organizational costs, also impacting economic performance (Gupta and Sharma, 2018; Klein *et al.*, 2023). Lean is related to social issues, such as workers' recognition and employee involvement, with a focus on safety, qualification and training (Klein *et al.*, 2023). However, measuring sustainability is difficult in the service sector as well as grouping indicators in broad sustainability areas (economic, environmental and social) is even more difficult (Marin-Garcia *et al.*, 2021). Hence, it is a challenge to establish indicators and measure environmental and social aspects for services (Marin-Garcia *et al.*, 2021).

Despite the importance and possible connections of Lean and its impact on sustainability perspectives (economic, social, environmental), there is a paucity of research on these relationships in the service sector (Caiado *et al.*, 2018; Hussain *et al.*, 2019). In addition, this scarcity is even greater when Lean is observed as a socio-technical system, there is a scarcity of studies that observe the social and technical Lean systems and the triple bottom line perspectives (Anuar *et al.*, 2018).

2.3.1 Lean and economic sustainability. Results highlighted the importance of implementing Lean practices such as STS and its capacity to improve performance (Hadid, 2019). There is evidence in several service sectors that Lean implementation positively impacts service organizations' performance (Tortorella *et al.*, 2021). Since Lean objectives of efficiency and improvement are defined in terms of cost reduction (Zirar *et al.*, 2020), then the use of Lean principles to improve the efficiency of services has a massive impact on economic performance (Gupta and Sharma, 2018).

Hadid and Mansouri (2014) investigated the impact of Lean services such as STS on the firm's performance and showed the impact of the different roles of each set of practices (social and technical) in improving firm performance. LTP and LSP were found to independently improve firm performance (Hadid and Mansouri, 2014). Vadivel *et al.* (2022) also confirmed that LTP and LSP are positively significant in operational performance and its effectiveness in postal service firms (Vadivel *et al.*, 2022). Other studies also confirm the promising effect of Lean service on financial performance (Hadid, 2019). Two of the Lean service factors (process factor, physical structure factor) are found to positively influence profit per employee and return on capital employed (Hadid, 2019). However, Hadid *et al.* (2016) identified that social practices of Lean service had a positive impact on firm operational and financial performance, while technical practices had a positive effect on only the operational performance (Hadid *et al.*, 2016). Sahoo (2019) shows that Lean social practices influence business performance by influencing LTPs, proving synergies exist between these factors.

Additionally, the application of Lean in service, specifically in healthcare, has been met with mixed results related to the impacts on financial performance (Dobrzykowski *et al.*, 2016). Fewer studies have proven that Lean healthcare practices have a direct influence on operational performance (Anuar *et al.*, 2018). The study conducted by Dobrzykowski *et al.*

(2016) failed to demonstrate a relationship between Lean and financial performance, measured by net income, in hospitals. The inconsistency in research findings demonstrates the need to further examine factors that impact economic performance (Dobrzykowski *et al.*, 2016). Therefore, the following hypotheses are proposed:

H1a. Lean Technical Practices have a positive impact on the economic performance of service organizations.

H1b. Lean Social Practices have a positive impact on the economic performance of service organizations.

2.3.2 Lean and environmental sustainability. There is a potential relationship between Lean's waste elimination focus and environmental goals (Gupta and Sharma, 2018; Klein *et al.*, 2023). The literature shows that operational Lean efficiency efforts can provide opportunities to balance both economic and environmental impacts (Zhu *et al.*, 2018). The Lean focus of doing more with less are essential for leading to the reduction of their environmental impacts, conserving energy and natural resources, being safe for their employees, their communities and, lastly their consumers (Klein *et al.*, 2022).Through a literature review, the authors identified that the majority of the research on the application of Lean and Green practices has talked about them as a complementary and integrated approach (Caiado *et al.*, 2018). However, that may not always be the case, since there are conflicting results also observed in several studies (Zhu *et al.*, 2018). Further it is observed that studies on the application of Lean methodology and its relationship with sustainable performance in a service enterprise are missing (Caiado *et al.*, 2018).

