Enhancing Green Supply Chain Resilience and Competitive Performance Through Open Innovation and Digital Innovations

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Abstract

This research delves into how green supply chain practices, open innovation, and digital innovations collectively enhance supply chain resilience and market competitiveness amidst the challenges of the COVID-19 pandemic. The study uses a comprehensive mixed-methods approach to collect qualitative and quantitative data from various supply chain professionals. Through structured interviews, online surveys, and the analysis of relevant literature and case studies, it assesses the impact of these practices on business competitive performance. The research uncovers a significant positive association, showing that organizations implementing these integrated strategies experience greater supply chain resilience, evident in their ability to adapt to disruptions and maintain resource efficiency. Furthermore, these practices lead to better competitive performance, marked by increased cost efficiency, revenue growth, and market share. Despite its insights, the study acknowledges limitations such as the reliance on self-reported data and its primary focus on the post-COVID-19 context, which may affect the generalizability of the findings. However, these limitations highlight avenues for future research, including longitudinal studies and cross-industry analyses. This report contributes substantially to the evolving sustainable supply chain management field by offering novel insights on the intersection of green practices, innovation, and digital transformation in enhancing organizational resilience and competitive edge in a rapidly changing global landscape.

Keywords: Green Supply Chain, Supply Chain Resilience, Open Innovation, Digital Innovations, Competitive Performance, Sustainability, COVID-19.

Introduction

Green supply chain integration, a modern business and environmental sustainability concept, put forth influential perspectives on enhancing the industry (Khan & Khan, 2022). It's a mix of present supply chain practices and environmentally conscious principles (Khan et al., 2023). It includes orchestrating the flow of goods, services, and information all through a safer and ecologically better process (Khan et al., 2023). It emerged about three decades ago and has been researched since; when researchers started to integrate the environmental hazards caused by the supply chain management processes, it became very clear that something was to be done about it. Then, there came "Green supply chain management" (GSCM) (Khan et al., 2023). By adding business

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strategies with environmental, companies can optimize resource utilization, reduce waste, minimize emissions, and increase sustainability (Agha et al., 2021). In the severe competition and emerging markets, it has become important to recognize the need for 'Green sustainability'.
An example of this could be China, as Chinese companies have been very ahead in reducing their carbon footprint through green supply chain sustainability (Khan et al., 2022). Although Chinese companies have been forward in adapting to the methods of "The Green Supply Chain Management", they are still behind compared to the markets of Europe and the US markets (Khan et al., 2022).
Several articles show that the cost of buying environmentally friendly materials is the most important factor of green supply chain management. Green purchasing is the only component of 'ISO 14001' but also an important part of the company's green practices (Khan et al., 2023).

Purpose

The purpose of this research is to influence/help industries and companies to increase adaptions towards green supply chain for the prosperity of nature and its importance in decreasing the carbon footprint as much as possible; this research explores the factors that influence open innovation capability in supply chains by examining the governance mechanism and technology which will impact knowledge creation and drive the success of open innovation in supply chains (Iqbal et al., 2023). The objective of this research is to examine the influence of big data analytics capabilities (BDACs) on the integration of green supply chains (GSCI) and the promotion of green innovation (GI) within the setting of a developing nation (Ishizaka et al., 2023). The academic community has shown growing interest in studying sustainable supply chain management (SSCM) practices and green entrepreneurial preference (GEP). However, the effects of these practices on the competitive performance of businesses in the aftermath of the COVID-19 epidemic still need to be better understood. While the importance of Supply Chain Sustainability Management (SSCM) in supporting Business Continuity Planning (BCP) is widely recognized, existing literature suggests that there is a lack of substantial evidence about the linkages between Green Environmental Practices (GEP), SSCM, and BCP (Jamil et al., 2023). This study aims to address the existing gap in the literature by examining the potential influence of Green Entrepreneurship Programs (GEP) and Sustainable Supply Chain Management (SSCM) on Business Continuity Planning (BCP) (Jamil et al., 2023). This paper also posits the moderating influence of digital advances, including artificial intelligence and big data analytics, on the linkages above, focusing on the context of the COVID-19 pandemic.

Objectives

1. To understand comprehensively the factors influencing open innovation capability in the supply chain.
2. To create applications of information technology tools to enhance the performance indexes related to knowledge conversion and operational processes.
3. Enhance generalizability by proposing conceptual models in diverse countries.
4. To attain sustainable aims, engaging in information sharing, employing novel idea-creation techniques, enhancing smart manufacturing practices, and optimizing the circular economy is imperative.
5. Assist in enhancing all personnel's knowledge, behaviors, and attitudes to foster supply performance development and attain objectives.

6. The primary aim of this study is to gain a comprehensive understanding of the relationship between Big Data Supply Chain Management (BDSCM) and Sustainable Supply Chain Management (SSCM) in the context of Sustainable Competitive Performance (SCP). This research seeks to explore the mediating role of SSCM and the moderating influence of Customer Environmental Trust Attitude (CETA) in the impact of BDSCM on SSCM.

Digital Innovations and Repurchase Intention

Digital innovations have become instrumental in shaping consumer behaviors after the pandemic. The online sphere has taken precedence, and customers are making increasingly informed choices. From e-commerce platforms to transparent traceability mechanisms, digital solutions empower consumers to align their purchases with their values (Zaman et al., 2023). Companies that leverage these technologies to enhance their green supply chain practices can effectively communicate their efforts, thus influencing repurchase intentions positively and creating a bond between them and the customer, which is connected through an effectively communicative voice (Zaman et al., 2023). Open innovation, a concept involving collaboration with external stakeholders, presents an avenue for boosting sustainability and repurchase intention (Khan et al., 2023). Collaborating with suppliers, consumers, and competitors to brainstorm and implement sustainable solutions demonstrates a company's commitment to progress. This approach fosters a sense of shared ownership and trust among stakeholders, directly influencing their repurchase decisions (Khan et al., 2023).

