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Importance of Continuous Improvement and Emerging Technologies on Service Sector Firms in an Emerging Economy

César A. Bernal-Torres[1*], Luis Paipa[2], Yavar Jarrah-Nezhad[3], Fernando Crespo[4]

[1]*International School of Economic & Administrative Sciences, Universidad de La Sabana (Colombia)*

[2]*Universidad de La Sabana (Colombia)*

[3]*Masters Program in Data Science, Escuela Colombiana de Ingeniería Julio Garavito (Colombia)*

[4]*Faculty of Economic and Business; Universidad Alberto Hurtado (Chile)*

cesar.bernal@unisabana.edu.co
[*]*Corresponding author: luispg@unisabana.edu.co*
yavar.jarrah@escuelaing.edu.co, fcrespo@uahurtado.cl

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Abstract:

Purpose: This study examines the impact of continuous improvement practices and emerging technologies on business performance in the service sector of an emerging economy. It seeks to identify whether these factors contribute positively to competitiveness and how their effects compare to findings from developed economies.

Design/methodology/approach: A survey was conducted among 85 senior executives from medium- and large-scale service companies. The data were analyzed using Principal Component Analysis (PCA), a multivariate statistical method widely used in social science research to identify key patterns and relationships.

Findings: The results contrast with studies in developed economies, where continuous improvement practices and technology adoption are strongly associated with enhanced business performance. In the context of this emerging economy, the findings suggest a more nuanced relationship, highlighting the need for further investigation into sector-specific and regional factors.

Research limitations/implications: The study is limited to a single emerging economy and focuses exclusively on the service sector. Future research could expand the sample size and explore additional industries to provide a more comprehensive understanding of these relationships.

Practical implications: The insights from this study can help business leaders refine their strategies for implementing continuous improvement and technological advancements, ensuring better alignment with the unique challenges of emerging markets.

Social implications: By improving business performance through strategic technological and process innovations, companies in emerging economies may enhance job stability, service quality, and overall economic development.

Originality/value: This study contributes to the ongoing discussion on business performance in emerging economies by providing empirical evidence from the service sector. It offers valuable insights for academics, entrepreneurs, and policymakers seeking to enhance competitiveness and adapt continuous improvement practices to dynamic economic conditions.

Keywords: continuous improvement, emerging technologies, industry 4.0, service sector, emerging economies

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1. Introduction

Various studies have indicated that the interrelationship between continuous improvement practices and technologies of the Fourth Industrial Revolution is an excellent strategy to enhance the competitive and sustainable capacity of companies, especially in the manufacturing sector (Gillani, Chatha, Sadiq-Jajja & Farooq, 2020; Kamble, Gunasekaran & Dhone, 2020; Schulze & Dallasega, 2023; Treviño-Elizondo, García-Reyes & Peimbert-García, 2023). These studies demonstrate that improvement practices are an effective strategy for implementing emerging technologies and that, complementarily, technologies also facilitate a better implementation of these practices. The efficient interrelationship of these two variables has a significant impact on business performance outcomes (Peças, Faustino, Lopes & Amaral, 2022; Rosin et al., 2020).

However, in the service sector, the research remains inconclusive. Companies in this sector lack understanding of how to integrate improvement practices and new technologies. Moreover, they are unclear about the benefits of such integration and consider that implementing both improvement practices and technologies requires significant investments, worker training, and cultural changes (Alsadi, 2023; Rossini, Cifone, Kassem, Costa & Portioli-Staudacher, 2021; Yilmaz, 2022).

Furthermore, research on the interrelationship between improvement strategies and new technologies in the context of companies in emerging economies is very scarce. The business culture regarding these topics is limited, reinforcing the need for more studies, especially because companies in these economies require improvements in their production or service delivery processes. These companies are characterized by being labor-intensive, with not highly qualified human capital, having limited financial resources, and pursuing short-term goals (Aguilar-Rodríguez, Bernal-Torres, Aldana-Bernal, Acosta-Aguinaga, Artieda-Cajilema & Chalá, 2021; Bernal, Paipa, Jarrah-Nezhad, Agudelo & Millán, 2021; Javaid, Haleem, Singh, Rab, Suman & Khan, 2022).

Given these challenges, this study aims to analyze the role of continuous improvement and emerging technologies in enhancing the performance of service sector companies within an emerging economy. The study focuses on understanding the unique characteristics of these companies and their ability to adopt and integrate continuous improvement strategies and advanced technologies. By doing so, we hope to provide insights that can inform decision-making among entrepreneurs, academics, and government officials, ultimately contributing to increased competitiveness and innovation within the service sector of emerging economies.

The content of the article is structured as follows: after this introduction, Section 2 presents the theoretical background of the research (continuous improvement, emerging technologies in the context of emerging economies); Section 3 describes the methodology applied in the study; Section 4 outlines the data processing, as well as the analysis and discussion of the results; Section 5 provides the conclusions, highlighting some theoretical and practical implications of the research findings for business managers, policymakers in the field of business, and scholars in economics and management, and offers recommendations for future research on the subject.

