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Let's Start!

## Do Sustainable Supply Chain Performance Enhance Circular Economy: Mediation Analysis

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# Do Sustainable Supply Chain Performance Enhance Circular Economy: Mediation Analysis


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## Abstract

The circular economy (CE) method is crucial for manufacturing firms to address sustainability concerns. This study uses Stimulus-Organism-Response to analyses how circular economy (CE) practices affect manufacturing firms' sustainable supply chain performance (SSCP). Data was collected from manufacturing employees, and the hypotheses were tested utilized SPSS-26. The findings reveal that circular economy practices have positive impact on SSCP, mediated by capabilities and supply chain flexibility. This research fills a gap in literature by presenting empirical evidence of the mechanisms connecting CE practices and SSCP. The study highlights integrating CE strategies importance to improve adaptability, resource optimization, and long-term business success.


**Keywords:** sustainable, circular economy, flexibility, capabilities, S-O-R model

## INTRODUCTION

Circular economy practices have arisen in response to growing influence business management sustainability (Awan & Sroufe, 2022). Circular economies can help reduce resource consumption and waste creation while transforming supply chain competencies into SSCP and address environmental issues (Jia et al., 2020). Prior research also highlighted that sustainable development can be attained through supply chain capabilities (SCCs) (Hysa et al., 2020). Since sustainable development is defined with the help of three key principles, namely environmental,

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social, and economic, circular economy requires synergy among economic activity & environmental health. Scholars have also raised their concern in the study linking capabilities of the supply chain to its performance on incorporating environmentally conscious occurrences in business environments. In the context of the realization of the world today, Awan & Sroufe (2022) it is faced with major problems arising from exploitation of natural resources and industrial wastes. Since CE is a practical domain of knowledge and since it has an impact on how a less exhaustive world functions, the literature review has grown significantly in recent years (Habib et al., 2021). It has received much attention since, as per Jia et al.'s research from 2020, it continuously presses policymakers for a change in the way societies produce, consume, and dispose of products. From this point of views, the concept of corporate entrepreneurship (CE) is a significant step in transforming the management of businesses. It is described as 'the proactive, accountable synergistically ensuring and realizing an organization's social, environmental and economic objectives into an organizational systematic management of other major inter-organization business processes with the desire of enhancing the perpetual profitability of the individual business and its supply networks' (Cantele et al., 2023). SSCP is paradigm that involves elaborate approach to managing supply chains. As mentioned by Yang, X., & Wang, J. (2023), it is needed to connect environmental well-being and economic actions lead to new business models creation that affect socio-environmental and economic performance (Hysa et al., 2020). The current literature is of the belief that sustainability of production systems has primarily been defined with the help of CE. These systems are linked to a range of theoretical frameworks, with the aim of reconciling opposing ideas. Since there are still relatively few empirical studies, it is necessary to consider circular economy and SSCP. We propose integrating supply chain flexibility and capacity to fill this gap and add to our understanding of how CE practices affect the outcomes of durable supply chains.

Academics and practitioners have keenly sought to understand the various ways through which manufacturers enable sustainable supply chain outcomes. The authors are not aware of how manufacturers respond to circular economy practices or how such practices influence SSCP. Moreover, SCC and flexibility are not clearly linked to management solutions that can be considered sustainable for supply chain operations. Following what has been discussed so far, our primary objective is to provide answers to current study questions:

Q1: Does a CE practice effect supply chain's capability in firm long-term success?

Q2. Is there any relationship between SCC and SCF in association among CE and SSCP?

The study addresses gap in literature on SSCP by addressing research concerns highlighted above. To begin, we apply stimulus organism response (Mehrabian & Russell, 1974)model to describe CE practices affect long-term supply chain performance. Moreover,

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hypothesis tested using S-O-R model to establish the relationship between sustainable SC performance and CE practices with an emphasis on whether sustainable CE practices can serve as the attribute to create awareness/tip-off of a relationship with sustainable SC performance. The model was tested by the Pakistani employees from manufacturing sector of the economy. After that research validates the usefulness of supply chain capabilities in enhancing SSCP. Thirdly, this study finds evidence in literature on SCF as mediation variables in improvement of SSCP, CE relations. Finally, the current study's objectives seek to establish the extent to which circular economy (CE) practices in manufacturing firms affects SSCP.

