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ORIGINAL PAPER

UNLEASHING THE ROLE OF BLOCKCHAIN TECHNOLOGY AND GOVERNMENT SUPPORT IN GREEN SUPPLY

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ABSTRACT. Background: With the advent of the technological revolution, digitalization and automation is expected to restructure the landscape of manufacturing operations. Blockchain technology (BCT) is likely to foster information sharing and transparency and facilitate collaboration on green issues in supply chain among firms. This quantitative research investigates the role of BCT in Green Supply Chain Management (GSCM) practices and its' effect on various performances, including economic and social performance.
Method: The data was gathered from 223 firms by utilizing a survey questionnaire, and PLS-SEM was employed to analyze the hypotheses.
Results: The findings showed that BCT has a key role in the implementation of GSCM practices (comprising green purchasing and green manufacturing). The outcomes also elucidated that green manufacturing is positively associated with economic and social performance. Whereas, green purchasing is negatively correlated with economic performance and has an insignificant effect on social performance. Moreover, government support (GS) moderates the link between BCT and GSCM practices (including green purchasing and green manufacturing).
Conclusion: This research provided ample understanding about the role of BCT in implementing GSCM practices. The findings suggested that government bodies need to provide interest free loans and tax exemption to effectively implement GSCM practices.

Keywords: Blockchain technology; Green supply chain management; Logistics Management; PLS-SEM; Transportation

INTRODUCTION

In the current era of industrialization, sustainability concerns are arising across the globe. The rapid increase in industrialization and globalization have provided societies with a huge amount of benefits in terms of economic gain and enhanced production of goods and materials but has given rise to sustainability concerns. Keeping in view the enhanced sustainability problem, countries across the globe have forced countries and enterprises to take steps in order to keep balance between industrial activities and sustainability. In this regard, the research on Green Supply Chain Management (GSCM) [Sheng et al. 2023], Green intellectual capital [Asiaei et al. 2023], GHRM [Bahuguna, Srivastava & Tiwari, 2023], Green marketing [Mukonza & Swarts, 2020], Green finance [Zhou et al. 2020], and sustainability is getting attention among scholars to provide enriching details for enterprises and countries to adopt such strategies that can help manage ecological problems, as well as provide people with a healthy life. Nevertheless, the obstacles are enhancing and cropping up, which leads to suggestions for different feasible techniques for solving ecological problems, thus changing the landscape towards green operations and practices such as GSCM, which includes involvement of green criteria in all supply chain (SC) processes from production to disposal of products or goods [Umar et al. 2022]. GSCM is stated as a crucial business strategy that has the potential to eradicate the harmful effect of traditional SC

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activities and can improve the social and economic performance (ECP) of firms [Habib, Bao & Ilmudeen, 2020].