2. Theoretical Framework

2.1. Continuous Improvement

The findings of scientific research on continuous improvement practices–employing tools such as Lean, Operational Excellence, Six Sigma, TQM, Kaizen, 5S, Just-in-Time, and fishbone diagrams, among others–demonstrate a growing interest among managers in their implementation within organizations. This interest is explained by the significant

contributions these practices make to business performance, as reflected in process optimization, defect and waste reduction, the elimination of non-value-added activities, as well as time and cost savings, among other benefits (Carneiro, Nóvoa, Carvalho & Lamilla, 2025; Harry, Van-Aken & Glover, 2025; McDermott, Antony, Bhat, Jayaraman, Rosa, Marolla et al., 2022; Vinodh, Antony, Agrawal, Douglas, 2021).

Recent studies underscore the growing relevance of continuous improvement practices in the service sector, which has historically lagged behind manufacturing in adopting these methodologies (de-Jesus-Puppi, Nocera-Alves, Alves-Queiroz, Costa-Melo & do-Nascimento-Rebelatto, 2023; Sunder & Ganesh, 2021; Vanichchinchai, 2022). Techniques that were once predominantly applied in manufacturing are now increasingly recognized as essential in service industries, where the demand for efficiency and quality has risen significantly (Fenner, Arellano, von-Dzengelevski & Netland, 2023; Sunder & Ganesh, 2021).

While there is consensus in the literature regarding the positive impact of continuous improvement on the performance of manufacturing companies (Fenner et al., 2023; Schulze & Dallasega, 2023), the application of these practices in service companies remains contentious (Harry et al., 2025; Monteiro, Rocha, Miguéis & Afonso, 2024). This is because service delivery often lacks the predictability and standardization found in manufacturing processes, making it more challenging to consistently achieve comparable levels of efficiency (Monteiro et al., 2024; Fenner et al., 2023; Dombrowski & Malorny, 2018).

Additionally, service companies tend to focus more on ensuring quality of service delivery rather than on productivity and waste reduction, which are often the primary goals in manufacturing (Alsadi, Antony, Mezher, Jayaraman & Maalouf, 2023; Ortega, Amrani & Vallespir, 2022; Vanichchinchai, 2022). The literature points out that the alignment between continuous improvement practices and quality is not always effectively achieved in the service sector, leading to inefficiencies (Vanichchinchai, 2022).

Nevertheless, several studies have examined the application of continuous improvement tools in service-sector companies, particularly in the financial, healthcare (hospitals), food, and hospitality subsectors, among others. Their findings demonstrate that the use of these tools has a significantly positive impact on organizational performance (Monteiro et al., 2024; Harry et al., 2025; Suarez-Barraza & Huertas-Carvajal, 2024; Alamsjah & Asrol, 2023; Vanichchinchai, 2022).

Accordingly, this research aimed to provide empirical evidence on the relationship between continuous improvement, the use of emerging technologies, and business performance in medium- and large-sized service-sector firms within the context of an emerging economy, with the purpose of contributing to a deeper understanding of this relationship.

2.2. Emerging Technologies

Emerging technologies, particularly those associated with Industry 4.0, have garnered significant attention for their transformative potential across various sectors. Studies have shown that companies in developed economies are increasingly adopting these technologies to address the complexities of modern competitive environments (Cañas, Mula, Díaz-Madroñero & Campuzano-Bolarín, 2021; Chong, Ramakrishna & Singh, 2018). However, the adoption of these technologies is notably slower in companies from emerging economies, and this disparity is particularly evident in the service sector (Tapera, Hamunakwadi, Mashapure, Mthombeni & Mutanda, 2025; Canbay & Akman, 2023; Xu, Xu & Li, 2018).

Emerging technologies such as process automation, digital automation, cloud computing, the Internet of Things (IoT), artificial intelligence, virtual and augmented reality, 3D printing, and others are being implemented to enhance efficiency, flexibility, and responsiveness in service delivery (Alsadi et al., 2023; Ghobakhloo & Fathi, 2020; Rudrapati, 2022). Nevertheless, although these technologies provide substantial benefits, their adoption in the service sector remains limited, often due to financial constraints and a shortage of skilled labor (Alvarez-Aros & Bernal-Torres, 2021; Narula, Puppala, Kumar, Frederico, Dwivedy, Prakash et al., 2021).

The literature highlights the need for developing countries to enhance their technological competencies, particularly in the service sector, to remain competitive in a globalized economy (Moraes, Carvalho & Sampaio, 2023; Stentoft, Adsbøll-Wickstrøm, Philipsen & Haug, 2020; Yilmaz, Dora, Hezarkhani & Kumar, 2022). This suggests that more

attention should be paid to how emerging technologies can be leveraged in service industries to address evolving stakeholder demands and environmental challenges.

2.3. Continuous Improvement, Emerging Technologies, and Business Performance

The interaction between continuous improvement practices and emerging technologies has the potential to significantly enhance business performance, offering increased operational flexibility and competitive advantage (Kumar, Dadwal, Verma & Kumar, 2025; Fallahiarezoudar, Ahmadipourroudposht, Bagherian-Rafi & Ngadiman, 2025; Miqueo, Torralba & Yagüe-Fabra, 2020; Treviño-Elizondo et al., 2023; Yilmaz, 2022). This synergy is particularly valuable when these strategies are adopted in tandem, allowing firms to optimize processes, reduce waste, and meet customer demands more efficiently (Bernard, Budde, Hänggi & Friedli, 2025).