The relation of Lean with environmental performance in the context of services is a missing link in the published literature (Marin-Garcia *et al.*, 2021). For example, Lean initiatives in a service setting such as in healthcare operations are more focused on internal efficiency than on internal or external environmental benefits (Zhu *et al.*, 2018). In the context of healthcare, the Lean philosophy contributes greater value toward economic and social sustainability, with limited impact on environmental sustainability (Morell-Santandreu *et al.*, 2021). Therefore, the following hypotheses are proposed:

H2a. Lean Technical Practices have a positive impact on the environmental performance of service organizations

H2b. Lean Social Practices have a positive impact on the environmental performance of service organizations

3. Lean and social sustainability

Previous studies highlighted the relationship between Lean implementation and financial performance in the healthcare setting. However, those studies did not report any relationship due to Lean implementation on social and environmental performance for service organizations (Anuar *et al.*, 2018). There is a dearth of studies that observe social indicators and Lean tools in the service sector (Marin-Garcia *et al.*, 2021). Managers of organizations adopting Lean need to give thoughtful attention to human resource practices, since employees are the assets who support the processes that provide value to customers (Zirar *et al.*, 2020). Kaizen, quality and productive maintenance were found to be indirectly linked to social aspects (i.e. improving the image and work environment) (Hussain *et al.*, 2019). The study by Hussain *et al.* (2019), suggests positively moderate impact of Lean practices on social sustainability in the hospitality sector (Hussain *et al.*, 2019). The applicability of the Lean methodology in healthcare makes it possible to achieve better social sustainability. This is due to better employee involvement and reduced work-related stress because of the adaptation and continuous change of protocols to suit the needs of the employees and their environment (Morell-Santandreu *et al.*, 2021).

Therefore, there is a possibility of a potential relationship between the implementation of Lean and the indicators of social sustainability. Thus, the following hypotheses are proposed:

H3a. Lean Technical Practices have a positive impact on the social performance of service organizations.

H3b. Lean Social Practices have a positive impact on the social performance of service organizations.

3.1 Size and implementation time

Previous studies have noted that company size was considered as an important variable that could influence the proposed relationships in service companies (Hadid and Mansouri, 2014; Dobrzykowski *et al.*, 2016; Hadid, 2019) and was operationalized by the total number of employees of the company. Another variable was the Lean implementation time, which can also affect the goals of Lean projects and actions.

4. Research method

A global survey of large, small and medium-sized service enterprises was conducted in five continents. The service companies surveyed were located in Europe, Asia, North America, South America, Australia and Oceania. As with similar previous studies in Lean (e.g. Antony *et al.*, 2020; Antony and Sony, 2021), the survey sought to observe companies on different continents to present a global view of the relationships studied. The sampling and data collection procedures are described in Section 4.1, the development of the research instrument and variables are presented in Section 4.2, response bias and common method variance is discussed in Section 4.3 and, finally, the data analysis approach is outlined in Section 4.4.

4.1 Sampling and data collection

The target population of the study was those responsible for the Lean program or Lean consultants from service companies. Respondents were selected on corporate social media from professionals with experience in Lean and service companies. Many researchers are exploring data from social media platforms to investigate management practices (Potter, 2022). One of the main social media platforms used was LinkedIn, where professionals from all over the world have accurate information about their experience and skills, including Lean manufacturing skills (Potter, 2022). Target respondents were contacted via LinkedIn and received a brief explanation about the study with the question about their interest in responding to the study voluntarily. After accepting to participate in the survey, the online questionnaire, developed on the Google Forms platform, was sent. The confirmation that the professional was dedicated part- or full-time to Lean and worked in a service company was made through the questionnaire. The questionnaire was sent to 600 potential respondents, obtaining 139 completed valid responses.

Before data analysis, the 139 surveys were examined to check missing data, suspicious response patterns (straight lining or inconsistent answers) and outliers, to ensure data quality (Hair *et al.*, 2017a, b). There were no suspicious response patterns, nor missing data in the questions related to the variables and outliers. The outlier analysis was performed using the Mahalanobis distance, which is one of the most used approaches for outlier detection, mainly in multivariate data (Dai, 2020). Therefore, the final sample consisted of 139 responses from professionals from service companies from different sectors. The sample size complies with the main rules for determining the minimum sample size for the PLS path model. Considering the 10 times rule, the sample is sufficient, since it has 10 times the number of independent variables in the structural model (minimum sample size of 20) (Hair *et al.*, 2017a, b). Considering the minimum R-squared method, which observes the maximum number of arrows pointing at a construct, significance level and minimum R^2 value, the minimum sample size should be 90 (two predictors, 5% significance level and $R^2 = 0.1$) (Kock and Hadaya, 2016; Hair *et al.*, 2017a, b). The inverse square root method was also observed, in which the minimum sample would be 128 (Kock and Hadaya, 2016).

Table 1 shows that most respondents (60%) are dedicated full-time to Lean. The respondents' position that occurred the most in the sample was senior manager (25%), Lean manager (22%) and continuous improvement or operational excellence manager (17%). The respondents' profiles show that they are qualified to answer the questions.

As the purpose of the survey was to obtain a global view of the relationships studied, the sample is composed of companies from five continents (Table 2). The companies in the sample belong mainly to the following service sectors. Most of the sample has Lean implemented for more than 5 years (57%) while most of the organizations (64%) have more than 500 employees.