Moreover, the advent of I4.0 technologies in the current era has revolutionized the processes of GSCM [Mubarik et al. 2021; Kouhizadeh & Sarkis, 2018] and made manufacturing operations more efficient and sustainable [Khanfar et al. 2021]. Researchers have defined I4.0 as an attempt to transform and build smart systems through the integration of various technologies such as Artificial intelligence (AI), BCT, Big data analytics (BDA), Internet of things (IoT), and Additive Manufacturing (AM) [Ghadge et al. 2022]. The adoption of which can enhance the efficiency of production operations [Khan et al. 2022; Khan et al. 2023a; Khan et al. 2023b], provide transparency and visibility in SC processes, and help gain sustainable goals [Umar et al. 2021a]. Also, I4.0 is pushing automation and digitization to an unprecedented level and making possible human-machine interaction in the form of advanced robotics [Khan et al. 2021; Baur and Wee, 2015; Khan et al. 2022a; Khan et al. 2023c]. Moreover, I4.0 is unlocking the potential of sustainable firms and helps in moving towards sustainable societies and sustainable manufacturing [Sharma et al. 2020; Parmentola et al. 2022]. Of the I4.0 technologies, i.e., BCT, which is known as distributed ledger technology, have provided implication for SC sustainability. Scholars have stated that the implementation of BCT facilitates modern ways of production, provides data transparency, immutability, and smart contract facility to firms [Kouhizadeh & Sarkis, 2018], and can stimulus the adoption of GSCM practices [Ghadge et al. 2022; Khan et al. 2022b] in manufacturing firms. Similarly, Feng et al. [2022] also demonstrated that manufacturing firms can benefit from the applications of BCT in terms of higher cooperation and communication across all SC processes, improved trust and reliability, better management and information traceability, and enhanced efficiency of GSCM practices, including green purchasing and investment recovery. Moreover, scholars have indicated that GSCM consists of complex activities and adopting BCT in GSCM can effectively manage and enhance its performance [Mubarik et al. 2021]. Limited studies have been held on BCT and GSCM, and these concepts still need to be explored further [Ghadge et al. 2022]. Researchers have also suggested conducting research on examining the role of BCT in GSCM practices [Yu, Khan & Umar 2022; Khan et al. 2023d]. Thus the present study seeks to fill the existing gap in literature by investigating the effect of BCT on GSCM practices and their role in achieving social and financial performance. Moreover, the current study also analyzes the moderating role of government support among BCT and GSCM practices.

The paper is organized as follows: section 2 indicates the theoretical underpinning and research proposition, while methodology is presented in section 3, followed by results in section 4, and discussion in light of previous research is indicated in section 5. Section 6 illustrates the conclusion and policy implications, and future research plans are in the last section.

Theoretical Underpinning and Research Proposition

The resource-based view (RBV) is the influential theory that is used to explain specific unique resources of firms that yield sustained competitive advantage [Barney et al. 2011]. RBV helps firms to examine their capabilities and resources and empower them to perform better and create a sustainable competitive advantage. Firm resources include information, assets, attributes, capabilities, and organizational processes, which can be controlled by firms, and help firms implement such strategies that improve their effectiveness and efficiency. The resources are categorized into tangible (e.g., information technology (IT) infrastructure) and intangible (e.g., knowledge or process knowledge) [Barratt and Oke, 2007]. Moreover, resources must be inimitable, rare, and non-substitutable to attain a competitive edge [Barney, 1991] and higher performance [Malik et al. 2020]. In contrast, capabilities pertain to the firm's approach in utilizing resources with organizational processes to achieve the desired outcome [Liu et al. 2016].

In this study, I4.0 technology such as BCT is considered the most valuable resource of a firm

[Bressanelli et al. 2018]. It has the ability to provide transparency, automation, and integration among inter and intra-organizational processes [Wang et al. 2020] and ultimately enhance the productivity of SC processes. Bag et al. [2021] also elucidated that along with I4.0, various other resources, i.e., GHRM, green logistics, and ecological knowledge can aid organizations in enhancing ECP and social performance (SP) [Umar et al. 2022a]. It is generally stated that technological resources have a significant impact on the adoption of GSCM practices. Particularly, the adoption of I4.0 enhances the capability of firm in performing numerous processes, such as traceability of products, inventory management, development of green production lines, self-configuration of workstations, and remanufacturing, hence ameliorating the whole manufacturing system [Mohamed & Al-Jaroodi, 2019; Nandi et al. 2021]. Therefore, investigating how the adoption of BCT helped in the implementation of various sustainable practices is vital to form a viable strategy and improve sustainable performance.

