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Integrating Sustainability Management and Lean Practices for Enhanced Supply Chain Performance: Exploring the Role of Process Optimization in SMEs

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Abstract: The paper aims to investigate the integration of sustainability management and lean practices in small and medium enterprises (SMEs) and its impact on supply chain performance. The study also explores the mediating role of process innovation in this relationship. Sustainability has gained significant attention in recent years as organizations strive to align their operations with environmental and social responsibility goals. Similarly, lean practices have been widely adopted to streamline processes and eliminate waste in supply chains. However, limited research has focused on the simultaneous integration of sustainability management and lean practices in SMEs and their combined effect on supply chain performance. The research adopts quantitative approach, which involves collecting survey data from a sample of SMEs operating in diverse industries. Statistical analyses, including structural equation modeling, are conducted to examine the direct and indirect relationships among sustainability management, lean practices, process innovation, and supply chain performance. Through the lens of SMEs, the research examines how the integration of sustainability and lean practices fosters competitive advantages and sustainable performance outcomes in the supply chain context. The findings contribute to both theoretical and practical domains by shedding light on the mechanisms through which sustainability and lean practices synergistically influence supply chain performance. For SMEs, the research offers valuable insights into harnessing sustainable and lean principles to achieve operational excellence and long-term success. Ultimately, this study advocates for a holistic approach to supply chain management that embraces sustainability, lean thinking, and process optimization to promote enhanced performance and a more sustainable future for enterprises of all scales.

Keywords: Sustainability; Management; Supply Chain; Lean; Innovative; Process Optimization; SMEs

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1. Introduction

SMEs are recognized for their crucial contribution to economic development as they collectively impose a notable environmental burden due to their extensive resource and energy consumption, leading to the generation of significant by-products [1]. Despite this, SMEs' environmental efforts have yielded limited outcomes, especially in contrast to larger corporations. Sustainability is a dynamic business concept that is reshaping competitiveness and propelling innovation. To maintain a competitive edge or at least parity, businesses across the supply chain are embracing various sustainability initiatives. While acknowledging the vital role of SMEs in economic development, it is crucial to recognize their shared environmental responsibility. To enhance efficiency and reduce waste, enterprises are turning to Lean Practices (LP) in manufacturing and service sectors. The

alignment of LP with environmental sustainability is gaining traction due to its emphasis on resource optimization and waste reduction. The relationship between sustainability and LP, particularly in manufacturing, is backed by research, yet diverse outcomes highlight its intricate nature [2].

LP center on waste reduction, quality enhancement, cost cutting, and supply chain adaptability. Implementing LP leads to financial sustainability through operational enhancements, cost reduction, surplus increase, and risk management. Innovation, organizational process, and product realms, drives progress [2]. Process Optimization (PO), characterized by novel production techniques, holds potential for environmental sustainability. Organizational innovation incorporates environmental management systems and eco-design as both LP and PO influence Sustainable Practices (SP) in SMEs [3], with LP emphasizing economic sustainability and PO fostering social and environmental performance. The research aims to address this gap by explaining the interplay between PO and LP in shaping SP. The study evaluates the direct impacts of PO and LP on SP while also exploring how PO and LP facilitate the relationship between SMEs and SP.

2. Literature Review

The concept of sustainability has gained significant prominence in recent decades, leading to increased interest in research focused on PO, LP, and SP and their transformative influence on organizational performance. In recent times, the forces of globalization, resource depletion, and dramatic shifts in climate conditions have amplified the significance of sustainability within the business landscape. Study by [4] underscore the fact that customers are increasingly concerned about organizations' impact on the environment. This customer-centric perspective has prompted businesses to incorporate environmental sustainability considerations into their decision-making processes, aiming to achieve a competitive advantage.

2.1. Lean Practices

In the contemporary era, several interconnected trends within the supply chain landscape have converged to create a progressively intricate business environment. These trends include the global shift, green initiatives, the integration of process innovation, and the implementation of lean practices. The core focus of lean strategies is to reduce waste by streamlining activities that do not add value, such as excess space, equipment, and inventories throughout the supply chain [5]. This waste reduction approach not only enhances service quality for customers but also contributes to cost reduction. A growing number of companies have adopted lean practices to drive ongoing improvements in supply chain operations. These practices target various operational aspects, including waiting times, inventory levels, transportation efficiency, production optimization, excess processing, and error rectification. Scholarly literature exploring the integration of lean principles into supply chains has focused on specific functional domains, such as lean logistics, just-in-time approaches in supply chain management, and the incorporation of lean and agility practices [6]. This dynamic interplay between globalization, environmental consciousness, process innovation, and lean practices shapes the intricate fabric of modern supply chain management [7].