4.2 Research instrument and variables

The research was divided into three sections: information for characterizing the company and respondent, use of Lean social and technical practices and, finally, sustainability performance. In the first section, information was collected about the respondent's position, dedication to Lean activities, organization location, sector, number of employees and Lean implementation time. Part two focused on the use of social and technical Lean practices and part three focused on sustainability, social, economic and environmental performance variables. The choice of scales for measurement, including the variables for each construct, were based on previously published data in the literature about scales and surveys on Lean practices and sustainability performance in service organizations. The constructs are multi-item, to capture the theoretical domain of the construct and thus demonstrate content validity (Hinkin, 1998; Malhotra and Grover, 1998; Hair *et al.*, 2017a, b).

The pretest was developed in two steps, the first was a content analysis, asking the experts if they agreed with the items in each construct, to ensure that the items represented

	Number	Percentage
*Respondent position**		
Senior manager	35	25%
Lean manager	30	22%
Continuous improvement or operational excellence manager	23	17%
Associate or middle manager	18	13%
LSS master black belt	18	13%
LSS black belt	14	10%
Executive manager (C-position)	12	9%
Nonmanager-level employee	12	9%
Operational excellence director	11	8%
Lean champion	7	5%
Other	4	3%
Lean responsibility		
Full-time involvement	84	60%
Part-time involvement	55	40%

Note(s): *The respondent could mark more than one option
Source(s): Author's own work

Table 1. Respondent description

	Number	Percentage
Company location		
South America (Brazil)	44	32%
Europe (Ireland, Netherlands, United Kingdom, Romania, Poland, Italy, Scotland and Bulgaria)	40	29%
Asia (India, Oman and United Arab Emirates)	25	18%
North America (the USA and Canada)	23	17%
Australia and Oceania	3	2%
Global	4	3%
Service area		
Healthcare	27	19%
Banking/finance	22	16%
Consultancy	17	12%
Information technology	10	7%
Insurance	8	6%
Telecommunication	7	5%
Transport	7	5%
Retail	7	5%
Utilities	3	2%
Education	1	1%
Hospitality/hotel	1	1%
Other	29	21%
How long lean has been used (years)		
Between 0 and 1	27	19%
Between 2 and 5	10	7%
Between 6 and 10	26	19%
More than 10	53	38%
No answer	23	17%
Company size		
1–49	24	17%
50–249	13	9%
250–500	13	9%
501–5.000	45	32%
>5.000	44	32%

Note(s): *The respondent could mark more than one option
Source(s): Author's own work

Table 2. Characteristics of companies

the construct (Hinkin, 1998). In the second, following the recommendation of Forza (2002), the questionnaire was sent to four academic experts, who research Lean and are reviewers of renowned journals, seven experts with Lean experience in the service sector and three target respondents to verify the clarity of the questions, the questionnaire format and the scale of items. There was no need to make significant changes.

The themes of this study, social and technical Lean practices and sustainability performance in service organizations are recent in the literature. To guarantee the construct validity, well-known constructs and variables found in the literature were used as the basis for the questionnaire. A conceptual model was made considering two second-order hierarchical constructs (social and technical Lean practices). The main references for social and technical practices were Alsmadi *et al.* (2012), Malmbrandt and Åhlström (2013) and Hadid *et al.* (2016). The second-order construct for technical Lean practices is effectively represented by seven first-order constructs: *customer involvement, continuous flow, pull, supplier feedback, TPM, visual control and work standardization.* The second-order construct for Social Lean practices is effectively represented by six first-order constructs: *continuous improvement culture, employee involvement, leadership, multifunctional employees, training and people development, reward and recognition*. For sustainability performance, three reflective constructs were observed: economic, social and environmental performance, based on Fernando *et al.* (2019). For these sections, a seven-point Likert scale, varying from 1 ("strongly disagree") to 7 ("strongly agree") was used (Malhotra, 2014; Hair *et al.*, 2017a, b). Table 3 shows the second and first order constructs, the items and the literature consulted.

4.3 Response and common method bias

Common method variance (CMV) is a potential problem, which may be associated to a bias in answering questions, causing the indicators to share a certain amount of common variation (Podsakoff *et al.*, 2003). The potential for CMV occurs in cross-functional survey design when a single informant is used to gather data about dependent and independent variables (Guide and Ketokivi, 2015). Nevertheless, some recommendations were applied to reduce CMV (Podsakoff *et al.*, 2003): (1) guarantee of anonymity of respondents; (2) indication that there are no right or wrong answers; (3) the respondent's knowledge of the research topics; (4) multi-item constructs to ensure the conceptual domain; and (5) distinct format between the dependent and independent variables. Additionally, the Harman's Single Factor Test was performed to address CMV, the test consists of loading all the variables into an exploratory factor analysis and check the covariance among the measures in one factor, what should not be the majority to ensure there is no CMV (Podsakoff *et al.*, 2003). The test showed that less than 50% of all variance was explained by the single factor (39.9%), thus ensuring that CMV was not a major concern. To test for possible non-response bias was verified if the answers of the early and late respondents are similar, using Levene's test and a *t*-test to verify equality of variance and means, respectively (Armstrong and Overton, 1977; Gastwirth *et al.*, 2009). No difference was identified in the mean or variance of any variable considering a significance of 5%.