BCT and GSCM practices

Industry 4.0 (I4.0) is a new paradigm of autonomous and smart manufacturing and known as the fourth industrial revolution, in which modern technologies are integrated with manufacturing systems with the aim of attaining sustainable performance [Bai et al. 2020]. In today's technological era, 14.0 technologies are adopted by firms to develop green production lines and improve SC performance [Fatorachian & Kazemi, 2021]. I4.0 includes BCT, IoT, AI, cybersecurity, BDA, and robotics [Jamwal et al. 2021, Massaro et al. 2021]. Its implementation is transforming business models and enabling firms to move toward sustainable operations [Li et al. 2017]. Previous literature has illustrated the importance of I4.0 technologies in adopting GSCM practices to mitigate the adverse environmental externalities [Khan et al. 2023a]. For instance, Mastos et al. [2020] indicated that implementing IoT enabled firms to facilitate GSCM practices by reducing pollutants and enhancing resource availability and response time optimization. Kouhizadeh and Sarkis [2018] also demonstrated that the implementation of BCT aids enterprises to maintain the information regarding supplier and material, as well as origin, quality, and quantity of products, which helps enterprises to ensure green purchasing. In addition, scholars have also stated that through BCT, lifecycle assessment of any product can be carried out by utilizing the actual data of a product instead of an estimated value, which is the contribution of this revolutionary technology.

Recently, researchers have stated that BCT is an innovative technology that promotes GSCM practices through its various applications and helps in optimizing and managing ecological issues such as minimizing carbon emission and waste from production and transportation [Elhidaoui et al. 2022]. Similarly, Böckel, Nuzum & Weissbrod [2021] indicated that BCT has a crucial role in the execution of green manufacturing (GM) and green purchasing (GP), as its features improve transparency and traceability and provide immutability and security in green operations. Moreover, Khanfar et al. [2021] affirmed that the adoption of BCT in green/sustainable manufacturing had improved the prediction accuracy by providing quality data for prediction analysis. Also, it has minimized production time through sharing real-time information and enhanced the flexibility of manufacturers through innovative process development, which helped in responding to changing market demand and meeting customer requirements. However, the literature still lacks empirical research on the link between BCT and GSCM practices. Thus, the current research has been carried out to examine the role of BCT in crucial GSCM practices such as GP and GM. Hence, this research hypothesized that:

- H1a: BCT has a positive and significant effect on GP.
- H1b: BCT has a positive and significant effect on GM.

GSCM Practices and Performance

GSCM is a proactive approach in which ecological thinking is implemented among all phases of SC, from purchasing to final product and from finished product to recycling [Srivastava, 2007]. GSCM encompasses various practices such as GP, GM, green design, and

green logistics. The adoption of these practices has a crucial role in enhancing TBL, i.e., ecological, financial, and social performance. The traditional way of manufacturing is causing various ecological issues [Tseng et al. 2021]. Thus, the adoption of sustainable practices has the potential to mitigate ecological adversities [Ozceylan et al. 2014]. The literature also tends to support the position that green practices can help minimize waste and harmful emissions, thus helping in conserving the natural environment and human health [Khan & Yu, 2021]. Among GSCM practices, GM is sought as the most crucial practice, as it helps in enhancing manufacturing capability and productivity through effectively utilizing resources, which improves firm performance [Baah et al. 2021; Habib et al. 2021]. Past research also confirmed that effective consumption of product/material, energy, and green manufacturing operations are the crucial drivers that help in improving sustainability performance [Afum et al. 2020; Cankaya & Sezen, 2018]. GM also ensures efficient consumption of resources and improves firms' operational performance through enhancing functionality of materials and products [Abdallah & Al-Ghwayeen, 2019; Leong et al. 2019]. Existing studies also elaborated that sustainable manufacturing practice is focused on minimizing natural resource consumption and ecological adversities such as toxic and hazardous chemicals and carbon emissions, which helps to improve SP and ECP [Abdul-Rashid et al. 2017]. In addition, GP, which is focused on acquisition of green product/material and evolving strong relationships with suppliers [Zhu et al. 2008], also helps to enhance ECP and SP. Moreover, the literature has provided mixed findings about the impact of GSCM practices on various performances. For instance, Khan et al. [2017] carried out a study on Chinese production enterprises to assess the role of GP in ECP; the scholars have affirmed a negative link between GP and ECP. Contrastingly, Çankaya & Sezen [2019] and Amjad et al. [2022] tend to support that GP is positively linked with ECP. Younis et al. [2020] studied the association among GSCM practices and firm performance and affirmed that GP has an insignificant effect on SP. This indicates that green practices have a varied impact on organizational performance and needs to be examined more comprehensively. Therefore, GP and GM are examined in the current study. On the bases of the above-mentioned arguments, this research hypothesized that:

- H2a: GP has a positive and significant effect on ECP.
- H2b: GM has a positive and significant effect on ECP.
- H3a: GP has a positive and significant effect on SP.
- H3b: GM has a positive and significant effect on SP.

Government support as Moderator

The notion of GSCM is still underexplored in manufacturing enterprises of emerging economies [Malik et al. 2020]. Most of the firms in these regions are just using the logo of green practices. Scholars have also affirmed that there is less focus on implementation of GSCM practices in manufacturing enterprises of emerging economies [Khan & Yu, 2021]. The reason behind this is an inadequate provision of government support (GS) and resources [Martín-Gómez et al. 2019]. GS in this research is defined as the support given by the authorities to strengthen the execution of GSCM practices and advanced technologies such as BCT [Hussain et al. 2022]. Undoubtedly, governmental institutions have a major role in the completion and implementation of any projects. In emerging economies, the government is the financier, while the other authorities are responsible for the maintenance of the projects. Prior literature has indicated that government support is a key driver of advanced technologies [Bosman et al. 2019; Majumdar et al. 2021] and GSCM practices [Ilyas, Hu & Wiwattanakornwong 2020]. The legislative rules and policies of governmental authorities can push industries to move towards I4.0 technologies to enhance the adoption of GSCM practices.

Sustainable development goals have also forced governmental bodies to support communities in conserving natural resources [Ilyas, Hu & Wiwattanakornwong 2020]. Thus, firms are also affected by pressures from governmental institutions to achieve sustainable

initiatives [Schoenherr et al. 2014]. In emerging economies, the government can promote the adoption of green/sustainable practices [Luthra et al. 2015] and advanced technologies. Various departments have been created to support the execution of advanced technologies and green practices. Thus, on the basis of the above arguments, it can be stated that GS can assist in the adoption of BCT and green practices. Hence, the current study hypothesizes that:

- H4a: GS significantly moderates the relationship between BCT and GP.
- H4b: GS significantly moderates the relationship between BCT and GM.

Research Methodology

The primary objective of embracing GSCM practices in SC is to improve the social and financial outcomes by minimizing waste, harmful emissions, cost of energy consumption, and enhancing safety for employees. GSCM practices enabled businesses to enhance their organizational performance. The researcher indicated that GP, ecological product design, and GM were widely discussed green practices [Naim et al. 2022; Khan, Yu, & Umar 2022; Khanra et al. 2022; Hassan & Jaaron, 2021; Jabbour et al. 2017].

In the current research, BCT was linked with GSCM practices to improve social and financial performance. The data were collected from large manufacturing firms which are registered on the Pakistan Stock Exchange. Manufacturing firms were chosen because these firms are jeopardizing the sustainability of the country. Table 1 indicates the demographic profile of the respondents. The data were collected in two phases; the 1st phase lasted from November 2021 to January 2022, and 163 questionnaires were returned. Those large manufacturing firms who did not respond in the first phases were reminded through a telephone call. Whereas, in the second round during February and March of 2022, only 79 questionnaires were returned. Out of the total number, 19 questionnaires were excluded as they were not properly filled. Thus, a total of 223 responses were utilized for analyses, which provided a response rate of 58.6%. Figure 1 indicates the theoretical framework.