In this regard, Bernard et al. (2025) analyzed the role of emerging technologies in continuous improvement and their overall impact on operational efficiency in five European manufacturing companies. Using qualitative content analysis and case comparison to identify patterns and key insights, they concluded that the adoption of new technologies–such as process automation, artificial intelligence, and the Internet of Things–positively influences continuous improvement in five key areas: increased flexibility, error reduction, improved product quality, enhanced decision-making, and more effective implementation of change processes.

As evidenced by the aforementioned reference, most of the existing literature focuses on manufacturing firms in developed economies, leaving a gap in understanding how these practices and technologies interact in service companies, especially in emerging markets (Kumar et al., 2025; Alsadi et al., 2023; Rosin, Forget, Lamouri & Pellerin, 2020).

In this regard, Kumar et al. (2025), when analyzing the role of emerging technologies in the sustainability and growth of firms in emerging markets–characterized by unique challenges for technological transformation such as cultural differences, limited financial resources to invest in technology, restricted access to advanced technologies, insufficient availability of qualified human capital for their implementation, and, in many cases, the absence of a culture of continuous improvement–found a positive relationship among the variables evaluated. As a result, they propose a model that enables firms in emerging economies to develop a clear strategy to enhance their performance through investment in technological capabilities, the promotion of an innovation-oriented culture, and the institutionalization of continuous improvement.

Complementarily, Tortorella, Miorando, Caiado, Nascimento and Portioli-Staudacher (2021), in their study on the relationship between employee participation, the adoption of Industry 4.0 technologies, and the improvement of operational performance through continuous improvement practices–based on a survey of 147 Brazilian manufacturers–demonstrated that employee participation exerts a positive mediating effect on the relationship between the adoption of Industry 4.0 technologies and the enhancement of firms' operational performance. Consequently, the authors encourage managers to leverage this relationship to strengthen the competitive capacity of their organizations.

Despite the potential benefits, the implementation of both continuous improvement practices and emerging technologies in service firms faces several challenges. A primary issue is the limited awareness among entrepreneurs and managers regarding the advantages of these practices, particularly in terms of their ability to drive long-term business performance (Najwa, Bertrand, Yassine, Fernandes, Abdeen & Souad, 2022). Many service firms, particularly in emerging economies, still focus on short-term objectives, further complicating the adoption of forward-thinking strategies like Industry 4.0 technologies and continuous improvement methodologies.

Moreover, the literature highlights that while there are numerous studies showcasing the benefits of these practices in manufacturing, there is a paucity of research that examines their impact on the service sector. As a result, there is a pressing need for more targeted studies to bridge this knowledge gap, enabling service-oriented firms, especially those in emerging markets, to effectively implement and benefit from continuous improvement and technological advancements (Moraes et al., 2023; Vanichchinchai, 2022).

3. Methodology

To examine the relationship between continuous improvement practices, emerging technologies, and business performance, this study employed a survey methodology targeting senior executives from medium and large service companies in an emerging economy. The research focused on companies operating within the last five years.

3.1. Sample and Data Collection

A total of 150 senior executives from the most recognized medium- and large-sized service companies in the country were invited to participate. After presenting the research objectives to the executives, 107 agreed to participate, and 96 completed the survey. Following data cleaning, which involved removing incomplete responses, a final sample of 85 valid surveys was used for analysis. The invitation of 150 business executives (one per company) was based on the fact that this figure represents approximately 80% of the medium- and large-sized private companies in the sector located in the country's capital city, where the research was conducted.

3.2. Survey Instrument

The survey consisted of four sections designed to capture comprehensive data on company characteristics and practices:

- General Company Information: This section included items related to the economic sector, international presence, number of employees, company nature, and years of operation.
- Continuous Improvement Strategies: A total of 24 Likert-scale items (ranging from 1 to 5) were developed based on the literature on continuous improvement (Fenner et al., 2023; Gupta, Sharma & Sunder, 2016), covering practices such as waste elimination, process optimization, and customer engagement.
- Use of Emerging Technologies: This section featured 10 Likert-scale items (ranging from 1 to 5) developed in alignment with existing research on the use of technologies like automation, IoT, and cloud computing (Alsadi et al., 2023; Neumann, Winkelhaus, Grosse & Glock, 2020).
- Organizational Performance Indicators: The final section assessed 19 performance indicators (also using a Likert-scale from 1 to 5), including factors such as service quality, operational efficiency, and market competitiveness.

The survey was administered both in person (62%) and through digital means (38%), with the support of a group of final-semester students from the International School of Economic and Administrative Sciences at Universidad de La Sabana, who had previously received specific training for this purpose.

3.3. Data Analysis

Once data collection was completed, the survey responses were analyzed using Principal Component Analysis (PCA), a technique well-suited for reducing the dimensionality of large datasets while preserving the most significant patterns (Abdi & Williams, 2010). PCA was chosen because it helps to identify key components that explain the variance in complex datasets, making it particularly useful for uncovering relationships between continuous improvement practices, emerging technologies, and performance metrics.