Problem Statement

Green Supply Chain Management (GSCM), a concept still being researched, is a source of challenges organizations face in effectively implementing environmentally sustainable practices across their supply chain operations. Despite the increased awareness of the benefits of GSCM, business individuals have hurdles in adapting green supply chain methods in their supply chain operations. Issues include selecting and evaluating environmentally responsible suppliers, creating faster routes for less carbon exposure, efficient waste management, and ensuring compliance with evolving environmental regulations. The challenge of balancing environmental and economic factors and the need for collaboration among various stakeholders further compound the problem. Consequently, the central problem revolves around devising strategies and methodologies that enable companies to successfully embed green principles into every supply chain while maintaining competitiveness and profitability.

Organizations have encountered numerous challenges in delivering innovative solutions to augment sustainable performance. Within the supply chain management (SCM) realm, Organizations globally encounter many obstacles that can impede their capacity to achieve success and enhance performance over an extended period. In summary, the concept of the green supply chain aims to achieve environmental sustainability. However, the practical implementation and adoption of new approaches pose significant challenges, as they require substantial human resources to develop staff training programs and modify work practices inside industrial facilities. Multiple studies have brought these challenges to attention and have demonstrated significant environmental and economic implications for emerging economies.

Theory Development and Literature Review

This literature review will give an overview of key themes, challenges, benefits, and approaches related to green supply chain integration (GSCI), Sustainable Supply Chain Management (SSCM)

Practices, Green Entrepreneurial preference (GEP), and Business Competitive performance (BCP) (Zaman et al., 2023). A green supply chain refers to environmentally sustainable practices while holding industrial standards (Jiang et al., 2019). In response to growing concerns about environmental degradation, industries have grown eager to adopt green sustainability practices (Jiang et al., 2021).

SSCM

Businesses often cite several reasons for implementing eco-friendly corporate activities, including the utilization of renewable resources, reduction of energy consumption, waste, and pollution, as well as the assurance of ecologically sustainable industrial operations (Yousaf, 2021). Implementing Sustainable Supply Chain Management (SSCM) has attracted scholarly attention to address environmental challenges and enhance the sustainable competitiveness of enterprises (Junaid et al., 2022). For supply chains (SC) to achieve sustainability, the adoption of sustainable supply chain management (SSCM) practices is important (Zaman et al., 2023). The study by Bhatia et al. (2022) highlights the integration and collaboration between a profit-making organization and a non-profit supply chain in the industrial sector. This strategic alignment aims to improve customer satisfaction and reduce total operational costs. According to Gangwani (2021), There is a growing trend among businesses to adopt Sustainable Supply Chain Management (SSCM) as a means to showcase their commitment to environmental responsibility and customer service (Ilyas et al., 2020).

GEP, SSCM, and BCP

Teece (2020) posits that the idea of dynamic capabilities suggests that strategic preferences, such as global environmental performance (GEP), should be regarded as valuable intangible capacities that enable businesses to effectively adapt to and embrace strategic practices, such as sustainable supply chain management (SSCM), hence leading to improved firm performance. According to Teece (2020), the concept posits that GEP can modify, appropriate, and perceive. According to Habib et al. (2020), the sensing capabilities of GEP enable the identification of feasible business possibilities and the proactive pursuit of green initiatives. This is done in response to the demands of environmentally conscious customers and corporate partners to present and future difficulties (Jamil et al., 2023). The primary objective of Firms implementing Green Environmental Practices (GEP) is to fulfil customer demands by offering environmentally friendly products and services. Previous research conducted by Habib et al. (2020, 2021) has demonstrated a considerable enhancement in creativity and the generation of novel ideas as a result of the implementation of the General Education Program (GEP) (Khan et al., 2022). Based on the findings presented it can be inferred that adopting Green Environmental Practices (GEP) catalyzes implementing Sustainable Supply Chain Management (SSCM) procedures, with the ultimate goal of developing environmentally friendly products that confer a competitive edge in the market. Enterprises are adopting environmentally sustainable technologies and products to enhance production efficiency, minimize energy consumption, and mitigate pollution. This trend is attributed to the resource-capturing capabilities of Green Eco-Product (GEP), as highlighted by Jiang et al. (2018). Green compliance and audits, an environmental management system (EMS), and ISO 14000 are among the several eco-friendly management systems implemented by firms utilizing GEP in order to safeguard their brand identities (Habib et al., 2020). In a context characterized by significant uncertainty and potential hazards, such as the ongoing COVID-19 pandemic, the increasing capacities of Green Energy Production (GEP) serve as a compelling incentive for

enterprises to adopt environmentally friendly approaches (Habib et al., 2020). Consequently, we propose the hypothesis

H1. The Global Environmental Program (GEP) promotes the adoption of Sustainable Supply Chain Management (SSCM) practices among enterprises.