4.4 Data analysis

There is a growing number of articles using Partial Least Squares – Structural Equation Modeling (PLS-SEM) in business research, including different disciplines such as organization research and strategic management (Cheah *et al.*, 2018). This choice stems from several factors, including the ability to handle very complex models as higher-order models with many indicators and constructs (Hair *et al.*, 2017a, b). Additionally, PLS-SEM is suitable for non-parametric scaling (ordinal measurement) and handles small sample sizes with the required level of care (Hair *et al.*, 2017a, b; Sarstedt *et al.*, 2019). To verify if the sample of 139 surveys was adequate for the analysis of the model, three rules for minimum suitable size were observed: (1) the ten times rule (minimum sample of 20 for the model), (2) the minimum R-squared method (minimum sample of 88) and the inverse square root method (minimum sample of 128) (Hair *et al.*, 2017a, b; Kock and Hadaya, 2016).

A conceptual model with second-order constructs was chosen because it allows complex and on a more abstract dimension (higher-order), constructs to be measured by their more concrete subdimensions (lower-order) (Sarstedt *et al.*, 2019). In the case of the present research, the constructs of social and technical Lean practices can be evaluated by concrete practices used in companies, however, these are diverse, requiring different constructs. This type of model requires specific approaches to be analyzed in the PLS-SEM (Hair *et al.*, 2018; Sarstedt *et al.*, 2019). The disjoint two-stage approach was used to analyze the higher-order model (Hair *et al.*, 2018; Sarstedt *et al.*, 2019). This approach consists of considering only the

Practice	Code	Items	Authors*
Technical lean practices (TLP)			
Supplier feedback	SUP1	Close contact with our suppliers	1; 3; 9
	SUP2	Suppliers feedback on quality and delivery	
	SUP3	Establish long-term relationship with suppliers	
	SUP4	Treat suppliers with respect	
Customer involvement	CUS1	Close contact with customers	1; 3; 6; 9
	CUS2	Customers feedback in quality and delivery performance	
	CUS3	Customers are actively involved in current and future offerings	
	CUS4	Customers frequently share current and future demand information	
	CUS5	Regularly conduct customer satisfaction surveys	
Work standardization	WST1	Standardized work activities	6; 8; 9
	WST2	Formalization of work standards	
	WST3	Stable and predictable tasks	
	WST4	Value stream and waste identification	
Continuous flow	FLOW1	Use workplace and information system design to produce a continuous flow	1; 3; 6; 8; 9
	FLOW2	Use information and resources located based on when and where they are needed	
	FLOW3	Pace of operation is linked with the rate of customer demand	
	FLOW4	The areas work together to connect the process cross-functionally	
Visual control	VCON1	Uses visual control for making problems transparent	6; 8; 9
	VCON2	Uses visual indicators for detecting problems/deviation	
	VCON3	Has the information needed in the right place	
	VCON4	Makes improvement information available in central locations	
TPM	TPM1	Dedicate a portion of everyday to planned equipment maintenance	1; 3; 8
	TPM2	Maintain all equipment regularly	
	TPM3	Maintain records of all equipment maintenance related activities	
	TPM4	Provide a visual equipment maintenance for active sharing	
Pull	PULL1	Uses "pull" concepts in their operations	1; 3; 6; 8
	PULL2	Operation is "pulled" by the current demand of the next process	
	PULL3	Use a "pull" operations system	
	PULL4	Use Kanban or similar signals for operations control	
Social lean practices (SLP)			
Continuous improvement culture	CIC1	Use a structured problem-solving approach for improvement	6; 8; 9
	CIC2	Employee participation in problem-solving	
	CIC3	Work to sustain improvements	
	CIC4	Have management support to improve processes	
Employee involvement	EINV1	Employees are key to problem-solving teams	1; 3; 6; 8; 9
	EINV2	Employees drive suggestion programmes	
	EINV3	Employees lead service/process improvement efforts	
	EINV4	Employees are empowered to make changes	

(*continued*)