## LITERATURE REVIEW

### SOR (STIMULUS ORGANISM RESPONSE) MODEL

SOR is one of significant parts of organizational surroundings utilized as theoretical foundation in supply chain management research. SOR is widely predicting aspects that have arisen from individual behavior connected with supply chain are quite dynamic in present day ever changing face of business environments. S-O-R framework is more appropriate because CE practices are defined in terms of the organization, as well as the dynamic and long-term supply chain performance of enterprises concerned. The S-O-R model was developed by Malhotra in 2023. S-O-R model derives its origination mainly from the behavior of the consumer or the firm and the availability of the plethora of findings brought forward in the social sciences most prominently Psychology. The model focuses on the features of S – O – R relationship which defines stimulus as something that arouses or initiates or potentiates action, organism as the affection or thinking that occurs between the stimuli and the responses. Consequently, the model explains manner in which a perceived stimulus translates to internal emotions of the consumers or employees (i.e., organism) and their behavioral response (Arora et al., 2020). In contrast to earlier research, the current study viewed both the stimulus and the reaction as observable aspects of cause-effect relationships. This relationship will enable the organism to infer behavioral patterns for any decision making process. Accordingly, organization allows for the evaluation of the relationship between the consumers, the agents, and the suppliers. Coordination is referred to as Stimulus and involves the coordination of many facets of manufacturing operations encompassing information acquisition, and order-placement. However, effect mostly reflected in individual psychological (internal) condition, which means that they are beginning to react behaviorally (Jacoby, 2002). Even, the term "organism" comprises of cognitive and affective phase that are operationally involved in relationship between an outside stimulus and an individuals' reaction. Sharma et al., (2021) explain S-O-R framework offers signals as stimuli effect internal organism state and results in behavioral response. Being considered as an incentive in this study, circular economy strategies are

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evaluated. Moreover, the degree of efficiency in sustainable supply chain could affected by CE that includes functions of using resources such as price, order delivery, and promotion in response to the changing manufacturing firm needs (Kazancoglu et al., 2018). This research proposes that manufacturers employ circular economy practices as an extrinsic motivator that strengthens their supply chain competencies and adaptability while emphasizing sustainable supply chain execution by building on S-O-R model.

**HYPOTHESIS DEVELOPMENT**

In 1990, Pearce & Turner invented the circular economy (CE). The abstractions that form the basis of CE processes include resource conversion, use, circulation, and product recovery (Bag et al., 2022). Thus, CE contributes to optimizing available resources, and converting into consumers, producers, and markets useful products (Malhotra & Srivastava, 2023; Del Giudice et al., 2021). Likewise, the Unilever contributed to circular economy via developing “design for recyclability" that symbolizes increased recycling. This initiative introduced a novel business model and increased use of refills (Patwa et al., 2020). Mostly, businesses curious in implementing CE that facilitate longevity, renewability, reuse, and repair of technologies and business models, thereby optimizing resources and materials utilization that are already available on market and minimizing raw materials-consumption and associated waste (Bag et al., 2022). Prior research argues that mostly facilitate products and services delivery by manufacturing firms that are environmentally favorable, innovative, and dynamic, as well as to establish sustainable business opportunities, CE is necessary (Kouhizadeh et al., 2023). Even, business model is positively influenced by circular supply chain, which reduces waste matter (de Campos et al., 2017). We propose the following based on these observations:

**H1. Sustainable supply chain performance is positively impacted by circular economy practices.**

As part of their organizational profits and market share objectives, Malhotra (2023) have developed supply chain capabilities that are sustainable. Additionally, the SCC facilitates business partner’s collaboration and improve organization's "green image," resulting in organizational strength and expansion (Samad et al., 2021; Nguyen et al., 2013). Manufacturing and logistics firms particularly benefit from SSCP in terms of environmental management. These strategies are integrated into the designs of the companies to address environmental concerns in both forward and reverse logistics (Bag & Rahman, 2023). In turn, these capabilities contribute to the development of environmentally beneficial products by reducing packaging and waste material (Samad et al., 2021). Moreover, SSCP strategies include innovative measures to evaluate suppliers environmental performance, which ultimately enhances product ecological quality by reducing operational waste and costs (Samad et al., 2021).