The calculation of BCP is conducted by Guimaraes et al. (2017) taking into consideration the firm's return on assets (ROA) and return on equity (ROE). In order to meet the BCP criteria, the company's investments need to exhibit better performance than the overall market, its operational costs should be lower than those of its competitors, and its annual performance should surpass that of its rivals. According to Pratono et al. (2019) firms must enhance their competitiveness to succeed. They possess a strategic advantage over their competitors. Numerous empirical investigations have demonstrated the favorable impact of Sustainable Supply Chain Management (SSCM) on the attainment of enduring corporate prosperity (Aldaas et al., 2022; Habib et al., 2020, 2022, 2021; Sharafuddin et al., 2022; Wang et al., 2020). The focus of this analysis is the performance of competitors. Previous studies have yielded empirical support for the association between supply chain sustainability management (SSCM) and business continuity planning (BCP) (Khan et al., 2022).

The implementation of Supply Chain and Sustainability Management (SSCM) has been identified by scholars such as Fu et al. (2022) and Huma et al. (2022) as a means to improve the financial and operational performance of businesses (Zaman & Kusi, 2023). These researchers have discovered a positive correlation between adopting SSCM practices and various aspects of operational competitiveness, including reduced production costs, improved production quality, and shorter delivery times. Moreover, previous studies conducted by Guimaraes et al. (2017) and Pratono et al. (2019) have demonstrated that the implementation of Sustainable Supply Chain Management (SSCM) can enhance firms' competitive advantages or Business Continuity Planning (BCP). However, the four research teams only proceeded with their investigations within the scope of the COVID-19 pandemic. This study posits that Supply Chain and Sustainability Management (SSCM) will positively impact Planning (BCP) after the COVID-19 pandemic. This assertion is supported by the findings of previous research, which have thus far overlooked the significance of this relationship in times of uncertainty. Hence, there is speculation that.

Hypothesis 2 posits that business continuity planning (BCP) is enhanced due to implementing sustainable supply chain management (SSCM) measures after the COVID-19 pandemic.

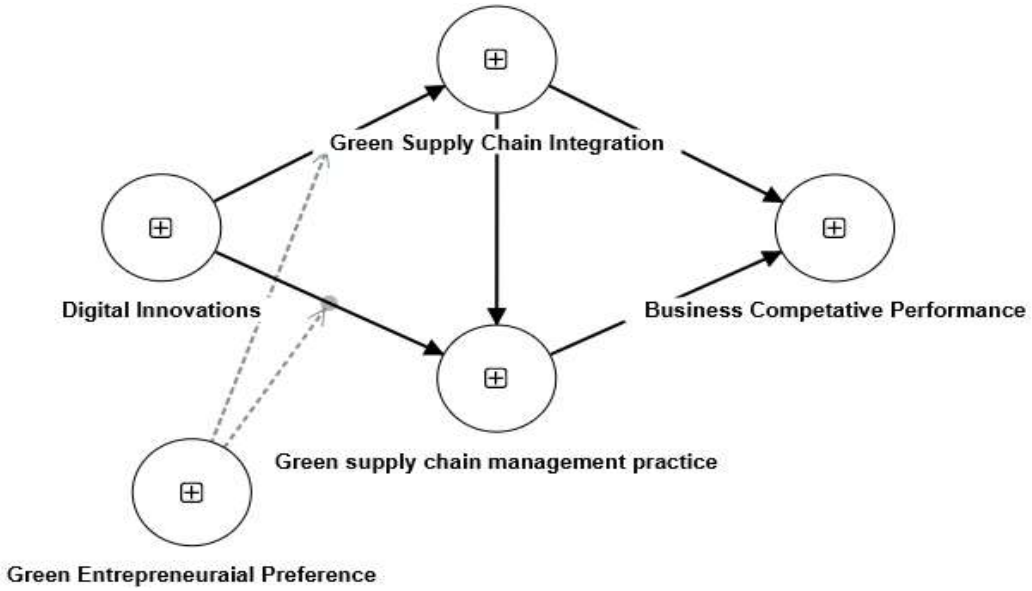
The present study posits that implementing Green Entrepreneurship Practices (GEP) will likely indirectly yet favorably impact Business Continuity Planning (BCP). This assertion is based on the notion that GEP enhances overall company performance, as suggested by Guo and Wang's (2022) research. The direct enhancement of firm success is contingent upon strategy alterations, such as implementing supply chain management (SSCM) practices, as shown by Habib et al. (2021). This is because entrepreneurial attributes, collectively known as the Global Entrepreneurship Program (GEP), bolster decision-makers in formulating effective strategies, as highlighted by Hughes et al. (2017). Prior research has established that a firm's resources and competencies mediate between the Global Entrepreneurship Program (GEP) and company performance. Pratono et al. (2019) posit that the relationship between global entrepreneurial orientation (GEP) and a firm's competitive advantage is mediated by inter-organizational learning. According to the research conducted by Guo and Wang (2022), it is contended that the relationship between green entrepreneurial practices (GEP) and business performance is mediated

by environmental innovation. Habib et al. (2020) demonstrates that there is a complete mediation effect of sustainable supply chain management (SSCM) practices on the relationship between green environmental practices (GEP) and sustainable firm performance.
Therefore,
H3. SSCM practice mediates the link between GEP and BCP.