The current study employed PLS-SEM for the following reasons: firstly, it can handle complex models and has a variance-based approach, which is more appropriate than a co-variance based approach. Secondly, it can handle both formative and reflexive models. Thirdly, it can provide optimal prediction accuracy. Lastly, it provides reliable results in the case of a small sample size.

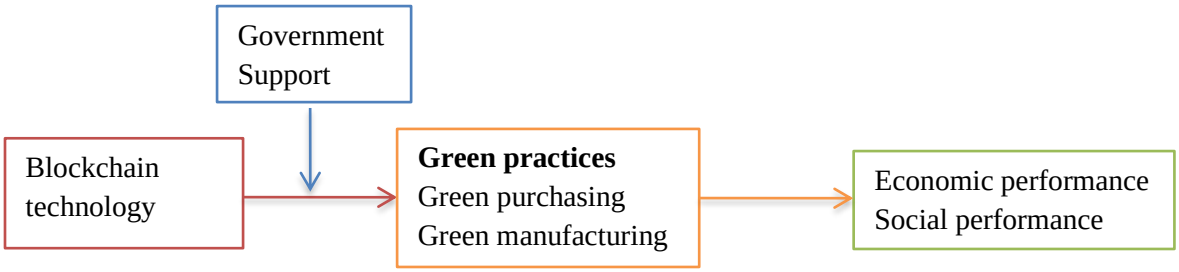

Fig. 1. Theoretical framework

Table 1. Demographic Profile of Responding Companies

Demographic	Variable	Frequency	Percentage (%)
Type of industry	Paper & board	8	3.58
	Automobile	17	7.62
	Synthetic & rayon	7	3.14
	Leather and tanneries	5	2.24
	Chemical	23	10.31
	Steel/iron	13	5.83
	Fertilizers	3	1.35
	Pharmaceutical	11	4.93
	Cable & Electrical goods	7	3.14
	Food and personal care	22	9.87
	Glass & ceramic	8	3.59
	Sugar and allied	26	11.66
	Textile	73	32.74
Number of employees in company	250 – 500	67	30.0
	501—1000	93	41.7
	1001-2000	41	18.4
	More than 2000	22	9.9
Position	Senior level management	74	33.2
	Middle level management	149	66.8
Job experience in Supply chain	Less than 1 year	6	2.6
	1 – 5 years	58	26.0
	6 – 10 years	74	33.2
	11 – 15 years	42	19.0
	16 – 20 years	34	15.2
	More than 20 years	9	4.0

Note: Senior management = SC director, SC manager, Purchase manager, Production manager, Inventory manager Middle level: SC senior officer, warehouse officer, purchase officer, transport officer.

RESULTS AND DISCUSSION

Measurement model

The current research evaluated convergent and discriminant validity for the measurement model. Table 2 illustrates the values of construct validity and reliability, in which all the values of composite reliability (CR) are greater than the threshold value of 0.7 [Hair et al. 2011], and the values of average variance extracted (AVE) also meet the criteria value of 0.5 [Hair et al. 2017]. As the value of AVE is higher than the cutoff value, this indicates that the constructs have well established convergent validity.

Discriminant validity is the second type used for validity evaluation. HTMT ratio of correlation is used to evaluate the discriminant validity. The value of HTMT must be less than 0.9 [Henseler et al. 2015]. The values in table 3 meet the thresholds criterion, which indicates that discriminant validity has been established.

