Sustainable supply chain management performance in post COVID-19 era in an emerging economy: a big data perspective

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Sustainable Supply Chain Management Performance in Post COVID19 Era in an Emerging Economy: A Big Data Perspective

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Abstract

Purpose: Big data analytics enriches the operational excellence of an organizational sustainable supply chain performance. The present study draws from the dynamic capabilities theory to examine the influence of big data analytics capabilities (Management, talent, and technological) towards sustainable supply chain performance.

Methodology: This study was quantitative and cross-sectional. Data were collected from 374 executives through a survey questionnaire method by applying an appropriate random sampling technique. To test the hypothesis we employed PLS-SEM (Partial Least Square Structural Equation Modeling) to analyze the data.

Findings: The results of the study revealed that big data analytics capabilities play a significant role in boosting sustainable supply chain performance by making a significant contribution to supply chain risk management and innovative green product development. Additionally, results revealed that both supply chain risk management and innovative green product development significantly influence innovation and learning performance. Moreover, innovation & green learning performance has a significant and positive relationship with sustainable supply chain performance.

Originality: The paper specifically emphasizes the factors that result in sustainability in the supply chain integration with big data analytics. Additionally, it offers the boundary condition for gaining sustainable supply chain management.

Keywords: BDA capabilities, Supply Chain Risk Management, Innovative Green Product Development, Green Supply Chain Performance.

Sustainable Supply Chain Management Performance in post COVID19 era in an Emerging Economy

1 Introduction

Planning and integrating digital resources in the supply chain decision-making have become an environmental necessity for today's firms. The adoption of green supply chain management strategies strengthens a business's ability to sustain the environment and its financial sustainability (Khan & Qianli, 2017). Notably, sustainability has emerged as a significant issue across the industries and particularly united nations are giving adequate attention towards sustainability and developed several goals for it (United Nations, 2022). Therefore, the alignment of the green supply chain management (GSCM) and operational management activities is undeniably important, warrant the supply chain's long-run performance. Big data and predictive analysis (BDPA) provide the opportunity to manage and understand the supply chain uncertainties (Bag, 2017). In the ongoing COVID-19 pandemic, manufacturers must become more mature and resilient in the global supply chain (Ivanov, 2020). Like all other value chain activities, manufacturing firms have to decide how big data analytics could support firms in the design of learning and innovation performance (Trabucchi & Buganza, 2018). Given the nature and importance of big data analytics for supply chain performance, previous research has called to examine under what conditions a firm improves supply chain performance (Kamble & Gunasekaran, 2020). Despite this, relatively little is known about what needs to be done to achieve a long term sustainable supply chain in the COVID-19 environment (Karmaker et al., 2021) because it has posed several challenges to the supply chain (Alam, Ahmed, Ali, Sarker, & Kabir, 2021) such as it affected the supply chain momentum (Karuppiah, Sankaranarayanan, Ali, & Paul, 2021) and represents an uncertain situation (Shukor, Newaz, Rahman, & Taha, 2020). Additionally, the supply chain in emerging markets is facing several challenges (Yeoman & Santos, 2019).