Digital Innovation (DI)
The supply chain (SC) is undergoing significant changes due to the Fourth Industrial Revolution and advancements in technologies such as artificial intelligence (AI), robotics, and the Internet of Things (IoT) (Nozari et al., 2022). Implementing digital technologies can facilitate the establishment of Smart Supply Chains (SC), which are crucial for ensuring sustainability across all SC operations. By using these technologies, the intricate nature of SC can be streamlined and integrated into a cohesive system (Nozari et al., 2022). Furthermore, Narkhede (2017) discovered that the integration of sophisticated technologies into supply chain (SC) procedures, particularly in the manufacturing phase, has a significant impact on manufacturing output, hence enhancing the overall performance of SC firms (Khan et al., 2023). increasing demand for technology capable of efficiently and intelligently processing large volumes of data has emerged due to the rapid expansion of data capacity and diversity across the whole supply chain. In the context of addressing supply chain (SC) concerns, the literature acknowledges that demand integration (DI) is often regarded as the most efficacious approach (Maheshwari et al., 2021; Benzidia et al., 2021). The utilization of digital technologies has witnessed a notable surge in the wake of the COVID-19 pandemic. After this period, 39 distinct categories of these technological advancements have been effectively applied (Agarwal et al., 2022).

Conceptual Framework

Figure 1: Conceptual Framework



Methodology

The methodology for this study on green supply chain practices, open innovation, and digital innovations is structured to ensure comprehensive and bias-free data collection. It employs a mixed-methods approach, gathering qualitative and quantitative data from diverse supply chain professionals. The primary data collection involves a survey targeting supply chain management experts, focusing on Green Supply Chain Integration and Digital Innovation. Secondary data, including literature and case studies, provide context. The study ensures participant anonymity and uses triangulation and time-separated data collection phases to minimize biases like self-reporting. The questionnaire, designed with Likert-scale and open-ended questions, measures construct like green supply chain practices and digital innovations with established scales. Key themes include environmental sustainability, collaboration, technology innovation, risk management, and challenges in implementation and coordination. This methodology aims to explore the impact of these practices on supply chain resilience and competitiveness post-COVID-19. This study sourced its data exclusively from reputable academic journals to assure its credibility. The evaluation process has included considering articles written by notable authors in recent times and in previous years. A selection of 10 articles was made. The preliminary data indicates that these journals are among the most frequently cited publications in the respective discipline. The Journal of Cleaner Production and Innovation and Knowledge are among the leading academic journals in their respective fields. Therefore, the sources utilized in this study have been demonstrated to be reputable and high quality.

Results and Discussion on Findings

This study examines The conceptual framework using an SEM with AMOS version 27. There are two levels of evaluation: (1) measurement framework assessment and (2) structural framework test assessment. The results are as follows:

Measurement Framework Assessment

In this study, the measuring framework is evaluated through the implementation of validity and reliability tests, following the procedures and conditions suggested by Fornell and Larcker (1981). The authors suggest that to assess validity, it is necessary to employ composite reliability (CR) and confirmatory factor analysis (CFA) or factor loadings, requiring the obtained findings to surpass the 0.7 threshold. In addition, it is necessary to assess the validity of the variables by employing Average Variance Extracted (AVEs). The AVE values should surpass the threshold of 0.5, indicating a satisfactory level of validity. Additionally, it is crucial to examine the parallel relationship of the variables. The statistical findings of this research indicate that the collective CR (composite reliability) and CFA (confirmatory factor analysis) rates exceed 0.7. This suggests that the study is fine with convergent validity. Moreover, the validity approach proposed by Fornell and Larcker (1981) is employed to examine the relationships between underlying predictors and average variance extracted (AVE) values. Indicators of discriminant validity serve as evidence of the robustness of a construct's validity, with all constructs exhibiting average and maximum shared variances (ASV and MSV) that are surpassed by the average extracted variances (AVEs). Table 2 demonstrates the occurrence of discriminant validity in alignment with the evaluation techniques conducted by experts, as outlined by Fornell and Larcker (1981). Moreover, the measurement framework exhibits exceptional fit indices, enabling deeper exploration of the path connections between the research subjects. The calculation of model fitness is determined by employing the prescribed thresholds proposed by Fornell and Larcker (1981).

Table 1: Findings of the structural path assessment

No.	Variables	Alpha	CR	AVE
1	Business Competitive Performance	0.744	0.855	0.666
2	Digital Innovations	0.765	0.864	0.680
3	Green Entrepreneurial Preference	0.770	0.867	0.685
4	Green Supply Chain Integration	0.730	0.849	0.653
5	Green supply chain management practice	0.779	0.872	0.695

Please take note that the level of significance for this study is set at 0.01, with a two-tailed test. SSCM, an acronym for sustainable supply chain management, refers to the practice of integrating environmental, social, and economic considerations into the management of supply chain activities. In this context, GEP refers to the green entrepreneurial preference, while DI stands for digital technologies, specifically artificial intelligence and big data analytics. BCP represents business competitiveness performance, SD denotes standard deviation, AVE5 represents average variance extracted, CR5 signifies composite reliability, ASV5 denotes average shared variance, and MSV5 represents maximum shared variance. The values shown by the italic sloping font are indicative of the square base of AVE.