2.2. Sustainable Practices

In the pursuit of social responsibility and environmental consciousness, the concept of sustainability has gained prominence in the business world. Achieving sustainability involves a blend of internal and external practices within firms. Internal practices, aligned with company goals, encompass actions taken within the business, such as procurement objectives aimed at specific outcomes [8]. Sustainability efforts also extend to supply chain collaborations, fostering "green" products and processes through sustainable programs. On the environmental front, internal practices focus on reducing a company's ecological

impact through efficient processes, materials, and resource usage. Socially, internal practices aim to enhance employee well-being through equitable compensation, job satisfaction, and health and safety policies. External sustainable practices target extending sustainability throughout the supply chain. Firms assess suppliers' sustainability, provide training, and collaborate to create an environmentally friendly supply chain [9]. The main goal is to align business operations with social and environmental objectives for greater sustainability. Numerous studies have examined the impact of both internal and external sustainability practices on sustainable performance, with the majority indicating a positive relationship between these practices and overall success.

2.3. Process Optimization

Process Optimization involves introducing new and creative ideas, commercializing novel concepts, and implementing fresh services, products, or processes [10]. It requires calculated risk-taking, experimentation, and fostering creativity within organizations. PO is driven by economic pressures and can contribute to social sustainability by promoting value creation. Positive effects on firms' performance and competitiveness are associated with PO, reflecting a positive correlation with environmental, social, and economic performances [11]. Integrating organizational, product, and process innovation is common for achieving SPr. PO is influenced by regulatory demands and customer expectations. Optimization is achieved through organizational, process, and product innovation, interconnected elements that drive progress. It introduces novel production or delivery methods and embraces changes in software, equipment, and techniques [12]. Examples include cleaner production for environmental sustainability and the implementation of environmental management systems like ISO 14000 for organizational performance towards environmental sustainability.

3. Materials and Methods

The research methodology employed in this study involves a systematic approach to investigate the relationship between Process Optimization, Lean Practices, and Sustainable Practices in the context of small and medium enterprises. This section outlines the research design, data analysis techniques, and hypothetical relation undertaken to achieve the research objectives.

3.1. Interlink between PO and LP

The existing research landscape lacks a comprehensive exploration of the intersection between Process Optimization and Lean Practices within the context of supply chain Sustainable Practices and their impact on SPr. This gap is significant, as it could help firms address potential trade-offs and synergies arising from potential incompatibilities between PO and LP strategies. Despite both PO and LP being essential for business success, they have distinct effects on firms' outcomes. The challenge is deciding whether to eliminate certain innovation ideas due to lean principles, even if they lack immediate value [13]. This emphasizes the need to explore how PO can coexist harmoniously with LP strategies. For SMEs, balancing economic focus and agility is crucial due to market competitiveness [14]. SMEs adopt LP to enhance efficiency and environmental friendliness. While they engage in various innovations, the lack of emphasis on PO stems from perceived cost-intensiveness in achieving social and environmental performance.

3.2. Interlink between PO and SP

The primary focus of Process Optimization centers on fulfilling customer needs at the lowest possible cost, often driven by policymakers' directives. The goal is to achieve synergy between supply chain strategies and competitive strategies, aiming to satisfy customer requirements while meeting social and ecological objectives. This approach can contribute to both economic performance and sustainability for Small and Medium

Enterprises [15]. However, evidence of the impact of PO on SMEs' social and environmental performance is limited. Research highlights a specific type of PO that not only enhances quality and production costs but also contributes to improved social and environmental targets [16]. This type of PO aligns with the desired relationship between SP and PO in the context of SMEs. In essence, the integration of PO can enable SMEs to achieve economic objectives while staying within the boundaries of sustainability, ultimately fostering a positive impact on social and environmental dimensions [17].

3.3. Interlink between LP and SP

The relationship between LP and SP involves assessing how the efficiency-focused waste reduction of LP intersects with the potential impacts on social and environmental dimensions. LP's drive for operational streamlining and waste reduction can lead to improved economic performance by cutting costs [18]. However, some social and environmental aspects of SP can be costly, potentially offsetting LP's benefits. LP's emphasis on efficiency aligns with economic goals, but its effects on broader sustainability need scrutiny [19]. Energy efficiency, a facet of LP, can positively influence social and environmental targets. However, the expenses tied to implementing energy-efficient solutions may present challenges [20]. This study aims to uncover the interplay between LP's waste reduction and SP's multilayered considerations. The goal is to find a balance between efficiency gains and broader sustainability outcomes, considering economic, social, and environmental factors.