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Thus, this study reduces environmental risks and effects, thereby increasing profit and market share (Chowdhury et al., 2022). Nevertheless, SSCP is dependent on its integration into its capabilities (Mardan et al., 2020). Therefore, proposed that:

**H2. The efficacy of sustainable supply chains is positively impacted by circular economy practices, which are mediated by SCC.**

CE practices greatly improve flexibility and efficiency of supply chains, leading to enhanced SSCP (Bag, 2023). Enhanced SSCP fosters a positive mindset among supply chain managers and strengthens their adoption of CE practices, and boost SSCP (Centobelli et al., 2021). SCF is vital; it allows suppliers to efficiently manage resources and swiftly adapt to customer demands, enhancing efficiency (Bag & Rahman, 2023). At the process level, flexibility minimizes manufacturing costs by reducing waste in labor, energy, logistics, and materials (Bag, 2023).

Flexibility involves adjusting to changes with low influence on performance, cost, effort, or time (Kamalahmadi et al., 2022; Hazen et al., 2021). Source flexibility, ability to access materials and services according to changing needs; operating system flexibility, providing diverse product features, combinations, and quantities to meet consumer demands; distribution flexibility, efficient management of distributors, warehouses, and logistical capabilities; and information system flexibility, ensuring that information systems adapt to fluctuating needs (Kamalahmadi et al., 2022).

By adopting sustainable practices—such as utilizing recycled materials and rapidly acquiring environmental data—organizations can adapt products to market changes and improve SSCP (Hazen et al., 2021). Numerous studies affirm supply chain flexibility influence on SSCP (Edwin Cheng et al., 2022). Manufacturing firms, in particular, benefit from various dimensions of supply chain flexibility. Research emphasizes that for firms to maintain flexibility, supply chains must identify external stimuli, devise appropriate responses, implement them, monitor outcomes, and make necessary adjustments (Phadnis et al., 2021).

To progress, supply chains must rapidly detect changes, evaluate strategic and tactical responses, deploy scalable resources, and employ metrics to assess effectiveness (Bag, 2023). In the competitive business landscape, achieving and leveraging such flexibility is essential, particularly for firms engaged in manufacturing within a CE framework. Based on these insights, we propose following recommendations:

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**H3. The efficacy of sustainable supply chains positively impacted by circular economy practices, which are mediated by the SCF**

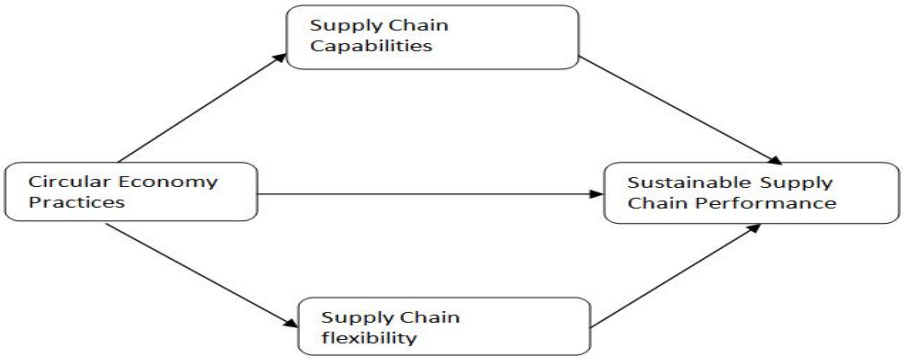


**Figure 1 Research Model**

**RESEARCH METHODOLOGY**

**DATA COLLECTION**

A quantitative research methodology was employed, gathering data from employees of manufacturing firms in Pakistan. The data collection spanned from October 2023 to February 2024. To test the proposed hypotheses, an online survey was administered to employees in Pakistan's manufacturing sector. Initially, manufacturing firms were approached to discuss their familiarity with organizations implementing or in the process of adopting CE practices. To enhance participants' understanding, the concept of CE in supply chain management was elaborated in the introductory section of the questionnaire. This introduction aimed to provide clarity and reduce potential biases related to unfamiliarity with CE concepts.

A pre-test of the survey was conducted with sample of 40 Pakistani manufacturing firms' employees to assess questionnaire's reliability. Feedback was sought from three experts working in manufacturing companies to ensure the questionnaire's robustness. Following necessary revisions, the finalized survey was distributed via email to manufacturing firms across Pakistan. Content validity guided the inclusion or exclusion of specific items, and final proofreading was conducted to eliminate any linguistic errors. Participant confidentiality, data privacy, and voluntary participation were strictly upheld throughout the study. To encourage timely responses, reminder emails were sent to participants.