The table provided in this work was created by the authors. The initial hypothesis (H1) posits that there is a positive relationship between Green Entrepreneurship (GEP) and the adoption of Sustainable Supply Chain Management (SSCM) practices by enterprises. The findings and trajectory outcomes (GEP→SSCM) exhibit statistically significant beneficial effects ($p < 0.000$, SE = -0.122, and $\beta = 0.391$), providing support for Hypothesis 1. The second hypothesis (H2) posits that there is a beneficial relationship between sustainable supply chain management (SSCM) and business continuity planning (BCP) in the post-COVID-19 context. In a similar vein, the findings presented in this study provide evidence in favor of H2, as indicated by the statistically significant and positive results of the relationship between SSCM and BCP ($p < 0.000$, SE=0.710 and $\beta = 0.588$). The third hypothesis (H3) posits that the practice of sustainable supply chain management (SSCM) serves as a mediator in the relationship between green environmental practices (GEP) and business performance outcomes (BCP). The data provide evidence in favor of H3, indicating that the indirect effect of GEP on SSCM, which subsequently affects BCP, is positive. The standard error (SE) is 0.010, the beta coefficient (β) is 0.580, and the confidence interval (CI) ranges from 0.003 (minimum) to 0.453 (maximum). Hypothesis H4 posits that the moderating effect of DI exists in the relationship between GEP and SSCM. The findings of this study provide evidence that the moderation effect of H4 on the relationship between GEP and SSCM, as mediated by DI, is statistically significant (standard error = 0.020, beta coefficient = 0.453, and confidence interval = [0.102, 0.472]). The findings of this study suggest that the implementation of DI in organizations' SSCM practice can lead to significant improvements. The results also indicate that those who engage in a higher frequency of DI are more inclined to implement SSCM.

Figure 2: Relationship between Green Entrepreneurship (GEP) and the adoption of Sustainable Supply Chain Management

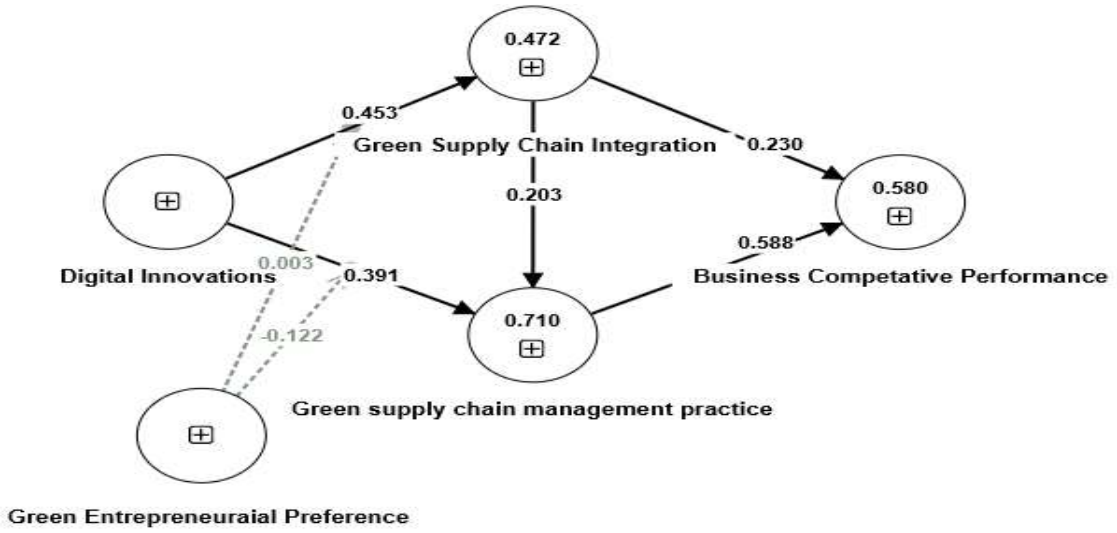


Table 2: Correlation Analysis

Variables	BCP	DI	GEP	GSCI	GSCMP	GEP x DI
Business Competitive Performance						
Digital Innovations	0.901					
Green Entrepreneurial Preference	1.051	0.944				
Green Supply Chain Integration	0.849	0.877	0.815			
Green supply chain management practice	0.961	0.997	0.971	0.888		
Green Entrepreneurial Preference x Digital Innovations	0.122	0.133	0.179	0.113	0.277	

After conducting a thorough analysis of the assessment of the structural path, the study proceeded to assess the extrapolative capabilities of the framework through the examination of out-of-sample computation. This was done in order to enhance the practical significance of the findings, as suggested by Acquah et al. (2021). The extrapolative potential of the framework was assessed by the utilization of partial least squares (PLS) estimation in an out-of-sample context. Based on the results presented in Appendix Table A5, it was seen that the Q^ exhibited superior performance compared to the linear framework, as reported by Acquah et al. (2021). Consequently, an evaluation of the calculation errors associated with the PLS and linear regression frameworks was conducted. The results indicate that the complete set of assessment items for Supply Chain Sustainability Management (SSCM) had decreased estimation errors, as measured by mean absolute percentage error, mean absolute error, and root mean square error, compared to the fundamental standard. As a result, the framework employed in this study demonstrates a high level of extrapolative capability (Hair et al., 2020). The study framework

generates the proposed relationships between GEP (Green Entrepreneurship), SSCM (Sustainable Supply Chain Management), DI (Digital Innovation), and BCP (Business Continuity Planning). The article provides support for the integration of Green Environmental Practices (GEP) and Digital Innovation (DI) within the framework of Sustainable Supply Chain Management (SSCM) as a means to enhance Business Continuity Planning (BCP) in the aftermath of the COVID-19 pandemic. Firms have the potential to enhance their ecosystems through the prioritization of Supply Chain and Sustainability Management (SSCM) and Digital Innovation (DI) implementations. These initiatives have been found to contribute to the au gmentation of firms' competitive advantages. Furthermore, the research proposes these hypotheses in order to investigate the multivariate assessment presented in Table 1.