Prior to conducting PCA, the dataset's suitability for this analysis was confirmed using Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy. Bartlett's Test showed significant correlations among the variables ($p < 0.05$), and the KMO value was 0.86, indicating that the data were appropriate for PCA.

PCA was conducted separately for each of the three areas under study: (1) continuous improvement practices, (2) adoption of emerging technologies, and (3) organizational performance indicators. This method allowed researchers to identify distinct components that contributed to each of these areas and to evaluate the relationships between them.

The results of the PCA were used to interpret how service firms in the emerging economy are integrating continuous improvement practices and technologies, and how these integrations are influencing overall business performance. The findings also provided insights into the specific challenges and opportunities faced by service companies in these regions when implementing such strategies.

4. Results and Discussion

This section presents the findings of the survey and offers a detailed discussion of the implications in relation to existing literature. The results are presented in three main areas: (1) descriptive analysis of emerging technology use and continuous improvement practices, (2) organizational performance outcomes, and (3) the results from Principal Component Analysis (PCA). Eleven tables summarize the data and support the analysis.

4.1. Descriptive Analysis

The companies surveyed operated in sectors such as finance, healthcare, hospitality, insurance, restaurants, retail, technology, and logistics, among others. On average, these organizations had 38 years of activity and 2,360 employees, reflecting the size and maturity typical of large service companies in the country.

4.1.1. Continuous Improvement Practices

Table 1 reveals the actions contributing most to the successful implementation of continuous improvement (CI) strategies within service companies. Maintaining close contact with customers (4.21) and engaging in frequent dialogue about customer requirements (4.15) were among the most highly rated practices. This customer-centric focus is crucial in-service delivery, where tailoring offerings to client needs is often more challenging than in manufacturing. These results echo the findings of Alsadi et al. (2023) and Vanichchinchai (2022), who noted that service sector firms are less likely than manufacturers to engage in rigorous process analysis and facility optimization, likely due to the intangible nature of services and the unpredictability in service delivery outcomes.

Furthermore**,** these results may be attributed to companies' concern with meeting customer needs as a strategy to cope with the increasingly intense competition from global firms in the sector originating from developed countries, as noted by Tran, Nguyen & Phan (2025), and Tapera et al. (2025).

Interestingly, the least adopted CI practices included the use of diagrams to identify the causes of quality problems (3.11) and adjusting facility design to align with service offerings (3.45). These results generally contrast with the findings of Monteiro et al. (2024), Suarez-Barraza and Huertas-Carvajal (2024), Alamsjah and Asrol (2023), and Vanichchinchai (2022), whose studies in the financial, healthcare, food, and hospitality sectors demonstrate that the use of continuous improvement practices has a positive impact on organizational performance in those service subsectors. This finding highlights the importance for service companies in emerging economies to carefully examine the potential benefits that continuous improvement practices can provide in strengthening their performance.

Improvement Strategies or Practices	Average
1. Collaborating with technology and input suppliers.	3.95
2. Frequent dialogue with suppliers about quality of inputs or required services.	4.07
3. Involving suppliers in the development of new services.	3.96
4. Requiring timely delivery of inputs or services from suppliers.	3.89
5. Having a formal supplier certification program.	3.68
6. Having suppliers committed to cost reduction.	3.47
7. Requiring timely availability from technology suppliers.	3.60
8. Selecting suppliers by service category.	3.59
9. Having suppliers that support service management.	3.44
10. Being in close contact with customers.	4.21
11. Frequent dialogue with customers about their requirements.	4.15
12. Involving customers in the design of current and future services.	3.81
13. Offering services based on demand.	3.78
14. Controlling service delivery through technological processes.	3.76

Improvement Strategies or Practices	Average
15. Classifying services into groups by similarities.	3.84
16. Grouping technologies for the continuous flow of similar services.	3.69
17. Adjusting facility design to offered services.	3.45
18. Making adjustments to reduce the time required for service delivery.	3.76
19. Reducing installation or repair times for service delivery technologies.	3.78
20. Having service delivery processes under statistical control.	3.64
21. Using diagrams to identify causes of quality problems in service delivery processes.	3.11
22. Conducting capacity studies of the process before launching new services.	3.55
23. Considering employees as key to solving service delivery problems.	3.80
24. Motivating employees to improve their service or process.	3.80
25. Regular maintenance of technologies used for service delivery and keeping records.	3.89

Table 1. Average scores for the use of improvement practices

4.1.2. Use of Emerging Technologies

The data presented in Table 2 highlights that, on average, service sector companies included in this study exhibit a moderate level of technology adoption, particularly Industry 4.0 (i4.0) technologies. Notably, the use of digital automation for service provision scored relatively high (4.13), alongside the adoption of digitization practices (4.11) and analytics for data processing (4.05). These results align with the propositions made by Cañas et al. (2021) and Xu et al. (2018), who emphasized that the implementation of i4.0 technologies in service sector firms, particularly in emerging economies, remains less prevalent compared to their manufacturing counterparts.