Table 3.
Constructs, variables and references

Practice	Code	Items	Authors*
Training people development	PEO1	Adopt training for skill building	8; 9
	PEO2	Adopt training for team building	
	PEO3	Adopt training for cross-functional skills	
Multifunctional employees	MEMP1	Employees measure and follow up on work	6; 8; 9
	MEMP2	Adopt multifunctional teams	
	MEMP3	Employees have multiple functions	
	MEMP4	Adopt cross-functional teams	
Leadership	LEAD1	Leaders have a coaching role and develop others	2; 8; 9
	LEAD2	Leaders support daily kaizen	
	LEAD3	Leaders create the vision and align goals	
	LEAD4	Leaders have thorough understanding of work	
Reward and recognition	REW1	Lean program is connected to human resources reward	4; 5; 7; 8
	REW2	Policies to recognize the team success in lean projects	
	REW3	Appropriate rewards provided to lean project members	
Sustainability performance			
Economic performance (ECP)	ECO1	Reduction in operational cost	10; 11
	ECO2	Improved competitiveness of business	
	ECO3	Productivity has gone up	
	ECO4	ROI has increased above the industry average	
	ECO5	Sales growth has increased above industry average	
	ECO6	Profit growth rate has increased above industry average	
	ECO7	Market share has increased in the last three years	
Environmental performance (ENP)	ENV1	Have substantially reduced energy consumption in facilities	10; 11
	ENV2	Have substantially reduced overall CO2 emission	
	ENV3	Have substantially reduced waste across processes	
	ENV4	Have achieved higher resource efficiency	
	ENV5	Have decreased resource consumption in processes	
	ENV6	Have substantially improved recycle of waste	
	ENV7	Have substantially improved reuse of resources	
Social performance (SOP)	SOC1	Social wellbeing across employees and community have improved	10; 11
	SOC2	Health and safety standard of our organization has improved	
	SOC3	Employee turnover has decreased	
	SOC4	Employee education and training have increased	
	SOC5	The employees' satisfaction and motivation have increased	
	SOC6	The employees' quality of life has increased	
	SOC7	We are actively engaged with the community	

Note(s): *(1) Shah and Ward (2007), (2) Liker and Convis (2011); (3) Alsmadi *et al.* (2012), (4) Laureani and Antony (2012); (5) Psychogios *et al.* (2012); (6) Malmbrandt and Åhlström (2013), (7) Albliwi *et al.* (2014); (8) Hadid *et al.* (2016), (9) Kundu and Manohar (2016) (10) Fernando *et al.* (2019); (11) Maletič *et al.* (2020)
Source(s): Author's own work

Table 3.

lower-order components of the higher-order construct in stage one, which will generate construct scores. These scores will be used in the second stage to evaluate the structural model (Sarstedt *et al.*, 2019).

The research model is depicted in Figure 1.