The survey was distributed to 400 managers in the manufacturing sector, yielding 319 complete responses. However, after applying pairwise deletion to address incomplete or invalid entries, 45 responses excluded, leaving 275 sample size5, resulting in 79.75% response rate. More, Table 1 illustrate demographic profile, revealing that sample was predominantly male

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(59.35%), with most participants aged 31–45 years (28.06%). The majority held a master's degree (28.06%), and the largest occupational group comprised workers (32.00%).

**Table 1: Demographics**

| | Frequency | % |
|---|---|---|
| **Gender- Male** | 165 | 59.35 |
| **Female** | 113 | 40.65 |
| **Age** | | |
| **20 – 25 Years** | 50 | 17.99 |
| **26 – 30 Years** | 50 | 17.99 |
| **31– 45 Years** | 78 | 28.06 |
| **46 –50 Years** | 58 | 20.86 |
| **51 and above** | 42 | 15.11 |
| **Education** | | |
| **Lower than Bachelors** | 69 | 24.82 |
| **Bachelor Degree** | 70 | 25.18 |
| **Master's Degree** | 78 | 28.06 |
| **Doctoral Degree** | 61 | 21.94 |
| **Designation** | | |
| **Senior Management** | 48 | 17.45 |
| **Middle Management** | 65 | 23.64 |
| **Supervisor** | 74 | 26.91 |
| **Worker** | 88 | 32.00 |

**MEASUREMENT SCALE ITEMS**

SCC, SCF, CE, and SSCP were four constructs that were included in proposed framework. Table 2 contains thorough presentation of the measurement items. Utilizing five-point Likert scale that ranged from (1- strongly disagree) to (7-strongly agree), each item has been modified from previously published research and evaluated. Investment recovery (6--items) and eco-design (6-items), management systems (6-items) measurement dimensions that were included in CE constructs, which were constituted of seventeen items that were adapted from Zeng et al. (2017). It was determined that capabilities of the supply chain could be evaluated using five elements from Bowen et al. (2001). Mangla et al. (2020) contributed eleven elements to SSCP, and Merschmann & Thonemann (2011) contributed eight things to SCF analysis.

This study employed Harman's one-factor test to assess existence of CMV.The results

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demonstrated that greatest component accounted for 32.68 % total variance, lower than fifty percent threshold, so establishing acceptability (Podsakoff et al., 2003). The VIF values were found to be below crucial threshold of 3.3 (Kock & Lynn (2012) and found no problems with multicollinearity.

**Table 2: CR, AVE & Cronbach Alpha**

| | Items | Mean | S.D | F.L | CR | AVE | α |
|---|---|---|---|---|---|---|---|
| **CE** | **CE1 – CE17** | 3.38 | 1.04 | 0.877-0.783 | 0.823 | 0.810 | 0.911 |
| **SSCP** | **SSCP1– SSCP11** | 3.3 | 1.10 | 0.786-0.856 | 0.825 | 0.792 | 0.828 |
| **SCC** | **SCC1-SCC** | 3.33 | 1.10 | 0.81-0.845 | 0.822 | 0.862 | 0.812 |
| **SCF** | **SCF1 - SCF** | 3.15 | 1.14 | 0.812-0.843 | 0.838 | 0.801 | 0.820 |

Correlations and discriminant validity analyses confirmed that all square root AVE values were higher than their corresponding correlations, establishing discriminant validity. The measurement model showed data good fit (e.g., $\chi^2/df = 2.216$, CFI = 0.909, RMSEA = 0.066).

**Table 3: Correlation Coefficient**

| | Mean | S.D | (1) | (2) | (3) | (4) |
|---|---|---|---|---|---|---|
| **CE** | 4.47 | 1.33 | **(0.84)** | | | |
| **SSCP** | 5.17 | 1.22 | 0.748 | **(0.87)** | | |
| **SCC** | 5.72 | 1.31 | 0.515 | 0.554 | **(0.77)** | |
| **SCF** | 5.55 | 1.32 | 0.234 | 0.312 | 0.598 | **(0.82)** |

*Fornell & Larcker (1981)

**HYPOTHESES TESTING**

The SPSS PROCESS modules were utilized to do hypothesis testing for mediation and moderation connections (Hayes, 2018). We utilized Model 4 to undertake a mediation study examining association between SSCP (dependent) construct, supply chain capacities and flexibility (mediating-variables), & circular economy practices (independent variable). To produce confidence intervals, we employed bootstrapping regression method 5,000 times.