Table 3: Path Coefficients of Partial Least Square

Hypothesis	Beta	SD	T	P values
Digital Innovations -> Green Supply Chain Integration	0.4528	0.0575	7.8735	0.0000
Digital Innovations -> Green supply chain management practice	0.3914	0.0474	8.2532	0.0000
Green Entrepreneurial Preference -> Green Supply Chain Integration	0.2840	0.0652	4.3589	0.0000
Green Entrepreneurial Preference -> Green supply chain management practice	0.3215	0.0506	6.3505	0.0000
Green Supply Chain Integration -> Business Competitive Performance	0.2298	0.0387	5.9364	0.0000
Green Supply Chain Integration -> Green supply chain management practice	0.2030	0.0402	5.0548	0.0000
Green supply chain management practice -> Business Competitive Performance	0.5879	0.0378	15.5634	0.0000

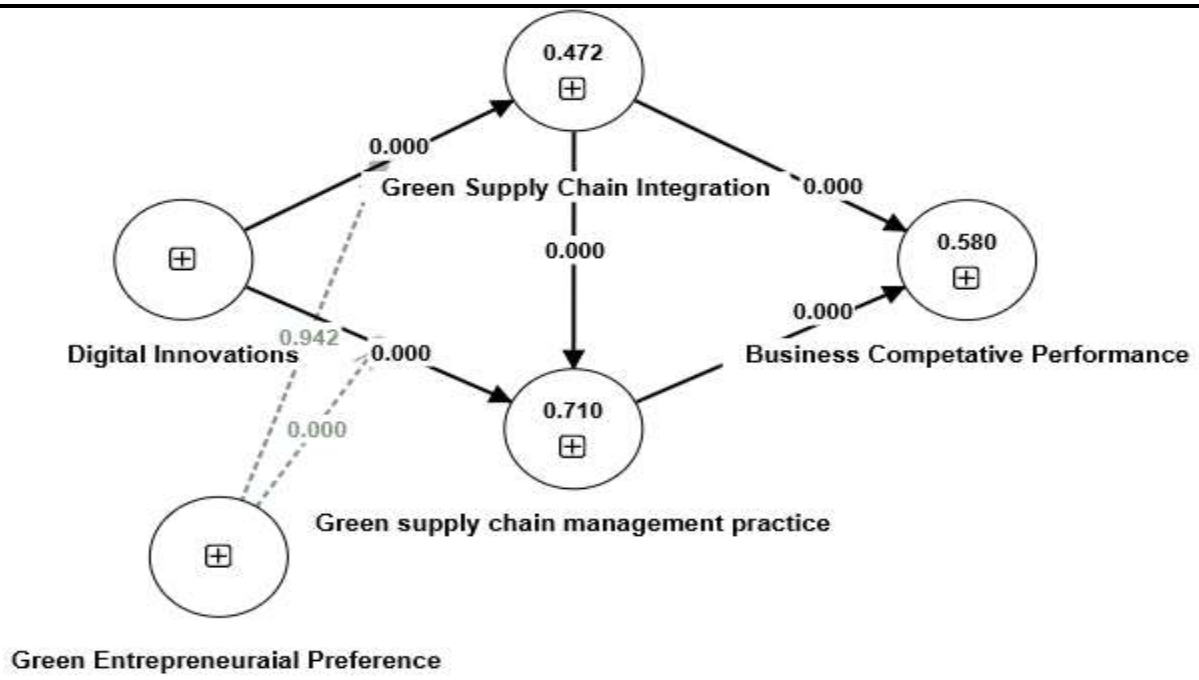
Competitiveness in the sector. Given the unpredictability of market transition post-COVID-19, stakeholders may choose to work with enterprises that engage in eco-friendly and sustainable operations.

What impact does DI have on the GEP-SSCM relationship after COVID-19?

Research Question 2 aimed to examine the potential moderating role of digital innovation (DI), specifically with regards to Hypothesis 4, in the relationship between the Global Environmental Performance-Shared Sustainable Consumption and Production (GEP-SSCM) link in the context of the COVID-19 pandemic. The resolution to this research question can be determined by evaluating whether implementing DI enhances or diminishes the relationship between GEP and SSCM. The empirical evidence strongly supports the moderating impact of DI on this relationship. The utilization of decision intelligence (DI) has been seen to have a beneficial impact on the link between green environmental practices (GEP) and sustainable supply chain management (SSCM). This suggests that incorporating DI into decision-making processes, especially during crises such as the COVID-19 pandemic, can contribute to the long-term sustainability of the GEP-SSCM association. Suppose the application of digital intelligence (DI) is expanded. In that case, enterprises are expected to embrace sustainable supply chain management (SSCM) practices, leading to an enhancement in green environmental performance (GEP) efficiency. The findings above provide more support for prior studies that have utilized DI

as a moderating variable to substantiate its relationships across various contexts and measurements while excluding GEP (e.g., CSR) and SSCM (Tortorella et al., 2019; Wang et al., 2020). The novelty of this research lies in its pioneering approach to advocating for the explicit use of Green Environmental Practices (GEP), Sustainable Supply Chain Management (SSCM), and digital technologies inside Halal food operations. The objective is to enhance Business Continuity Planning (BCP), particularly in periods of uncertainty, such as the post-COVID-19 era. In contrast to previous research that has established a clear correlation between the utilization of Sustainable Supply Chain Management (SSCM) and organizational success, the present study offers a fresh viewpoint on how digital advancements could facilitate the integration of Green Energy Practices (GEP) and SSCM inside internal business operations in the aftermath of the COVID-19 pandemic. The measuring items utilized in this study were modified from other publications, considering the recommendations provided by other scholars (Barkhordari et al., 2019; Venkatesh et al., 2012).