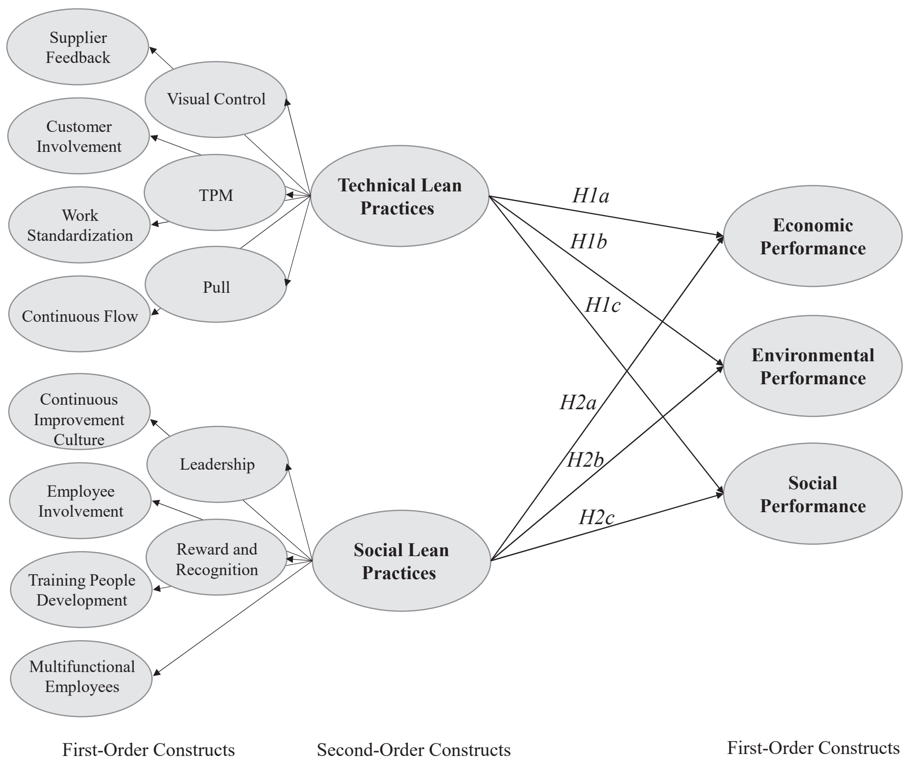

Figure 1.
Research model

Source(s): Author's own work

5. Results and discussion of findings

5.1 Validation of measurement model and hypotheses

The measurement model assessment aims to verify if the model satisfies all relevant criteria for reflective constructs: (1) internal consistency, measured by Cronbach's alpha (CA), composite reliability (CR), that must be above 0.70; (2) convergent validity, evaluated by the indicator reliability, in which the outer loadings for all indicators should be statistically significant and higher than 0.708 and Average Variance Extracted – AVE, which should be higher than 0.5; (3) and discriminant validity, assessed by heterotrait-monotrait ratio (HTMT), which should be less than 0.90 (Hair *et al.*, 2017a, b, ; Sarstedt *et al.*, 2019).

The model assessment first focuses on the lower-order components, and in stage two, it used the latent variable scores of the lower-order components obtained from stage one to estimate the model's criteria (Sarstedt *et al.*, 2019). Some items in lower-order constructs (EINV4, CIC2, LEAD2 and MENP1) were removed because they did not meet the threshold for indicator reliability or discriminant validity. Table 4 shows the results of the model measurement for first and second-order constructs. All lower-order and higher-order constructs meet the composite reliability and convergent validity criteria (Table 4).

Discriminant validity measures the distinctiveness of a construct ensuring that a construct measure is empirically unique and can be accessed via the HTMT criterion, which is the ratio of the between-trait correlations to the within trait correlations (Henseler *et al.*, 2015). HTMT has a 0.90 cutoff score for interpreting the results (Hair *et al.*, 2017a, b,).

Constructs	CA	CR	AVE	R2
Continuous improvement culture	0.928	0.954	0.874	–
Employee involvement	0.904	0.940	0.839	–
Leadership	0.910	0.944	0.848	–
Multifunctional employees	0.911	0.944	0.849	–
Reward and recognition	0.950	0.968	0.909	–
Training and people development	0.940	0.961	0.892	–
Continuous flow	0.881	0.919	0.741	–
Customer involvement	0.888	0.918	0.692	–
TPM	0.936	0.955	0.840	–
Pull	0.924	0.946	0.815	–
Supplier feedback	0.936	0.954	0.838	–
Visual control	0.923	0.946	0.813	–
Work standardization	0.913	0.938	0.792	–
Economic performance	0.942	0.951	0.683	0.627
Environmental performance	0.953	0.961	0.781	0.611
Social performance	0.946	0.954	0.675	0.618
Technical lean practices*	0.927	0.941	0.696	–
Social lean practices*	0.931	0.946	0.746	–

Note(s): *Second-order constructs
Source(s): Author's own work

Table 4. Convergent validity and reliability results

The discriminant validity between the higher-order construct and the lower-order construct is not of concern as conceptual and empirical redundancies are expected (Sarstedt *et al.*, 2019), therefore these relations are given. The HTMT results are shown in Table 5.

After assessing the measurement model, the structural model, which displays the relationships between the constructs, was evaluated (Hair *et al.*, 2017a, b). Latent variable scores for the lower-order constructs were used to estimate the structural model, which encompasses the collinearity between constructs (via the inner VIF values), significance and relevance of the path coefficients, the effect size ($f2$) and explanatory (R2) and predictive power (Hair *et al.*, 2018, 2020; Sarstedt *et al.*, 2019). Table 6 shows that the model has no collinearity problems, since the inner VIF values were less than 5.0 (Hair *et al.*, 2017a, b). The bootstrapping procedure (5,000 sub-samples) was used to verify path coefficient significance and relevance for hypothesis testing (Hair *et al.*, 2018, 2020).

The results in Table 6 show that all hypotheses were validated. The technical Lean practices have a positive and statistically significant impact on economic performance ($\beta = 0.413$; p-value = 0.001), environmental performance ($\beta = 0.411$; p-value = <0.001) and on social performance ($\beta = 0.219$; p-value = 0.036). Social Lean practices impacts directly and positively affects economic performance ($\beta = 0.422$; p-value = 0.001), environmental performance ($\beta = 0.413$; p-value = <0.001) and social performance ($\beta = 0.599$; p-value = <0.001). The PLS-SEM allows comparing the intensities of the relationships between the constructs (Hair *et al.*, 2017a, b). Furthermore, the f^2 effect size measures the importance of a specific construct to explain other endogenous latent variables (Hair *et al.*, 2018). f^2 values of 0.02, 0.15 and 0.35, represent respectively small, medium and large effects. The results show that the impact of social and technical Lean practices has a similar effect on economic and environmental performance, observing both the magnitude of the path coefficient and f^2. However, Table 6 shows that social Lean practices have a large effect ($f^2 = 0.337$; $\beta = 0.599$) on social performance, while technical Lean practices has a small effect on social performance ($f^2 = 0.045$; $\beta = 0.219$).