**DATA ANALYSIS**

Table 1 details results including F.L, discriminant validity & composite reliability (CR). However, F.L values range from 0.786 to 0.877 in data extracted, although appropriate F.L value is typically 0.7 (Fornell & Larcker, 1981). Moreover, CFA utilizing SPSS Amos version 28 showed strong match among data-collected and satisfactory measurement model ($\chi 2 = 2.216$, RMSEA = 0.066, IFI = 0.904, CFI = 0.909, TLI = 0.921). Also, AVE values square roots exceeded respective correlation values (Table 3). We also examined discriminant validity using HTMT correlation

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ratio analysis. All values in Table 3 of measuring model HTMT exceed 0.85 values (Henseler et al., 2015). Hence, measuring model has good fit indices i.e. convergent & discriminant-validity.

**HYPOTHESIS-TESTING**

Table 4 shows direct and mediation test results. Practicing circular economy positively correlates with SSCP (β=.556; t=8.282), accepted H1. Moreover, SCC mediates association among CE and SSCP (β = 0.356; t=5.211; significant). However, indirect effect of CE on SSCP via SCC accepted (β = .174; LLCI = .106, ULCI = .241), supported H2. In support of H2, supply chain capabilities partially mediate. Findings also indicate significant direct (β = 0.218; t = 4.331) and indirect (β = 0.259; LLCI = 0.145, ULCI = 0.376) effects. Thus, SCF partially mediates association between CE and SSCP, supporting H3.

**Table 4: Direct & Indirect Relationship**

| | β | t | CI 95% (LL) | CI 95% (UP) |
|---|---|---|---|---|
| **H-1: CEP - SSCP** | .356 | 5.211 | .222 | .448* |
| **H-2:CEP-SSCP-SCC** | .174 | 0.039 | .106 | .241* |
| **H-3:CEP- SSCP-SCF** | .259 | 0.089 | .145 | .376* |

**DISCUSSION**

This study provides empirical evidence supporting role of CE in enhancing sustainable supply chain performance. This study employs Stimulus-Organism-Response (S-O-R) framework to improve comprehension of sustainable supply chain management and its alignment with circular economy principles. This study underscores the substantial impact of circular economy practices on sustainable supply chain performance, highlighting the importance of integrating these strategies into manufacturing processes.

The results validate direct association among CE and SSCP (H1). Results also argue that CE initiatives, i.e. resource optimization, recycling, and waste reduction, provide excellent sustainable foundation. These practices mitigate environmental issues while producing economic advantages through the reduction of operational inefficiencies. This aligns with prior research (Bag et al., 2022; Malhotra & Srivastava, 2023), highlighting CE dual impact on environmental conservation and economic sustainability.

The SCC mediating role elucidates mechanisms through which CE practices influence SSCP. Research demonstrates that SCC, including effective collaboration, green logistics, and

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resource sharing, are essential for transforming CE practices into sustainable outcomes. The results correspond with research conducted by Nguyen et al. (2013) and Samad et al. (2021), emphasizing SCC importance in civilizing environmental management strategies and organizational performance. Improving supply chain capabilities is crucial for manufacturers aiming for long-term sustainability.

The mediating effect of supply chain flexibility (H3) supports notion that adaptability is crucial for achieving sustainable outcomes. Supply chain flexibility encompasses sourcing, operational, and distribution elements, enabling firms to respond effectively to market fluctuations and environmental uncertainties. This adaptability improves resource utilization and guarantees operational resilience. Prior findings align (Hazen et al., 2021; Kamalahmadi et al., 2022) existing study emphasizing flexibility importance in adapting to evolving market demands and achieving SSCP.

The incorporation of circular economy principles within supply chain management fosters proactive stance toward sustainability. This study highlights importance of manufacturers prioritizing CE-driven innovations, such as recyclable product designs and sustainable sourcing. The findings are consistent with the conclusions of Patwa et al. (2020) and Centobelli et al. (2021), demonstrating that circular supply chains enhance resource efficiency and minimize waste.

This study expands use of S-O-R framework in supply chain research by providing an indication of how CE practices (stimuli) affect SCC and flexibility (organism) that, in turn, enhances SSCP (response). This framework provides a systematic approach for analyzing the behavioral dynamics of supply chains in context of sustainability.