Table 2 Construct Validity and Reliability

Variables	Composite Reliability	Average Variance Extracted
BCT	0.896	0.635
GP	0.824	0.540
GM	0.809	0.520
ECP	0.880	0.650
SP	0.864	0.624
GS	0.849	0.653

Note: BCT = Blockchain technology, GP = Green purchasing, GM = Green manufacturing, ECP = Economic performance, SP = Social performance, GS = Government support

	GM	GP	BCT	GS	ECP	SP
GM						
GP	0.287					
BCT	0.387	0.844				
GS	0.251	0.753	0.575			
ECP	0.866	0.132	0.241	0.158		
SP	0.762	0.180	0.228	0.161	0.785	

Table 3 Heterotrait-Monotrait Ratio (HTMT)

Table 4. Summary of hypotheses

Hypotheses	Effect	Original Sample	T Statistics	P Values
H1a	BCT -> GP	0.512	7.823	0.000
H1b	BCT -> GM	0.308	3.356	0.000
H2a	GP -> ECP	-0.083	1.689	0.046
H2b	GM-> ECP	0.697	19.165	0.000
H3a	GP -> SP	-0.036	0.661	0.254
H3b	GM-> SP	0.598	13.875	0.000
H4a	GS*BCT -> GP	0.152	3.137	0.001
H4b	GS*BCT -> GM	0.144	2.432	0.008

Table 5. Collinearity assessment

	GM	GP	BCT	GS	ECP	SP
GM					1.039	1.039
GP					1.039	1.039
BCT	1.275	1.275				
GS	1.275	1.275				
ECP						
SP						

Structural Model

The structural model indicates the associations among the constructs that were hypothesized in the research model [Hair et al. 2014]. After the establishment of the outer model, the proposed hypotheses were observed. The summary of hypotheses is illustrated in Table 4.

The findings illustrate that BCT has a significant effect on GP ($\beta = 0.512$, $p < 0.01$) and GM ($\beta = 0.308$, $p < 0.01$). The outcomes also indicated that GM has a key role in improving ECP ($\beta = 0.697$, $p < 0.01$) and SP ($\beta = 0.598$, $p < 0.01$). However, GP is negatively linked with ECP ($\beta = -0.083$, $p < 0.05$) and has an insignificant effect on SP ($\beta = -0.036$, $p = 0.245$). Moreover, the findings elucidated that GS substantially moderates the link between BCT and GP ($\beta = 0.152$, $p < 0.01$) and GM ($\beta = 0.144$, $p < 0.01$).

Table 5 indicates the values of VIF, which are less than 5, representing no issue of collinearity in our estimated model. R^2 evaluates variance elucidated in each of the endogenous constructs [Hair et al. 2022]. The R^2 value ranges from 0.02 – 0.12 is considered small, 0.13 – 0.25 is moderate and 0.26 and above is substantial. The values of R^2 are indicated in table 6.

BCT explained 54.6% of the variance in GP ($R^2 = 0.546$) and 10.2% of the variance in GM ($R^2 = 0.102$), respectively. As the value of R^2 for GP is above 0.26, it is considered substantial. The value of R^2 for GM is considered small, as its value is in the range of 0.02 – 0.12. Moreover, GSCM practices (i-e., GP and GM) explained 47.1% of the variance in ECP ($R^2 = 0.471$) and 35.2% of the variance in SP ($R^2 = 0.352$). The R^2 values are above 0.26; thus, it is considered substantial.

Predictive relevance is measured through Stone-Geisser's Q^2 [Geisser, 1974]. The values of Q^2 in Table 6 indicate that all the exogenous constructs considered in the current study have predictive relevance.

Table 6. Predictive relevance

Variables	Q Square	R Square
GM	0.046	0.102
GP	0.274	0.546
ECP	0.300	0.471
SP	0.215	0.352

Discussion

The result of H1a in Table 4 indicated that BCT has a positive impact on GP. This outcome is aligned with the findings of Bag et al. [2020]. The researchers indicated that GSCM consists of complex activities, and that the adoption of BCT in GSCM can effectively manage and enhance its performance. Kouhizadeh and Sarkis [2018] also elucidated that BCT helps in ensuring GP by managing and maintaining supplier and material information. Moreover, Ivanov et al. [2019] stated that BCT based SC allows a transparent and secure flow of information in the value chain and enhances productivity through increasing integration among enterprises.