Although supply chain risk has come up with many practical suggestions of improving innovation performance and integrating sustainability practices into the whole supply chain life cycle (Awan, 2019). There is little knowledge about how supply chain innovativeness improves sustainability in the supply chain (Bag, Wood, Xu, Dhamija, & Kayikci, 2020). In the current uncertain environment, the Management of a GSCM could be high risk and decrease the firm's SC sustainability performance and competitiveness (Mathivathanan, Kannan, & Haq, 2018). Organizations must reconsider supply chain policy development to prepare for future pandemics, such as COVID19 (Karmaker et al., 2021) since it has disrupted the supply chain (Shahed, Azeem, Ali, & Moktadir, 2021). Green supply chain management (GSCM) is widely regarded as a critical technique for organizations seeking to combine economic, social, and environmental concerns while promoting organizational sustainability (Ilyas, Hu, & Wiwattanakornwong, 2020). Now risks are more relevant to be understood and handled with care as the environmental impact because the organizational actions can aid the risks regarding reputation and financial insufficiency in emerging countries (De Silva et al., 2021). It is worthy of mentioning the big data analytics (BDA) tools that can serve as a diver for business benefits and offer an organization improvements. Previous studies have examined supply chain sustainability determinants, generally adopting big data and predictive analytics capability (Gunasekaran et al., 2017). While supply chain performance has been previously discussed in the literature (Dangelico, Pujari, & Pontrandolfo, 2017; Mandal, 2019), some other studies examined the sustainable developing capabilities (Singh & El-Kassar, 2019) and market performance (Chakphet, Saenpakdee, Pongsiri, & Jermsittiparsert, 2020) and manufacturing performance (Dubey, Gunasekaran, & Childe, 2019). According to Siddique et al. (2021), the recent emergence of the data-driven business markets and exclusion of the conventional data management systems to track have pushed the application of big data analytics in the supply chains as well. Bag et al. (2020a) find that big data management analytics positively impacts innovative green product development and consequently on learning and innovation performance. Organizations are not unknown to big data analytics as they are growing with the help of vital data extracted from bib data analytics (Salehan & Kim, 2016). Recently, Ali et al. (2020) contended that few studies are there which address the collection of valuable information from big data for sustainable product development. Additionally, the development of the environmental perspectives needs to be considered such as the hazarded quality of life (Tan & Zhan, 2017). And, the development of social aspects denotes the fulfillment of human needs by addressing the parties of the innovative product development whereas the economic perspective deals with the requisites for the economic growth of organizations (Ahmad, Iteng, Saad, & Abd Rahim, 2018). Recently, Ali et al. (2020) contended that advancing the process of sustainable development of products influences the value and quality of the products along with enhancing the image of the organization as well. More importantly, competitive advantage inform of the sustainable product development can be accomplished by applying the big data analytics. Since, previous few research studies have examined the impact of big data management on SC risk management and learning and innovation performance, the present study has considered both of them as a outcome of the big data analytics capabilities.

Accordingly (Lin, Tseng, & Pai, 2018), big data analytics is the tool whose application to supply chain management of an organization can potentially address the business performance. Several studies have recently highlighted the importance of big data analytics for supply chain performance (Bag et al., 2020a). Recently, Sezen (2008) highlighted the necessity to focus on the impact of supply chain integration and information sharing on supply chain performance. In this study, we advance the research findings of (Bag et al., 2020a) by introducing SC risk management in the relationship between big data analytics and innovation and learning performance. The Research study by (Bag et al., 2020a) has investigated the relationship between employee development and innovation and learning performance, consequently on the sustainable supply chain. We modify the conceptual framework offered by (Bag et al., 2020a) in the manufacturing context by introducing SC risk management practices and providing new insights into SC literature. Additionally, the previous literature identifying the predictors of the sustainable supply chain is not much up to date. The previous decade on sustainable supply chain has extensively emphasized the cost reduction strategies and commercial outcomes for boosting the supply chains (Liao & Fan, 2020). Notably, the recent pandemic has changed the old assumptions regarding sustainable supply chains (Choi, 2020). It hints about considering the new approach for the creation of sustainable supply chains. Karmaker et al. (2021) reported that supply chain leaders are emphasizing emerging technologies to have sustainable supply chains. Therefore, the present study has addressed the big data analytics capabilities as a possible driver for the sustainable supply chain in the post-Covid-19 era.

Motivated by the above-mentioned research gaps and the current situation of Covid-19 the present study attempted to address sustainable supply chain creation through the big data analytical capabilities. According to the following (Bag et al., 2020a) research framework, this study especially investigates whether or not SC risk management mediates the relationship between big data management capabilities and learning and innovation performance. Notably, literature is scarce regarding BDA capabilities' role in innovative green product development and SC risk management, which enhances the learning and innovation that serves as the base for having a sustainable supply chain. Hence, this study expands the literature discussion on supply chain performance by answering the following questions. (1) How do different types of extensive data analytics capabilities influence innovative green product development and supply chain risk management and consequently on the learning and innovation performance? (2) Do the innovative green product development and supply chain risk and innovation and learning performance mediates the association between BDA capabilities and supply chain performance?