Emerging Technologies	Average
1. Use of digital automation for service delivery.	3.96
2. Use of monitoring for service delivery.	3.52
3. Use of technologies for provided services.	4.13
4. Use of virtual and augmented reality for service design and delivery.	3.41
5. Use of artificial intelligence for service design and delivery.	3.45
6. Use of simulation systems for service design and delivery.	3.86
7. Use of analytics for data collection, processing, and analysis.	4.05
8. Use of cloud computing.	3.99
9. Use of digital interconnections in services (Internet of Things).	3.94
10. Use of process digitization in service delivery.	4.11

Table 2. Average scores for the use of technologies by companies

The lower scores for technologies such as virtual and augmented reality (3.41) and artificial intelligence (3.45) suggest that while there is some integration of advanced digital tools, many service firms have yet to fully capitalize on the potential of emerging technologies. These findings corroborate previous studies which argue that service sector companies, especially in emerging markets, tend to adopt i4.0 technologies at a slower rate due to financial constraints and lack of infrastructure (Chong et al., 2018).

Nevertheless, as Kumar et al. (2025) point out, although the incorporation of new technologies in firms from emerging markets faces unique challenges for technological transformation–such as cultural differences, limited financial resources for technology investment, restricted access to these technologies, insufficient availability of

qualified human talent, and, in many cases, the absence of a culture of continuous improvement–it is imperative that these companies implement strategies to overcome such barriers. This is particularly important because these technologies are currently shaping, to a great extent, people's lives, organizational activity, and the dynamics of society.

4.1.3 Organizational Performance Indicators

The data in Table 3 demonstrates that, overall, service companies show acceptable performance across a variety of organizational metrics, with most scores ranging between 3.5 and 4.0 on a 5-point scale. The highest-performing indicators include significant improvements in provided services (4.21), reduction in work accidents (4.16), and improvements in relationships with customers (4.13). These results suggest that service companies are successfully focusing on safety, service quality, and customer satisfaction.

Organizational Performance Indicators	Average
1. Improvements in processes, times, and service quality.	4.08
2. Reduction of difficulties and work accidents.	4.16
3. Significant improvements in services.	4.21
4. Technological updates for service delivery.	3.42
5. Improvements in company administration.	3.86
6. Company concern for the environment.	3.79
7. Improvements in company relationships with the community.	3.97
8. Improvements in company relationships with state entities.	3.81
9. Improvements in organizational climate.	3.98
10. Adoption of international standards by the company.	3.89
11. Improvements in relationships with customers.	4.13
12. Improvements in relationships with suppliers.	3.97
13. Improvements in market positioning.	4.09
14. Access to new markets.	3.75
15. Reduction of process costs for service delivery.	3.65
16. Improvement in flexibility for service design and delivery.	3.57
17. Decrease in non-conformance complaints.	3.62
18. Increase in service sales.	3.81
19. Improvement (increase) in company profits.	3.76

Table 3. Average scores for organizational performance indicators

Nonetheless, the relatively lower scores for technological updates (3.42) and process flexibility (3.57) indicate that there is still considerable room for improvement in adapting business operations to rapidly evolving technological environments and client demands. These challenges are well documented in the literature, where scholars such as Tapera et al. (2025), Canbay and Akman (2023), and Schulze and Dallasega (2023) emphasize the growing importance of technological agility in maintaining competitiveness and responding to constant and unpredictable environmental changes–conditions increasingly shaped by the rapid and equally unpredictable pace of technological advancements (Kumar et al., 2025).

4.2. Principal Components Analysis

4.2.1. Emerging Technologies Use

Bartlett's Test for the items related to digital technology use returned a value of 3.7028 (p-value = 0.93), indicating that the assumption of multicollinearity among the variables was rejected. The KMO measure of 0.86 confirmed that the data were suitable for PCA.

Table 4 provides the results of a Principal Components Analysis (PCA) applied to the variables associated with emerging technology usage. Four key components were identified, accounting for 82.66% of the variance in the dataset. The first component alone explains 58.0% of the variance and is strongly associated with the use of simulation systems for service design and delivery, which aligns with existing literature that highlights the growing importance of digital automation and real-time process control in enhancing efficiency (Anvari, Edwards & Agung-Yuniarto, 2020).

Component	Impact	% Variance	% Cumulative Variance
Component 1	5.800	58.003	58.003
Component 2	1.053	10.528	68.532
Component 3	0.786	7.861	76.392
Component 4	0.626	6.264	82.657

Table 4. Principal Components for the Use of Technologies

This suggests that the most impactful technological advancements for service firms lie in enhancing process simulation and automation capabilities. However, it is important to note that lower-weighted components, such as monitoring systems, suggest areas where companies might improve by integrating more sophisticated monitoring and analytics tools into their service delivery processes.

Overall, as previously noted, these results contrast with empirical evidence from several studies that emphasize the importance of Industry 4.0 technologies for organizational performance, regardless of sector or context. These studies call for the evaluation and adoption of such technologies as a key strategy to ensure organizational continuity and sustainability in the coming years, a need that becomes particularly critical in the context of firms operating in emerging economies (Kumar et al., 2025; Tapera et al., 2025; Fallahiarezoudar et al., 2025; Bernard et al., 2025).