Figure 3: Beneficial relationship between sustainable supply chain management (SSCM) and BCP



The acronym "BCP" refers to Business Continuity Planning. In their respective studies, Guimaraes et al. (2017) and Pratono et al. (2019) modified four measuring items in order to evaluate business continuity planning (BCP). This company has attained superior strategic benefits compared to its rivals after the COVID-19 pandemic. The utilization of a five-point Likert scale is implemented.

On a scale of 1 (strongly disagree) to 5 (strongly agree), please indicate your level of agreement. This study investigates the relationship between variables using AMOS 27 and Smart PLS 3.3.7 software as statistical tools for hypothesis testing. This study aims to investigate four primary components and their corresponding 18 questions about the four elements of Sustainable Supply Chain Management (SSCM), Green Environmental Practices (GEP), Digital Integration (DI), and

Business Continuity Planning (BCP). Subsequently, a comprehensive framework is proposed based on the findings. Before examining the hypotheses, this study conducts a normality check to ascertain that the data does not exhibit significant aberrations, as Hair et al. (2017) recommended.

The presence of an excessive amount of data abnormalities can lead to an increase in the observed findings within the Smart PLS software. The findings of the normality test indicate that the data in this study does not exhibit significant deviations from the expected distribution. In addition, the available data are sufficient and support the statistical hypothesis, as Hair et al. (2017) stated. In addition, the normality of the data in this study was assessed using the Kolmogorov-Smirnov test, which yielded negligible results, thus indicating the presence of data normality (Biu et al., 2020). The Pearson correlation coefficient was employed to calculate the associations between the dependent and independent components. In this study, the assessment of the research framework's goodness of fit is conducted by utilizing normed, comparative, and absolute fit indices.

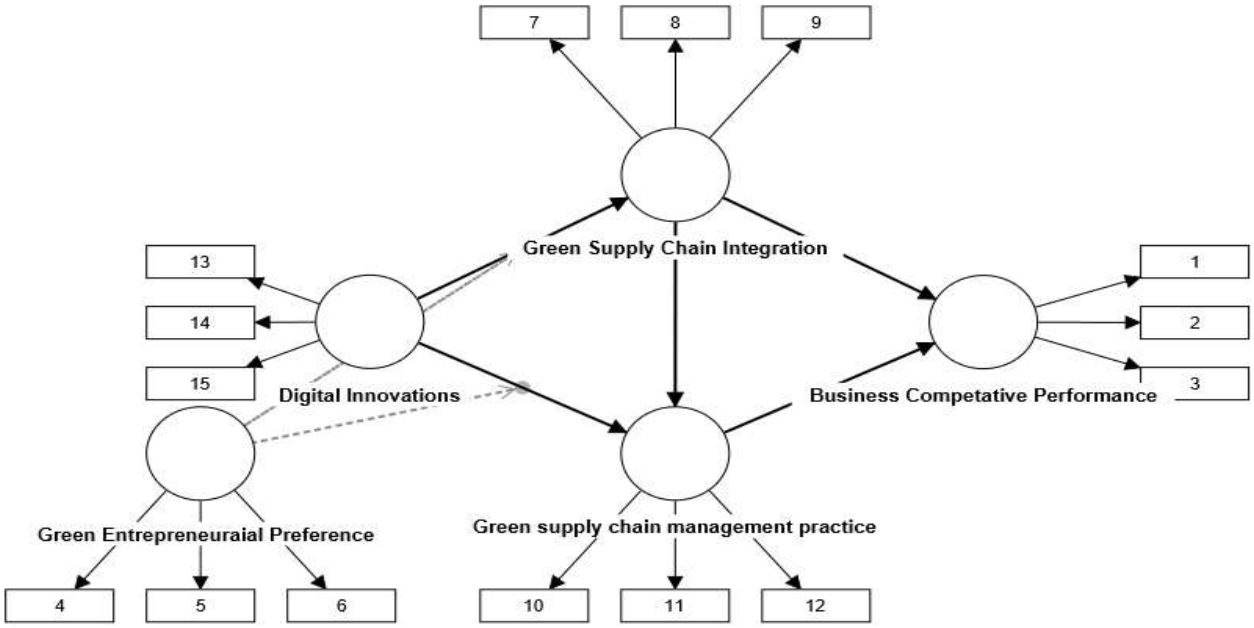
Implications

Theoretical implications

This study contributes theoretically to the existing body of knowledge by examining the link between the GEP instrument and BCP. According to the study conducted by Khan et al. (2022), The primary objective of this study is to examine the adoption of Sustainable Supply Chain Management (SSCM) and its potential impact on Business Continuity Planning (BCP). This research offers a comprehensive analysis of how integrating Green Environmental Practices (GEP) through SSCM could enhance BCP. According to Khan, Zaman, and Rais (2022), Previous literature has shown divergent perspectives regarding the adoption of Sustainable Supply Chain Management (SSCM) in enterprises, including concerns related to diminished financial returns, elevated operational costs, and inefficient resource utilization (Yousaf, 2021). However, this study offers actual data and support for the potential benefits of integrating Sustainable Supply Chain Management (SSCM) with Green Energy Practices (GEP) in organizations, hence enhancing Business Continuity Planning (BCP).