Table 5.
HTMT results

	Flow	CIC	CUS	ECP	EINV	ENP	LEAD	MEMP	Pull	REW	SOP	SUP	TPM	PEO	VCON	TLP*
FLOW																
CIC	0.75															
CUS	0.82	0.72														
ECP	0.70	0.78	0.74													
EINV	0.73	0.89	0.70	0.76												
ENP	0.69	0.73	0.68	0.74	0.69											
LEAD	0.77	0.86	0.72	0.75	0.87	0.74										
MEMP	0.64	0.79	0.62	0.64	0.75	0.62	0.71									
PULL	0.82	0.65	0.67	0.67	0.65	0.60	0.56	0.46								
REW	0.59	0.65	0.52	0.54	0.70	0.58	0.60	0.56	0.61							
SOP	0.65	0.79	0.70	0.79	0.75	0.76	0.76	0.62	0.54	0.60						
SUP	0.69	0.60	0.69	0.66	0.62	0.62	0.55	0.51	0.61	0.37	0.58					
TPM	0.69	0.70	0.57	0.62	0.63	0.69	0.67	0.59	0.64	0.60	0.61	0.65				
PEO	0.60	0.77	0.65	0.64	0.81	0.69	0.84	0.82	0.44	0.60	0.75	0.53	0.60			
VCON	0.87	0.85	0.66	0.69	0.76	0.71	0.74	0.62	0.78	0.66	0.65	0.65	0.84	0.64		
WST	0.76	0.69	0.64	0.57	0.63	0.60	0.68	0.41	0.60	0.47	0.62	0.55	0.70	0.51	0.81	
SLP*				0.79		0.78					0.82					0.86
TLP*				0.80		0.78					0.74					

Source(s): Author's own work

	VIF	f^2	Path (β)	Stdev	p-value
Social lean practices → economic performance	2.79	0.171	0.422	0.128	0.001
Social lean practices → environmental performance	2.79	0.158	0.413	0.1	<0.001
Social lean practices → social performance	2.79	0.337	0.599	0.099	<0.001
Technical lean practices → economic performance	2.79	0.164	0.413	0.124	0.001
Technical lean practices → environmental performance	2.79	0.156	0.411	0.104	<0.001
Technical lean practices → social performance	2.79	0.045	0.219	0.104	0.036

Note(s): Bootstrapping method – 5,000 sub-samples
Source(s): Author's own work

Table 6.
Hypothesis testing

Producing generalizable findings requires assessing whether the results not only apply to in-sample data (data that have been used in the model estimation process), but also to out-of-sample data sets (Shmueli *et al.*, 2019; Hair *et al.*, 2020). The coefficient of determination (R^2) measures the in-sample predictive power and research context determines acceptable R^2 levels (Hair *et al.*, 2017a, b; Shmueli *et al.*, 2019). Table 3 shows that the three endogenous constructs, economic performance, environmental performance and social performance are highly explained by the exogenous constructs (R^2 = >0.611). To assess the statistical model's predictive power, was confirmed: (1) the PLS-SEM Q^2_{predict} values are higher than 0 for all items; (2) the PLS-SEM values for the mean absolute error (MAE) was smaller than the values given by the linear regression model (LM) results for all items (Shmueli *et al.*, 2019). This suggests that the model has high predictive power (Shmueli *et al.*, 2019). Therefore, the structural model showed both in-sample and out-sample predictive power (Shmueli *et al.*, 2019).

5.2 Multigroup analysis

We considered the Lean implementation time and company size variables that could imply heterogeneity and differences in the model. Both variables were transformed to binary for this test. Lean implementation time was considered from 0 to 5 years and more than five years. Company size considered the number of employees, less than 250 was considered small or medium and companies with more than 250 employees were considered large. A multigroup analysis test was applied to verify the moderating effect results for all relationships (Sarstedt *et al.*, 2011; Hair *et al.*, 2018). The multigroup test was applied via permutation, and the first step was to verify the configural and compositional invariance assessed using the Measurement Invariance of Composite Models (MICOM) procedure (Henseler *et al.*, 2016; Hair *et al.*, 2018). The MICOM procedure must guarantee configural invariance (identical indicators, data treatment and identical algorithm settings across groups) and compositional invariance (the composite scores do not significantly differ across groups) so that multigroup analysis is applied (Hair *et al.*, 2018). The second step was to verify differences in the path coefficients in the permutation test (Hair *et al.*, 2018) considering the groups for time and size. There were no statistical differences in the path coefficients either for the two different Lean implementation time groups or for the two groups of company sizes (all p-values>0.05) (Table 7). Therefore, the results indicate that the hypotheses are confirmed and consistent regardless of the Lean implementation time and the size of the service company.