3.4. Hypothesis Development

- H1: There is a significant positive relationship between Sustainable Practices and Lean Practices of Small and Medium Enterprises.
- H2: There is a substantial positive relationship between Sustainable Practices and Process Optimization of Small and Medium Enterprises.
- H3: Lean Practices mediate a significant positive relationship between Sustainable Practices and Sustainable Performance of Small and Medium Enterprises.
- H4: Process Optimization mediates a substantial positive relationship between Sustainable Practices and Sustainable Performance of Small and Medium Enterprises.

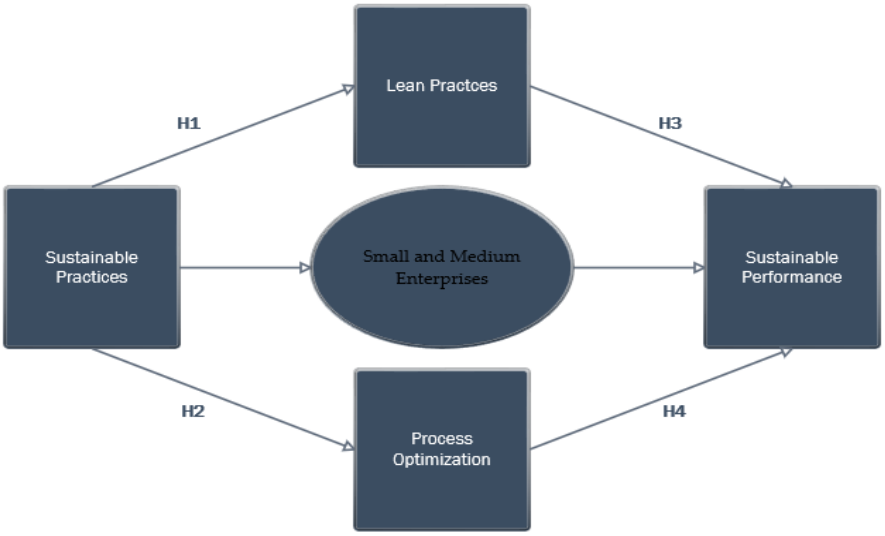

Figure 1. Hypothetical Model.

4. Thematic Correlation with Existing Literature

4.1. Globalization and Environmental Concerns

The study aligns with the literature highlighting the global shift and increasing customer [4] concern about organizations' environmental impact. This connection emphasizes the contemporary relevance of the research in addressing the growing importance of sustainability in the business landscape.

4.2. Lean Practices in Supply Chains

The study builds upon existing scholarly literature that explores the integration of Lean Practices into supply chains [6]. It acknowledges the multifaceted impact of LP on various operational aspects, emphasizing waste reduction and efficiency improvement in the supply chain, which is consistent with the referenced literature.

4.3. Sustainable Practices and Performance

The research aligns with the literature that emphasizes the positive relationship between Sustainable Practices and overall business success [9]. By investigating the interplay between LP, PO, and SP in SMEs, the study contributes to understanding how sustainability practices can enhance performance in different dimensions.

4.4. Process Optimization and Economic Performance

The study connects with literature that discusses the positive effects of Process Optimization on economic performance [11]. By exploring how PO can align with social and environmental objectives, the research extends the understanding of the broader impacts of PO beyond economic considerations.

5. Result and Analysis

The research provides valuable insights into the relationship among LP, PO, SP and SMEs. The findings highlight the significance of integrating LP conscious SP practices into the supply chain framework. This mutually supportive link indicates that when SMEs adopt lean practices, they optimize their operations, resulting in increased effectiveness and efficiency. Consequently, the performance of suppliers within the supply chain is positively impacted by these optimized procedures.

5.1. Correlation Test

The association between the two parameters is displayed as a positive value in the mentioned correlation matrix, indicating that any shift or rise in the independent variable will likewise alter or increase the dependent variable.

- SP and LP have a correlation coefficient of 0.702, indicating a moderate positive correlation.
- SP and PO have a correlation coefficient of 0.521, indicating a moderate positive correlation.
- SP and SPr have a correlation coefficient of 0.605, indicating a moderate positive correlation.
- LP and PO have a correlation coefficient of 0.685, indicating a moderately strong positive correlation.
- LP and SPr have a correlation coefficient of 0.576, indicating a moderate positive correlation.
- PO and SPr have a correlation coefficient of 0.435, indicating a moderate positive correlation.

Table 1. Correlation Matrix.

	SP	**LP**	**PO**	**SPr**
SP	1			
LP	0.702	1		

PO	0.521	0.685	1	
SPr	0.605	0.576	0.435	1

5.2. Regression Analysis

In order to understand further about the interrelationships between the variables in the research, regression analysis is carried out. These regression studies provide data on the process through which LP and PO impact the link between SP and SPr.