Because of the increasing focus on cost-based outsourcing and growing concerns of the stakeholders related to the environment, society, and technology, supply chain sustainability is considered as important in both the developed and emerging economies (Paul, Ali, Hasan, Paul, & Kabir, 2022) and sustainability has gained much importance due to the strategic advantage (Raian et al., 2022). Therefore, the present study examines big data analytics in the Pakistani context, particularly from Pakistan's multinational companies. Notably, it is quite desperate to digitize the economy and use big data analytics as well. Recently, government institutions have made various policies that are directly related to information technology, connectivity, e-commerce, education, and agriculture, etc. In sum, all of the sectors are being emphasized for digitization. With a population consisting of 64% of youth (below the age of 30 years) and a median age of 'digitally savvy' for the youth demographic in Pakistan is 22 years, promise the digitization. It can be argued that due to the absence of the worldwide big data country, Pakistan has lagged behind almost 5-10 years in big data (Latif et al., 2018). Additionally, sustainability performance and dynamic capabilities are improved at the business process level, and it also happens while managing an organization's resources.

The study has three-fold contributions to the existing literature. First of all, it determines the factors such as big data analytics capabilities as a potential predictor for sustainable supply chain performance. Things do not happen in a vacuum, so the study also identifies and examines the process of how an organization employing big data analytics can have sustainable can supply chain performance. Secondly, the study is based on the theoretical gaps identified by the previous studies (Bag et al., 2020a). Their study contended that further studies might enhance the scope of BDA by considering the three types of BDA capabilities. Second, a recent study (Dubey et al., 2019) considered the big data analytics capability as a one-dimensional construct that may have hindered understanding. Additionally, they also recommended using theories other than contingency theory and dynamic capabilities view. Considering the research mentioned above, the present study examined the three types of big data analytics capabilities. It also considered the multinational companies from multiple sectors to have better and broader insights regarding the influence of significant data analytics capability on the sustainable supply chain performance. Thirdly, the study is a valuable addition to the literature as it offers Asian cultural insights on big data analytics, and particularly, to the best of our knowledge, it is among the few studies. Further, to best of the only research in Pakistan which has provided the insights regarding the big data analytics and its contribution towards the supply chain risk resilience and its sustainable performance from the multinational companies related to different sectors.

2 Literature review

2.1 Theoretical Background

The present study is underpinned by the Dynamic Capability View (DCV). According to dynamic capability, the theory is an extension and reaction against the inability of the resource-based view for the interpretation to develop and redevelop the resources and capabilities to entertain the dynamic environment (Bleady, Ali, & Ibrahim, 2018). Similarly, it is regarded as the extension of the resource-based view that explains the sustainability of the competitive advantage for an organization. These capabilities offer the individuals a competitive advantage (Mukhtar, Baloch, & Khattak, 2019). An organization can easily obtain a sustainable competitive advantage when they get the dynamic capabilities for gaining the functional competencies (Pervan, Curak, & Pavic Kramaric, 2017).

Besides the explanation of the factors that result in gaining the competitive advantage The theory also serves to explain the underlying factors that may result in sustainable supply chains. Accordingly, contended that supply chains do have dynamic changes as compared to the casual markets due to the changing customer's behaviors or the non-governmental institutions (Hall, 2000). These capabilities help an organization to identify the opportunities in the market and avail them. Dynamic capabilities theory has been previously used for examining the various indicators of the supply chains. Accordingly, the present study also adopts the dynamic capability theory to underpin the current research framework.

The study has considered big data analytics as a dynamic capability that enables an organization to identify the opportunities and avail them. Qwabe (2020) reported that big data as an analytical capability enables managers, statisticians, trend analysts, and other professionals to systematically analyze the incoming data. Additionally, the capabilities of an organization facilitate the productive and competitive utilization of the resources whether they are tangible or intangible. Thus, the present study argues that different big data capabilities (Management, talent, and technological) enable an organization to identify and gain sustainable opportunities that result in innovative green product development and supply chain risk management leading towards innovation learning and performance enabling the sustainable supply chain.