**THEORETICAL CONTRIBUTION AND MANAGERIAL IMPLICATION**

This study provides theoretical insights of CE understanding within manufacturing firms. This study is among first to examine association among CE practices and SSCP within manufacturing enterprises, employing mediation analyses. This study enhances the theoretical framework of Stimulus-Organism-Response by applying it to SSCP. This research illustrates how CE stimulates SCC and SCF, subsequently impacting SSCP. It improves idea of behavioral dynamics in supply chain and expands area of interest on framework. Furthermore, the results offer empirical support for incorporation of circular economy (CE) principles within SSCP. This underscores the significance of implementing resource-efficient practices that reduce waste and environmental impact, while simultaneously improving the economic and social aspects of sustainability, thereby addressing essential gaps in the current literature. The study identifies SCC and flexibility as mediating mechanisms that connect CE with SSCP. This enhances theoretical discourse by identifying specific operational and strategic pathways that lead to sustainability

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outcomes, providing actionable insights for scholars and practitioners. The study provides a sector-specific analysis by concentrating on the manufacturing industry in Pakistan. This context-specific approach facilitates a deeper understanding of the influence of CE on SSCP in emerging economies, establishing a basis for comparative studies across various industries and regions to evaluate the generalizability of these findings. Adopting circular economy techniques in manufacturing organizations can promote the development of sustainable capabilities that enhance environmental practices, leading to improved SSCP (Hazen et al., 2021).

The study offer valuable insights for manufacturing professionals, emphasizing integrating CE importance with SSCP. Adopting these practices enables firms to enhance supply chain capabilities and flexibility, thereby improving overall performance and reducing environmental impact. This alignment contributes to sustainable business operations and mitigates economic risks, thereby supporting the broader economic stability of the nation. Manufacturing firm managers can utilize findings to formulate targeted strategies for integrating CE principles into their processes. Strategies encompass investments in resource efficiency, recycling, and waste reduction initiatives, potentially resulting in long-term cost savings, enhanced operational efficiency, and increased profitability. Additionally, these practices enable firms to maintain competitiveness in markets that are increasingly focused on sustainability. The study highlights necessity for managers to weigh costs and benefits of adopting circular economy strategies. Initial investments in training, procurement, and operational changes may elevate expenditures; however, the long-term benefits, including enhanced resource optimization, reduced waste, and improved stakeholder relations, validate these costs. Managers can utilize cost-benefit analyses to strategically allocate resources to initiatives that produce the highest returns in sustainability outcomes. Fourth, it is recommended that managers cultivate an organizational culture that emphasizes environmental education and awareness. Equipping employees with knowledge of sustainable practices and the circular economy enables firms to foster behaviors that support environmental conservation objectives. This approach enhances internal collaboration and strengthens the firm's reputation as a socially responsible organization. This study provides a framework for enhancing sustainable supply chain performance via circular economy strategies. Managers must create explicit guidelines, including checklists of facilitators and obstacles, to pinpoint opportunities for circularity within their operations. Furthermore, by observing and adjusting to the changing dynamics of environmental regulations and market requirements, managers can guarantee that their firms stay flexible, innovative, and able to sustain growth. This proactive strategy enables firms to attain sustained success in a dynamic global economy.

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**LIMITATIONS AND FUTURE RESEARCH DIRECTIONS**

This study, while striving for reliability and validity, is cross-sectional and survey-based, resulting in notable limitations. The identified limitations present avenues for additional research to enhance the findings and expand the study's applicability. The proposed model was analyzed using cross-sectional data, limiting its ability to depict dynamic relationships over time. Future research could utilize longitudinal designs to offer more comprehensive insights. However, study focused exclusively on manufacturing companies in Pakistan.Extending the conceptual framework to encompass additional sectors of the economy or geographical locations may enhance the understanding of CE practices and sustainability. The assessment of the real-world effects of circular economy activities and its influence on SSCP may be achieved through the use of secondary data sources. Further research may explore moderating and mediating variables, including dynamic capabilities, innovation, and organizational ambidexterity, to enhance understanding of the relationships among these factors. Moreover, emerging technologies offer significant research opportunities. Hence, CE activities influence on SSCP may be enhanced via new concept expansion like blockchain, AI, and IoT. Future research may focus on agricultural and allied services, although this study primarily addresses the manufacturing sector. Examining interactions among SCC, SCF, and circular economy strategies within these industries may yield critical insights. Projects of this nature would facilitate the advancement of theoretical contributions and practical applications for sustainable practices across various industries.

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