5.2.1. Relation between LP and SP

Table 2 presents the results of a regression analysis examining the connection between LP and SP. The table shows that there is a significant and strong positive relationship between these two variables. The coefficient of determination (R-Square) indicates that about 49.2% of the variability in Sustainable Performance can be explained by variations in LP. The standardized regression coefficient (Beta) indicates that higher levels of LP are associated with a notable increase in SPr. The investigation demonstrates that LP have a substantial positive impact on SP.

Table 2. Interrelation between LP and SP.

R	R-Square	Beta	Adjusted R-Square	F	T	Sig.
0.702	0.492	0.702	0.502	70.5	7.88	0.00

Dependent Variable: LP

5.2.2. Relation between PO and SP

Table 3 presents the findings of a regression analysis examining the relationship between PO and SP. The results reveal a statistically significant positive correlation between these two variables. The R-Square indicates that around 27.1% of the variability in Sustainable Performance can be explained by PO. The Beta of 0.521 suggests that an increase in PO is associated with a noteworthy increase in SP. The statistical significance of this relationship is affirmed by the F-statistic of 110.5 and a T-statistic of 9.78, both yielding a p-value of 0.00. Overall, the analysis underscores the positive impact of PO on influencing SP in a significant manner.

Table 3. Interrelation between PO and SP.

R	R-Square	Beta	Adjusted R-Square	F	T	Sig.
0.521	0.271	0.521	0.268	110.5	9.78	0.00

Dependent Variable: PO

5.2.3. Relation between SPr and LP

Table 4 presents regression analysis results that explore the connection between SPr and LP. The table indicates a significant and moderately strong positive relationship between these two variables. Around 33.1% of the variation in SPr can be explained by changes in LP, as reflected by the R-Square value. A higher presence of LP corresponds to an evident increase in SPr, as indicated by the positive Beta coefficient. The statistical significance of this relationship is reaffirmed by the F-statistic, t-statistic, and very low p-value (0.00). The analysis highlights that LP strongly contributes to the adoption of SPr in the study's context.

Table 4. Interrelation between SPr and LP.

R	R-Square	Beta	Adjusted R-Square	F	T	Sig.
0.576	0.331	0.576	0.327	140.3	14.34	0.00

Depended Variable: SPr

5.2.4. Relation between SPr and PO

Table 5 presents the results of a regression analysis examining the relationship between SPr and PO. The table indicates a significant positive correlation between these two variables. Approximately 18.9% of the variability in SPr can be accounted for by changes in PO, as evidenced by the R-Square value. The positive Beta coefficient further signifies that an increase in PO corresponds to an increase in SPr.

Table 5. Interrelation between SPr and PO.

R	R-Square	Beta	Adjusted R-Square	F	T	Sig.
0.435	0.189	0.435	0.185	106.4	12.57	0.00

Dependent Variable: SPr

6. Study Limitations

6.1. Generalizability

The findings of this study may be limited in terms of generalizability due to the focus on SMEs. The characteristics and operational contexts of SMEs can vary significantly across different industries and regions, making it challenging to generalize the results to a broader business landscape.

6.2. Cross-Sectional Nature

The research design of this study is cross-sectional, capturing a snapshot of the relationships between PO, LP, SP, and SPr at a specific point in time. This limitation may restrict the ability to infer causality or assess the dynamic nature of these relationships over time.

6.3. Measurement Challenges

The study relies on self-reported data, and there may be inherent challenges related to the accuracy and consistency of responses. Participants may provide biased or socially desirable answers, impacting the reliability of the results.

6.4. Scope of Variables

The study focuses on specific variables such as PO, LP, SP, and SPr, and their interlinkages in the context of SMEs. While these variables are crucial for the research objectives, other potentially influential factors may not have been considered, leading to an incomplete depiction of the factors influencing sustainability in SMEs.

7. Conclusion

The study extensively explored the complex connections between LP, PO, SPr, and SP within the context of SMEs. The intention behind this investigation is to equip businesses with strategies that can enhance their resilience in the present-day challenging environment. It is widely acknowledged that companies prioritizing sustainability tend to outperform their counterparts across the globe. This research aims to establish new connections among stakeholders, enabling the development of robust relationships. By doing so, it will facilitate better decision-making within the competitive and sensitive landscape, fostering the integration of sustainability into core values. The research adds to the understanding of how different aspects of sustainability, such as Lean Practices and Process Optimization, interact and influence the performance of Small and Medium Enterprises. The findings stress the significance of integrating sustainable practices and optimizing processes to drive enhanced performance, offering valuable insights for businesses

striving for sustained success within the complexities of global challenges and economic dynamics.

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