Next, the result of H1b showed that BCT has a significant impact on GM. The current outcome is similar to the research findings of Mubarik et al. [2021], in which the authors found a positive effect of BCT on GSCM practices. The authors have also elucidated that the implementation of BCT boosts robustness in the SC process, enables firms to manage production through real-time monitoring, and keeps suppliers, customers, organizations, and other stakeholders connected in a real-time environment. Researchers have also stated that BCT is an innovative technology that improves GSCM practices through its various applications that help in optimizing and managing ecological issues, such as minimizing carbon emission from production and transportation [Elhidaoui et al. 2022; Queiroz & Wamba, 2019].

Moreover, the result of H2a indicated that GP has a negative effect on ECP ($\beta = -0.083$, $p < 0.05$). A similar finding is illustrated by Khan et al. [2018a] in their study, in which the researchers studied the production enterprises and affirmed that GP is negatively linked with ECP. The researchers have also indicated that in developed countries, ecological regulations are strict for sourcing green components from local or international suppliers and are encouraged through giving tax exemptions and low import duty to firms as compared to developing countries. The researchers are also of the view that GP enhances the cost of the overall SC system. Khan et al. [2019] also stated the similar finding that GP is negatively related with profit of enterprise because of heavy taxation and import duties on green materials and components.

Next, the results of H2b revealed that GM is significantly related to ECP ($\beta = 0.697$, $p < 0.01$). This research finding is similar to the study of Afum et al. [2020], in which the scholars analyzed the impact of GM on ECP in manufacturing firms of Ghana and stated a substantial link among GM and ECP. The researchers have also elaborated that managers need to unveil the implementation of GM to stakeholders and customers, as doing so can help firms earn more reputation. Singh et al. [2022a] also held a study to verify the influence of GM on enterprise performance, in which the scholars elaborated that the alarming increase in ecological pollution has forced firms to move towards GM. The researchers have also explained that the market position and share of enterprises can be increased if firms adopt GM. Researchers have also illustrated that the adoption of GM helps enterprises meet the requirement of stakeholders [Draghici & Ivascu, 2022] and boost their ECP [Prasad et al. 2022].

Moreover, the result of H3a illustrated an insignificant relationship among GP and SP ($\beta = -0.036$, $p = 0.245$). Similar findings are indicated by Çankaya & Sezen [2019], in which the researchers presented an insignificant effect of GP on SP. Scholars have also demonstrated that this practice has a direct influence on suppliers while having indirect influence on businesses by gaining green inputs. Moreover, Younis et al. [2020] studied the association among GSCM practices and firm performance and affirmed that GP has an insignificant effect on SP.

Next, the result of H3b indicated a substantial influence of GM on SP ($\beta = 0.598$, $p < 0.01$). Similar findings are illustrated by Abdul-Rashid et al. [2017], in which the scholars studied the impact of GM on the triple bottom line of performance. The scholars have affirmed GM as a crucial factor that can help in improving sustainable performance; moreover, the researchers have elaborated GM as an ecological initiative that can help firms in preserving the ecosystem and improve the standard of social life. Afum et al. [2020] also examined the association among GM and sustainability performance in Ghana and found substantial influence of GM on SP. The authors also discussed that Ghanaian manufacturing enterprises initiated giving green training to their workers to effectively carry out operations and to lessen the adversarial effect of production operations on the ecological system and quality of life. Similarly, Singh et al. [2022b] also carried out a study to investigate the role of GM in the production enterprises of India and affirmed that GM has a crucial role in achieving EP and SP. Scholars have also recommended adopting GM to develop sustainable products. The researchers are also of the view that GM can help firms in preserving the environment and reducing costs.