Table 5 complements this analysis by showing the most relevant items within the principal components, where simulation systems and automation consistently appear as key factors in explaining the variance in digital technology adoption. Monitoring and remote-control systems, while less prominent, also play a role, particularly in enhancing flexibility and real-time service adjustments.

The correlations between the emerging technology items and the first principal component are notably high, suggesting that these technologies constitute an integrated structural system for firms, carrying equal importance for their adoption. In this sense, emerging technologies tend to be perceived as an organic and comprehensive whole.

Interestingly, the second component shows a strong positive correlation with use of monitoring for service delivery and a negative correlation with use of digital interconnections in services (Internet of Things). This indicates that firms prioritize monitoring product delivery routes to customers over interconnecting devices, which can be interpreted as a "service-interest component."

Similarly, the third component exhibits a strong correlation with use of digital automation for service delivery, reflecting a greater emphasis on tracking and ensuring compliance with customer requirements.

Items for the Use of Digital Technologies	Comp. 1	Comp. 2	Comp. 3	Comp. 4
1	**0.713**	0.277	0.517	-0.017
2	**0.633**	**0.555**	0.330	-0.151
3	**0.663**	0.330	-0.212	**0.476**
4	**0.841**	0.210	-0.288	-0.172
5	**0.803**	0.123	-0.385	-0.252
6	**0.853**	-0.035	-0.230	0.084
7	**0.840**	-0.179	0.014	0.276
8	**0.741**	-0.372	0.267	0.196
9	**0.740**	**-0.490**	0.076	-0.007
10	**0.756**	-0.298	0.059	**-0.403**

Table 5. Most Relevant Items of Principal Components for the Use of Emerging Technologies

Finally, the fourth component reveals a strong positive correlation with use of technologies for provided services, combined with a negative correlation with use of process digitization in service delivery. This suggests that efforts to improve service provision are not necessarily aligned with digitalization progress, thereby highlighting a technological lag between the imperative need and the actual advances achieved.

4.2.2 Continuous Improvement Practices

The Bartlett's Test for the items in Table 2 related to improvement actions is 64.698 with 24 degrees of freedom and p-value < 0.01, assuming multicollinearity among the items. The KMO test for all items is 0.81, which is a good level of acceptability, indicating that performing the principal components analysis is meaningful.

The PCA of CI practices, as shown in Table 6, revealed that these strategies could be grouped into 10 components, explaining 81.30% of the total variance. The first component, accounting for 33.7% of the variance, emphasizes practices such as statistical control of service delivery processes and the reduction of installation times for service technologies. These elements, which have been found to significantly enhance service quality, are supported by prior studies (Alsadi et al., 2023; Vanichchinchai, 2022).

Component	Impact	% Variance	% Cumulative Variance
Component 1	8.430	33.718	33.718
Component 2	2.896	11.585	45.304
Component 3	2.143	8.572	53.876
Component 4	1.299	5.195	59.071
Component 5	1.169	4.677	63.748
Component 6	1.110	4.440	68.188
Component 7	0.927	3.709	71.896
Component 8	0.881	3.522	75.418
Component 9	0.751	3.005	78.423
Component 10	0.720	2.879	81.303

Table 6. Principal Components of Improvement Strategies in Service Companies

Table 7 provides a detailed breakdown of the most relevant items within each component, highlighting the key practices that drive continuous improvement efforts. Statistical control, close contact with customers, and the

reduction of service delivery times emerge as the main contributors to improvement outcomes. This finding indicates that the combination of customer engagement and process control constitutes an essential requirement for service companies to achieve higher levels of efficiency.

In this regard, it is important to note that scientific research on continuous improvement practices in firms from developed economies has documented the growing interest of managers in their implementation, given the magnitude of the contributions these practices make to organizational performance. Such contributions include process optimization, error reduction, the elimination of non–value-added activities, and savings in time and costs, among other benefits (Carneiro et al., 2025; Harry et al., 2025; McDermott et al., 2022; Vinodh et al., 2021). These findings are particularly relevant for service companies in emerging economies, as they represent an empirical criterion of competitive capability and strategic sustainability.