2.2 BDA Management Capabilities and Innovative Green Product Development

The COVID-19 virus has had a significant impact on health, economic, social, and industrial activities. It has severely interrupted supply chain management and hampered the transfer of critical commodities (Karuppiah, Sankaranarayanan, Ali, & Paul, 2021). Due to an extensive level of environmental uncertainty, the adoption of developed processes by using big data capabilities such as management, talent, and technological capabilities is vital for the organization to attain the supply chain's sustainability performance (Janssen, van der Voort, & Wahyudi, 2017). Moreover, it claimed that there is an extensive requirement of the initiatives and to implement the BD programs (Braganza, Brooks, Nepelski, Ali, & Moro, 2017). Moreover, Gunasekaran et al. (2017) explored the resource-based view to elaborate on the influence of resources on BD integration capabilities. They argued that the supply chain and overall firm performance are influenced by the IGPD which is further reliant on the mediation impact of management support. The success of the IGPD is only realized when a corporation incorporates operational excellence to attain a competitive advantage. Thus, the managerial, talent, and technological capabilities help the IGPD achieve sustainable achievements and growth. Teece (2016) defined that the dynamic capabilities as 'the skills of personals to build, integrate, and reconfigure competencies to answer rapidly changing environments.' Thus, the changing environment requires the employees to have Management, technological, and talent capabilities to incorporate climate change in the organization.

The dynamic variation in technology forces corporations to implement strategic deliberation of personal capabilities such as Management, talent, and technological capabilities. The difficulties in developing employees associated with contemporary corporations can be increased by the involvement of an extensive volume of big data (Shah, Irani, & Sharif, 2017). In addition, Tiwari, Wee, and Daryanto (2018) also conducted studies on BDA related to supply chain over procurement and strategic sourcing through logistics activities and demand planning for six years. To achieve the benefits of BDA, particularly for planning, specialized skilled staff is often required. Likewise, a study conducted by Zhong, Newman, Huang, and Lan (2016) examined that the application of BD in the business process can enhance the firm's performance. The technology processing will sharpen the processor to complete the numerous processing modes to fit various processing development (Mishra, Gunasekaran, Papadopoulos, & Childe, 2018). A lot of opportunities are available for holistic personals development that is based on the capabilities of BDA (Wang, Gunasekaran, Ngai, & Papadopoulos, 2016). Thus, BDA capabilities such as technological and talent enhance employee development, improving the organization's working style and creating innovative employee competencies (Zhao, Liu, Zhang, & Huang, 2017). Thus, based on these kinds of literature, the existing study formulates the following hypotheses:

H1: There is a significant relationship between the BDA management capabilities and innovative green product development.

H2: There is a significant relationship between the BDA talent capabilities and innovative green product development.

H3: There is a significant relationship between BDA technological capabilities and innovative green product development.

2.3. BDA Capabilities and Supply Chain Risk Management

One of the reasons behind BDA development is to provide coverage to aspects of Management, especially in supply chain management. Such as it provides coverage to the supply chain in multiple phases, i.e., identifying the prospect, supplying and distributing the product, and managing the activities of suppliers. The failure of proper management of the supply chain ends with project collapse. BDA results in the creation of substantial opportunities to develop the supply chain in the context of worldwide clients. Predictive analytics can forecast supply chain risk, and true forecasting results in inappropriate marketing and operations section strategies and cost-cutting in the supply chain process. Organizations apply BDA tools to attain a competitive advantage. Failure of the supply chain objectives can be eradicated (Zhan, Tan, Li, & Tse, 2018).

Talent capabilities require time and capital investment to develop programming skills, projects, data, and network management, its maintenance and analytics also manage the supply chain risk (Akter, Wamba, Gunasekaran, Dubey, & Childe, 2016). Active leaders play a vital role in generations. As the world has become a global village, the more and more changes in internet investment, technological skills are essential for existing workers' development and supply chain activities management in the organization. In agreement with a previous study (Marshall, Mueck, & Shockley, 2015), investigation leaders emphasize collaboration within the context of a structured approach by focusing on innovation.