Moreover, the result of H4a and H4b indicated that GS substantially moderates the link between BCT and GP ($\beta = 0.152$, $p < 0.01$) and GM ($\beta = 0.144$, $p < 0.01$). This outcome is aligned with the research conducted by Ilyas, Hu & Wiwattanakornwong [2020], their findings also elaborated that government support facilitates GSCM practices in SMEs. The scholars are also of the view that there should be a strong link among government bodies in order to access valuable resources, as in emerging economies, most of the valuable assets that are vital for green activities are owned by the government. The result also implies that governmental bodies need to provide ease in laws for industrial firms in order to encourage green practices in SC operations and provide tax exemption and interest free loans.

CONCLUSION AND POLICY RELEVANCE

The increasing concern regarding ecological issues has forced firms to move towards sustainable operations. In the current dynamic environment, the success of enterprises is to enhance their efficiency and competitiveness by going green in SC. To provide more in-depth detail, this study investigated the role of BCT in GSCM practices including (GP and GM), and how it leads towards social and financial performance. Also, the moderation role of government support was analyzed in relationships among BCT and GSCM practices. A questionnaire was used for the collection of data from large manufacturing enterprises. The hypothesis was tested by employing PLS-SEM. The measurement model has well-established convergent and discriminant validity, and the values of variance inflation factor meet the threshold criteria, indicating no issue of common method bias.

The outcomes indicated that BCT has a significant role in the adoption of GSCM practices, including GP and GM. The outcomes also elucidated that GM is positively associated with ECP and SP. Whereas, GP is negatively related with ECP and has an insignificant effect on SP. Moreover, GS substantially moderates the link between BCT and GSCM practices including GP and GM.

The implications of the study are as follows: first, the current study enhances the literature on GSCM theoretically and prolongs the scope of SC research by analyzing the moderating role of government support among BCT and GSCM practices, which aligns the recent call in SC literature [Ghadge et al. 2022]. Second, although studies have been published on BCT, especially in developed countries, the discourse and investigation on BCT and GSCM in a Pakistani context is still less explored. This current research offers empirical observations that could be relevant for developing nations. Hence, it fills the gap by providing in-depth detail on a localized perspective of the subject matter.

For industry practitioners, the current study findings provide the direction and understanding that BCT has a vital role in effective implementation of GSCM practices. This implies that the managers can improve the adoption of GSCM practices in their enterprises through deploying BCT, which has the potential to facilitate green practices by providing security, ensuring traceability, and enhancing transparency in operations.

The findings also provide companies with the direction that GSCM practices have the potential to improve sustainable performance. This finding suggests that managers of production enterprises can implement GSCM practices in their operations. The implementation of green practices enables firms to reduce adverse pollutants, waste, and carbon emissions, thereby conserving the natural environment. Additionally, it helps companies meet the demands of stakeholders and enhances their reputation in the eyes of customers by producing eco-friendly products.

Moreover, the findings suggest that policymakers should exert pressure on production firms and develop strict rules for the implementation of green practices; doing this can help in achieving sustainability in businesses. The governmental bodies also need to develop a strong mechanism for rewards and punishment. If firms carried out unhealthy and adverse activities in manufacturing, suitable action should be taken against them, such as heavy fines and penalties to restore environmental loss and cancellation of license. Regulatory bodies can also give tax exemptions and interest free loans to those industries that implement green practices in order to pursue technological infrastructure and green practices effectively.

FUTURE RESEARCH PLAN

Like other studies, this study also has some limitations. First, this study only focused on one I4.0 technology, which is BCT, in manufacturing firms of Pakistan; future studies can be held by focusing on other I4.0 technologies such as AI and BDA in both manufacturing and service firms to provide more exhaustive explanations. Second, this research has only studied the current state of large manufacturing firms and did not examine the short or long run impact of GSCM on sustainability. Future studies can be held by using a longitudinal approach, as it will provide more exhaustive detail about the development of GSCM practices. Third, future studies can also test the same model in different countries and institutional settings or can hold comparative studies across various cultures and countries to provide more comprehensive explanations. Last, future studies can examine the role of BCT in green design and green logistics to add the body of knowledge.

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