Items Improvement Practices	Comp. 1	Comp. 2	Comp. 3	Comp. 4	Comp. 5	Comp. 6	Comp. 7	Comp. 8	Comp. 9	Comp. 10
1	**0.584**	0.374	-0.243	-0.183	0.198	-0.113	0.066	0.128	-0.191	0.152
2	**0.569**	0.406	-0.254	-0.187	0.297	-0.241	0.198	0.128	-0.091	0.128
3	**0.503**	0.459	-0.158	-0.339	-0.134	-0.187	0.266	0.007	-0.239	0.005
4	0.414	0.402	0.100	0.028	0.124	0.070	-0.264	0.578	0.366	0.125
5	0.348	**0.494**	0.197	0.074	-0.066	**-0.430**	-0.027	-0.300	0.248	0.194
6	0.487	**0.470**	0.312	-0.117	-0.281	-0.228	-0.082	-0.010	0.043	-0.170
7	**0.519**	0.261	0.505	-0.004	-0.002	0.329	0.268	-0.114	0.133	0.045
8	**0.519**	0.206	0.369	-0.211	0.052	**0.414**	0.229	-0.276	0.162	0.029
9	0.358	0.294	**0.541**	0.160	0.180	0.271	-0.019	0.229	-0.294	-0.234
10	0.505	0.429	-0.408	0.049	0.137	0.257	-0.172	-0.178	-0.091	-0.327
11	0.426	0.425	**-0.568**	0.015	0.263	0.176	-0.259	-0.137	0.159	-0.065
12	0.346	0.303	-0.266	**0.670**	-0.188	0.159	-0.070	-0.086	-0.135	0.147
13	0.492	-0.012	-0.086	**0.572**	-0.090	-0.013	0.475	0.174	0.132	0.131
14	**0.559**	-0.065	-0.307	0.055	**-0.493**	-0.127	0.163	0.118	-0.072	-0.315
15	**0.730**	-0.207	-0.207	-0.043	-0.319	0.156	-0.160	0.000	-0.043	0.182
16	**0.736**	-0.167	-0.094	-0.092	-0.163	0.243	-0.091	-0.100	-0.217	0.337
17	**0.615**	-0.387	0.064	-0.319	-0.162	0.131	-0.179	0.109	-0.056	0.239
18	**0.693**	-0.320	-0.116	-0.064	-0.101	0.027	-0.061	0.111	0.234	-0.118
19	**0.762**	-0.327	-0.019	-0.079	-0.086	0.045	0.045	0.185	0.081	-0.211
20	**0.813**	-0.085	0.199	-0.103	-0.100	-0.134	-0.023	-0.090	0.095	-0.152
21	**0.647**	-0.015	0.442	0.168	-0.036	-0.185	-0.314	-0.151	-0.088	-0.001
22	**0.558**	-0.166	0.377	0.267	0.193	-0.290	-0.218	0.047	-0.237	0.014
23	**0.634**	**-0.493**	0.037	0.047	0.350	-0.015	0.125	-0.103	-0.114	-0.051
24	**0.674**	**-0.485**	-0.066	0.023	0.379	-0.084	0.152	0.051	0.026	-0.001
25	**0.666**	-0.391	-0.225	0.094	0.169	-0.157	-0.026	-0.256	0.218	-0.057

Table 7. Most Relevant Items (Correlation) in Each Principal Component of Improvement Practices

With reference to the results presented in Table 7, it is particularly relevant to examine the meaning of the components associated with the most significant improvement strategies or practices. Component 1 shows a strong correlation with variables related to supply, customer relations, and delivery, and can thus be interpreted as a

dimension linked to business logistics. Component 2 articulates supplier development with cost considerations and employee motivation to improve service delivery. Component 3 links supplier management with customer relations for requirement analysis, thereby reflecting the integration between suppliers and the final service outcome. Component 4 relates to the development of future services and their anticipated demand. Component 5 focuses exclusively on delivery control through technological processes. Finally, Component 6 underscores the importance of supplier selection. Taken together, these six components provide a comprehensive perspective on how strategies are structured to strengthen organizational practices.

These results demonstrate that, although continuous improvement practices and their components constitute a structured pathway for enhancing organizational efficiency, their strategic implications are even more critical for service companies in emerging economies. In such contexts, firms face structural challenges (resource limitations, capability gaps, and institutional constraints) that hinder the systematic adoption of these practices. Consequently, the analysis of the interaction among these components not only offers insights into how improvement strategies are constructed but also underscores the need for tailored approaches that enable service firms in emerging markets to transform these practices into sustainable sources of competitive advantage.

4.2.3. Combined Analysis of Improvement Practices and Digital Technologies

The Bartlett's Test for the set of items from both improvement strategies and the use of digital technologies, using all variables, is 164.2 with 34 degrees of freedom and p-value <0.01, assuming multicollinearity among the variables. The KMO test for all variables is 0.78, a good level indicating that performing the principal components analysis is meaningful.

The combined analysis of CI practices and digital technology usage, illustrated in Table 8, shows a cumulative variance of 80.53%. The first two components, which together account for 41.66% of the variance, suggest that the integration of both CI practices and digital technologies is essential for improving cost-efficiency and expanding market access.

Component	Impact	% Variance	% Cumulative Variance
Component 1	10.191	29.118	29.118
Component 2	4.390	12.542	41.659
Component 3	2.988	8.537	50.196
Component 4	2.317	6.619	56.815
Component 5	1.346	3.846	60.661
Component 6	1.255	3.586	64.247
Component 7	1.149	3.282	67.529
Component 8	1.066	3.046	70.575
Component 9	0.966	2.760	73.334
Component 10	0.932	2.663	75.998
Component 11	0.805	2.299	78.297
Component 12	0.783	2.237	80.534

Table 8. Principal Components of the Combined Items Used to Evaluate Improvement Practices and Technologies

However, the data also indicates a relatively weak correlation between digital technology use and overall organizational performance. This finding is consistent with the literature, which suggests that many service companies, particularly in emerging economies, have yet to fully understand or harness the potential of Industry 4.0 technologies (Moraes et al., 2023; Yilmaz, 2022). Therefore, additional research and a focus on knowledge transfer may be needed to overcome these barriers and unlock the full potential of these technologies.