Furthermore, the present study has discovered that the construct of DI plays a beneficial role in moderating the link between GEP and SSCM. The findings of this study support the assertions made in the literature that the application of Data Integration (DI) enhances collaboration among stakeholders and organizations' decision-making capabilities (Maheshwari et al., 2021). Researchers have identified that several technological advancements, specifically artificial intelligence (AI), were employed during and after the COVID-19 pandemic (Agarwal et al., 2022). However, to date, empirical investigation has yet to be undertaken to examine the effects of DI on the views of GEP and SSCM during this period of ambiguity. According to Khan et al. (2021), Moreover, it has been established in prior studies that the utilization of Sustainable Supply Chain Management (SSCM) serves as a significant indicator of organizational achievement (Aldaas et al., 2022; Habib et al., 2020, 2022, 2021; Sharafuddin et al., 2022; Wang et al., 2020).

Figure 4: Potential of digital innovation (DI) to facilitate the integration of Green Economy Principles



Consequently, this research offers a fresh viewpoint on the potential of digital innovation (DI) to facilitate the integration of Green Economy Principles (GEP) and Sustainable Supply Chain Management (SSCM) inside the internal operations of Halal food businesses in the aftermath of the COVID-19 pandemic. This particular study suggests using digital innovation (DI) in the Halal food sector as an additional measure that should be considered during evaluation to reduce suspicion among stakeholders following the COVID-19 pandemic.

Additional theoretical implications of this study encompass the subsequent aspects. This study contributes to the existing literature by providing evidence of a significant and positive correlation between Sustainable Supply Chain Management (SSCM) and Business Continuity Planning (BCP). Prior studies have established a connection between Sustainable Supply Chain Management (SSCM) and the long-term performance of firms (Aldaas et al., 2022; Habib et al., 2020, 2022, 2021; Sharafuddin et al., 2022; Wang et al., 2020). However, it is worth noting that the firm performance analyzed in these studies does not specifically focus on competitiveness performance. Given the numerous disruptions that have affected the current global supply chain, such as pandemics, trade wars, demand fluctuations, technological advancements, customized product requirements, resource allocation strategies, and intense competition, it is imperative for firms to promptly adapt to changing market demands and effectively address challenges in order to attain competitive advantage (Huma & Ahmed, 2022). Consequently, conducting an analysis of business continuity planning (BCP) is crucial. Consequently, our research contributes to the existing body of scholarly literature on supply chain management.

Implications for Managers

This study presents empirical findings that support the notion that Green Entrepreneurship Programs (GEP) can effectively facilitate the implementation of Sustainable Supply Chain

Management (SSCM) within organizations, leading to improved Business Continuity Planning (BCP). According to Khanji et al., (2022), In the aftermath of the COVID-19 pandemic, managers must recognize Supply Chain and Sustainability Management (SSCM) as a promising tool that can safeguard industrial competitiveness. By embracing SSCM, managers can capitalize on the advantages of Green Environmental Practices (GEP) and enhance Business Continuity Planning (BCP) for long-term benefits. According to the study conducted by Miao et al. (2022), it is imperative for organizations to officially embrace Sustainable Supply Chain Management (SSCM) due to its direct influence on Business Continuity Planning (BCP). SSCM is characterized by decreased operational expenses, enhanced competitive edge, improved return on assets and return on investment, and superior performance compared to competitors (Guimaraes et al., 2017; Pratono et al., 2019).

The findings of this study indicate that companies implementing Sustainable Supply Chain Management (SSCM) exhibit superior performance. The financial benefits derived from implementing the Global Environmental Protection (GEP) program (Arif et al., 2023). This study offers managers a helpful understanding of the need to integrate Green Environmental Practices (GEP) with Digital Innovation (DI), which could have a more substantial influence on Sustainable Supply Chain Management (SSCM) inside their respective firms. It is imperative for managers to effectively implement data integration (DI) strategies and employ business analytics (BD) techniques in order to acquire valuable insights for business operations. The concept of development (Jiang et al., 2023)

Conclusion, Limitations and Future Research

The COVID-19 pandemic has hindered the ability of supply chain management to effectively collaborate and integrate to meet the demands and requirements of both customers and suppliers. According to the study conducted by Jiang et al. (2023). This study presents a sustainable tool. It highlights the implementation of Green Environmental Practices (GEP) and Sustainable Supply Chain Management (SSCM) as means to enhance Business Continuity Planning (BCP), especially in uncertain periods such as the post-COVID-19 era. According to the study conducted by Jiang et al. (2019). This study examines the impact of sustainable supply chain management (SSCM) on the association between SSCM activities and the competitive performance of enterprises operating in an unpredictable market setting. The research employs a questionnaire-based methodology and a structural equation modelling (SEM) investigative strategy.

Similar to prior studies, this paper possesses inherent limitations. This study utilizes the concept of Sustainable Supply Chain Management (SSCM) as a singular structural variable, specifically focusing on the internal practices of SSCM. Subsequent investigations could explore external factors, such as supplier selection, to examine their distinct impact on the Gross Economic Product (GEP). Moreover, this research utilizes Sustainable Supply Chain Management (SSCM) as a theoretical framework. Subsequent scholarly works should examine SSCM from a capability perspective and endeavor to tackle the particular challenges stakeholders have when adopting SSCM, such as the disparity between actual and declared practices (Zaheer et al., 2023). Future studies have the potential to do comparative analyses of sustainable supply chain management (SSCM) operations across various countries, thereby enhancing our comprehension of post-COVID-19 SSCM endeavors.

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