H4: BDA management capabilities are positively associated with supply chain risk management.

H5: BDA talent capabilities are positively associated with supply chain risk management.

H6: BDA technological capabilities are positively associated with supply chain risk management.

2.4. Innovative Green Product Development and Innovation and Learning Performance

Although sustainable supply chain performance depends on innovation, the question here is its implementation to upkeep performance? The true Management and talent capabilities make innovation (a key player in today's competitive world to secure competitive advantage) possible. By employing firm Resource Base View (RBV) Wamba et al. (2017) proposed the BDA leverage model by providing evidence in the livelihood of dynamic capabilities (process-oriented) to augment the capabilities of the organization to bring improvement in organization performance. For better development of capabilities, an organization will have to bring together the complexity of different employees' work and supply chain processes in multiple organizations (Wang et al., 2016). Further, organizations suggested that in the successful application of BDA, talent, process, and technological capabilities all together play a vital role. The development of the innovative green product ends at product launching by having started with an idea. Environmental knowledge sharing is essential among the environment and product team specialists to develop an innovative green product in small markets. Proper implementation of the IGPD process results in not only improvement of innovation but also organization employees' learning performance by permitting debate, errors, and failure analysis to the development of IGPD project by employing the application of BDA all the levels in that particular firm (Sivarajah, Kamal, Irani, & Weerakkody, 2017). Notably, the BDA capabilities at both the operational and strategic levels generate new knowledge and business value. Following are the hypothesis;

H7. There is a significant relationship between innovative green product development innovation and learning performance

H8: Innovative green product development is a significant mediator between the relationship of BDA management capabilities and innovation and learning performance

H9: Innovative green product development is a significant mediator between the relationship of BDA talent capabilities and innovation and learning performance

H10: Innovative green product development is a significant mediator between the relationship of BDA technological capabilities and innovation and learning performance

2.5 Supply Chain Risk Management and Innovation & Learning Performance

We can characterize the development of the supply chain with multiple events. The augmentation of continuous technological learning is one of the core factors. In progressive nature organizations, the personnel associated with the supply chain and committed to continuing their training usually get higher management support. The innovation and learning process supports effective supply chain processes (Awan, 2019). In contrast, development activities support the supply chain in optimizing the resources and boosting supply chain-related capabilities (Shohan et al., 2019).

In the development of competitive advantage, innovation permits the firms in supply chain development. Innovation is the key player in the process of competitive advantage in such a progressive culture (Awan et al., 2021). Improvisation in the supply chain process ends with employee satisfaction along with an increase in organization profit. The opportunities for growth and development result in strengthening supply chain performance (Moktadir, Ali, Rajesh, & Paul, 2018). The supply chain can also result in modifying the relationship between BDA capabilities and an organization's learning.

H11. There is a significant relationship between the supply chain risk management and innovation and learning performance

H12: Supply chain risk management is a significant mediator between the BDA management capabilities and innovation & learning performance

H13: Supply chain risk management is a significant mediator between BDA talent capabilities and innovation & learning performance

H14: Supply chain risk management is a significant mediator between BDA technological capabilities and innovation & learning performance

2.6 Innovation & Learning Performance and Sustainable Supply Chain Performance

One of the labor concentrated industries is the Mining industry, having high co-operation among employees is predictable as our world has become a global village. Rahman, Ali, Moktadir, and Kusi-Sarpong (2020) argued that insufficient technology and inadequate knowledge could also adversely affect a firm to improve GSCM. Alternatively, process improvement can increase learning, and in turn, can improve GSCM (Chowdhury, Ali, Paul, Mahtab, & Kabir, 2020). Learning continuously is the key to maximum performance. The Mining business situation is required the dynamic environment having the necessity of learning from past instances to avoid the same in the future to contribute to SSCP enhancement (Hammervoll, Jensen, & Beske, 2012). Innovation can reduce supply chain process costs and increase organizational profitability (Mahesar, Chaudhry, & Tariq, 2017).