Table 9 highlights the correlation between digital technology use and organizational performance. While the correlation remains weak overall, certain indicators, such as cost reduction in service delivery and access to new markets, show some positive association with digital technology adoption. However, these correlations are not strong enough to suggest a significant impact of technology on overall business performance, as observed in other sectors like manufacturing (Cañas et al., 2021).

Similarly, Table 10 reveals a lack of strong correlations between CI practices and performance metrics. The only significant correlation (0.558) was found between improvements in service delivery times and the first CI component. This further underscore the need for service companies to better align their CI strategies with their specific operational and performance goals, as suggested by Kumar et al (2025), Tortorella, Gloet, Samson, Kurnia, Fogliatto and Anzanello (2025) y Vanichchinchai (2022).

Finally, Table 11 shows that there is a minimal correlation between the principal components of CI strategies, digital technology usage, and general business characteristics such as company size, years of activity, and international presence. This reinforces the idea that the impact of these practices and technologies is context-specific and not necessarily tied to organizational scale or longevity.

Items of Performance Indicators	Comp. 1	Comp. 2	Comp. 3	Comp. 4
1	0.377	0.011	-0.024	0.369
2	0.334	-0.092	0.011	0.142
3	0.274	-0.032	-0.092	0.214
4	0.350	0.039	-0.081	0.056
5	0.355	0.014	-0.027	0.166
6	0.159	-0.113	-0.165	0.062
7	0.015	-0.133	-0.017	0.108
8	0.256	-0.246	0.096	0.137
9	0.285	-0.113	-0.038	0.027
10	0.381	-0.183	0.091	-0.022
11	0.259	-0.100	-0.041	0.076
12	0.172	-0.178	-0.096	-0.033
13	0.249	-0.076	0.009	0.085
14	**0.454**	-0.092	0.002	0.044
15	**0.487**	-0.101	0.117	-0.012
16	**0.484**	-0.071	0.165	0.058
17	0.279	-0.174	0.023	-0.090
19	0.282	-0.178	-0.049	0.051
20	0.289	-0.109	-0.175	0.016

Table 9. Correlation of Performance Indicators with Technology Use Components

5. Conclusions

The results of this study indicate that service-sector firms demonstrate interest in continuous improvement practices, particularly those related to customer service. Nevertheless, their commitment to practices associated with process optimization, defect and waste reduction, elimination of non-value-added activities, and the achievement of time and cost savings remains very limited. These firms also express interest in adopting emerging technologies; however, their implementation is primarily confined to service delivery activities, with scarce application in other operational domains. In this sense, the integration of these strategies is neither widespread nor fully optimized,

especially in service organizations where the relationship between continuous improvement practices, digital technology adoption, and organizational performance remains ambiguous. The weak correlations identified in this study suggest that companies have not yet fully understood or leveraged the potential synergies between these two strategic approaches.

In contrast, evidence from developed economies demonstrates that the adoption of Industry 4.0 technologies combined with continuous improvement practices has a direct and positive effect on business performance. Notwithstanding these findings, service firms in emerging economies appear to face significant challenges in aligning such strategies with their operational objectives. This discrepancy highlights the need for more targeted research that considers the distinctive conditions of emerging markets and service-oriented businesses. Overall, although the potential benefits of integrating continuous improvement practices with digital technologies are evident, the complexity of service operations together with the resource constraints typical of emerging economies continues to hinder their effective implementation.

5.1. Theoretical Implications

This study contributes to the ongoing discussion about the relationship between CI practices, i4.0 technologies, and business performance, particularly in the service sector and within the context of emerging economies. Current research on this topic is limited, especially regarding service companies that operate under different economic, cultural, and infrastructural conditions than those in developed markets. By examining this dynamic, the study provides a nuanced understanding of how these strategies interact in a less mature business environment.

The findings support the need for more theory-building efforts that explore the specific challenges and opportunities that service companies in emerging economies face when attempting to adopt CI practices and digital technologies. Unlike the manufacturing sector, where these strategies are more commonly studied and applied, the service sector presents unique obstacles that must be addressed, such as the intangible nature of service delivery and the variability in customer demands. Therefore, this research opens avenues for further exploration into how service firms can better integrate and adapt these strategies to their unique operational environments.

5.2. Practical Implications

For practitioners, the results underscore the importance of a more strategic and informed approach to adopting CI practices and i4.0 technologies in the service sector. Executives and entrepreneurs in emerging economies need to recognize that while these strategies have proven beneficial in other sectors and regions, their successful implementation requires a tailored approach that considers the specific needs and limitations of their business context.

Service firms should focus on developing the internal capabilities necessary to support the integration of these strategies. This includes investing in employee training, fostering a culture of innovation, and improving supplier relationships to enable more effective collaboration in implementing CI and digital technologies. Moreover, government policymakers and industry leaders should provide greater support for service companies, offering incentives and frameworks that help lower the barriers to adopting these advanced strategies, thereby boosting competitiveness and long-term sustainability.

Declaration of Conflicting Interests

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