6. Conclusion, implications, limitations and directions for future research

Identifying the gap in the present body of work, this study through a global survey presents insights on Lean implementation and its effect on sustainable performance from different service organizations.

Relationships	Time (years) Up to 5	More than 5	Path difference	*P*-value	Size (employees) Up to 249	More than 250	Path difference	*P*-value
SLP → ECP	0.44	0.41	0.03	0.95	0.63	0.23	0.40	0.15
SLP → ENP	0.44	0.39	0.05	0.82	0.28	0.52	−0.24	0.29
SLP → SOP	0.53	0.64	−0.11	0.64	0.49	0.74	−0.25	0.25
TLP → ECP	0.44	0.37	0.07	0.87	0.24	0.60	−0.35	0.21
TLP → ENP	0.40	0.35	0.05	0.82	0.54	0.32	0.23	0.34
TLP → SOP	0.29	0.18	0.11	0.62	0.42	0.04	0.39	0.10

Note(s): *n* Group up to 5–63; *n* Group more than 5–53 (23 respondents do not answer)
n Group up to 249–50; *n* Group more than 250–89
Source(s): Author's own work

Table 7.
Multigroup analysis (permutation)

Our analyses show that both technical and social Lean practices have a positive impact on sustainable performance and its indicators such as environmental, economic and social performance. While comparing the effects it is observed that both technical and social Lean practices have a similar effect on environmental and economic performance, but their effect varies for social performance. Social Lean practices have a greater effect on social performance, which shows the importance of focus on continuous change in the system to align well with employees and their well-being (Morell-Santandreu *et al.*, 2021). We also analyzed the model from the perspectives of Lean implementation duration and company size. A multigroup analysis test was conducted to understand the moderating effect of the relationships and it is observed that the model is not affected either by implementation duration or by company size.

6.1 Implications

The study fills the gap of empirical studies in the field as mentioned by several authors such as Hadid and Mansouri (2014) and Hadid *et al.* (2016). They highlighted the lack of empirical studies in the Lean services research area. The study helped in understanding the effect of technical and social Lean practices on environmental, economic and social performance. Thus, it provides an understanding of technical and social Lean practices and their impact in this sector, which has its own characteristics and dynamics (Alsmadi *et al.*, 2012). This study advances the current body of work by providing an empirical model showing how sustainable performance indicators are affected by technical and social Lean practices and thus making the findings relevant for both theory and practice (Ali *et al.*, 2020). As we have observed from the literature that the discussion is still limited on the relation between sustainable performance and Lean practices. Thus, our research provides an indication for future researchers to start focusing on individual performance, i.e. environmental, economic and social and their relationship with technical and social Lean practices. Analysis also highlights that technical Lean practices have more effect on economic performance whereas Social Lean practices have more effect on social performance. This is useful information for practicing managers to focus both on technical and social side of Lean to enhance both economic and social performance. Further our study shows that there is no effect of company size and implementation time on achieving sustainable performance through the two Lean practices.

An earlier study by Lizarelli *et al.* (2022) suggests, awareness of managers toward technical and social Lean practices as they are complementary and further focusing on social practices strengthen all the dimensions of sustainability. The current research is also helpful for service managers who are adopting or wanting to implement Lean service. As company size and implementation time does not affect sustainable performance so, managers can focus more on developing a system for better employee involvement. This is also observed from our analyses where we found that social Lean practices have a better effect on social performance. Thus, this study is valuable for organizational leaders and managers alike as they can confidently implement both Lean practices for achieving triple bottom line while simultaneously satisfying customers.

6.2 Limitations and future studies

Very few empirical studies have focused on linking Lean practices with sustainable performance in the service sector. Thus, the literature addressing the link between technical and social Lean practices with sustainable performance is limited. The survey conducted provides a cross-sectional data, which has its inherent limitations such as lack of dimension of time, recall bias and difficulty in inferring causality due to issues in establishing time related sequence (Connelly, 2016). Hence in the future the focus will be to have longitudinal studies to gain deeper insights in understanding how Lean practices are implemented and their impact on environmental, economic and social performance. Finally, future studies can include a multi-methods study such as a combination of both qualitative and quantitative methods to provide deeper insights and allow for a greater level of generalizability of the study results.

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