H15. There is a significant relationship between innovation & learning performance and sustainable supply chain performance

H16. Innovation & learning performance is a significant mediator between the relationship of innovative green product development and sustainable supply chain performance

H17. Innovation & learning performance is a significant mediator between the relationship of supply chain risk management and sustainable supply chain performance

2.7 Supply Chain Innovativeness

Competitive edge is a key player in the process of organization success, having dependence on innovation. Additionally, innovation throws a direct impact on any organization's supply chain process (Hult, Hurley, & Knight, 2004). An innovation-based supply chain process of any organization throws its impact on the new product and the process development while emphasizing an immediate response to the customer's requirement. In addition, both an organization's performance and supply chain are at a higher level backed by re-utilization and assimilation of BDA. Keeping the current technological transformation and intervention in our routine activities, one can't imagine looking into the future. Sivarajah et al. (2017) having their investigation on challenges faced by the organization along with BDA and proposed two prime challenges. 1) Data management process, specifically concerning data acquisition, storage, and mining, in the requirement of cleansing activities. 2) Challenges faced like Management of data privacy, its scrutiny and governance, the occurrence of sharing, and finally, Management and ownership of the data. It is not viable to produce the final product and services by overseeing innovation base factors in the process of the supply chain (Hult et al., 2004). One of the recent studies identified the crucial role of supply chain innovativeness to improve innovation & learning performance. Findings of their study revealed that supply chain innovativeness significantly moderates the association and strengthens the existing relationship (Bag, Wood, Xu, Dhamija, & Kayikci, 2020b). Alike, Begum, Ashfaq, Xia, and Awan (2022) contended that green innovation is an important factor for developing sustainability. So it is asserted that innovative green product development is also necessary for innovation and learning performance enhancement. The present study proposed that supply chain innovativeness may moderate the nexus among innovative green product development and innovation & learning performance based on the above-mentioned arguments. Thus, the following hypotheses are proposed:

H18. Supply chain innovativeness significantly is a significant moderator between the relationship between innovative green product development and innovation & learning performance.

H19. Supply chain innovativeness significantly is a significant moderator between the relationship between supply chain risk management and innovation & learning performance.

Figure 1 represents the research framework of the present study.

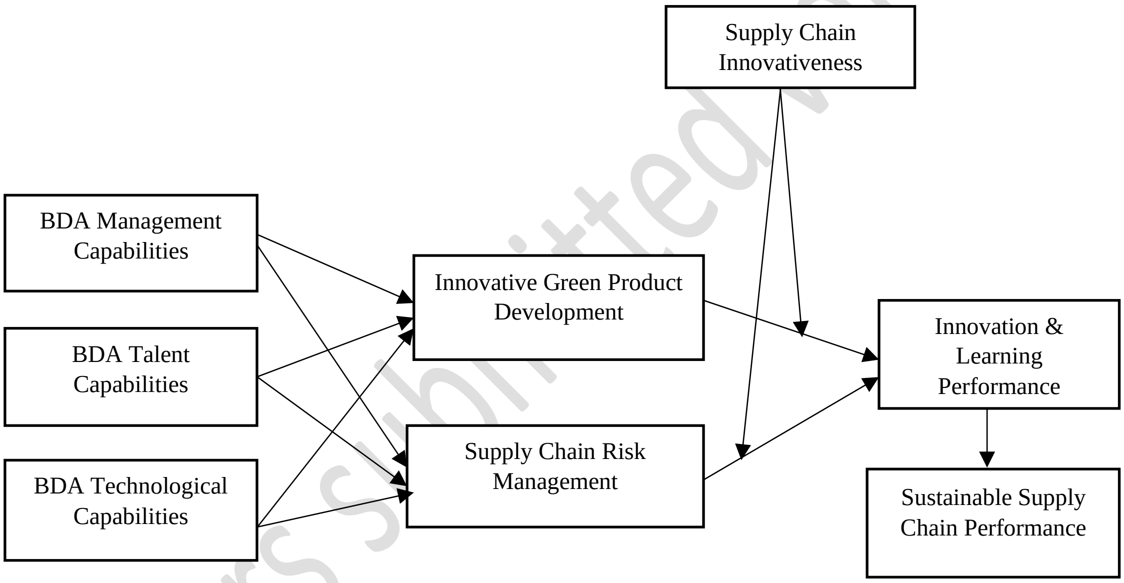

Figure 1: Research Framework

3 Methodology

3.1 Population and Sample Size

Pakistan is a developing country and desperate for the digitization of the economy. Having said that, the present study aimed to examine how the big data analytics capabilities contribute towards sustainable supply chain performance? Moreover, the study also examined innovative green product development, supply chain risk and innovation, and learning performance as facilitators for creating a sustainable supply chain performance. Big data analytics requires huge investments and infrastructures; therefore, the present study has considered the multinational organizations working itself in Pakistan and companies whose subsidiaries are working in Pakistan. Multinational organizations are selected because they are extensively or to some extent using big data as compared to the majority of the local (Pakistani) organizations. According to a State Bank of Pakistan (SBP) report, it provided a list of 899 multinational companies.

The sample size of the study was calculated by using the formula proposed by (Yamane, 1967). Following is the formula for sample size calculation:

$$n = \frac{N}{1 + N(e)^2}$$

In this formula n= Sample size; N= Total population; e=Precision level

$$n = \frac{899}{1 + 899(.05)^2} = 276$$

As per the formula, the minimum sample size for the present study is 276 respondents. Therefore, the sample size was inflated by 50% to gain the maximum responses from the respondents. Hence the sample size for the current study is 414 respondents. The sample size for the current study is also justifiable according to previous studies; for instance, to perform the structural equation model, a sample size of 200 to 400 respondents is enough (Oke, Ogunsami, & Ogunlana, 2012). According to Hair, Black, Babin, and Anderson (2010) 100 is the minimum sample size when there are five or fewer constructs in the model. Hence, there is no issue with the sample size of the present study.

3.2 Pre-testing and Measures

All of the measures for the present study are adapted from the previous studies. Big data analytics management capability measured by six items measuring instrument, big data analytics talent capability measured by nine items measuring instrument (Akter et al., 2016). Innovative green product development measured by 10 items (Pujari, Wright, & Peattie, 2003), innovation and learning performance measured by eight items (Akgün, Ince, Imamoglu, Keskin, & Kocoglu, 2014; Silvestre, 2015), and supply chain risk measured by six items (Singh & Singh, 2019) and finally sustainable supply chain performance measured by eight items (Gunasekaran et al., 2017).

After finalizing the measuring instrument for variables, it was then presented to two assistant professors and two practitioners for pre-testing. The pre-testing affirmed the content validity of the measuring instrument. Data were collected by using the questionnaires. An email was sent to the senior managers of randomly selected organizations with the purpose of the study and requested data collection participation. After gaining permission for data collection questionnaires were distributed among the individuals. Later on, questionnaires were recollected after 3 weeks. Overall, researchers received a total of 200 usable responses from the respondents and yielded a response rate of 48%. It is considered a good response rate as previous studies have reported a low response rate. For instance, Dubey et al. (2019) in their study, reported a response rate of 23.22%. Similarly, Shamim, Zeng, Shariq, and Khan (2019) also reported a response rate of 27% in their study and also applied the PLS-SEM. PLS-SEM was employed for data analysis using Smart PLS 3 as it is deemed a popular and advanced estimation technique in the hospitality and tourism domain (Ali, Rasoolimanesh, Sarstedt, Ringle, & Ryu, 2018). Moreover, the PLS algorithm followed by bootstrapping technique was used to assess the measurement and structural model.

4 Results

4.1 Demographics

This section deals with the demographic characteristics of respondents. Respondents' demographic profiles are presented in Table 1. A total of 374 respondents participated in this survey. Table 1 shows that out of 374 participants, 55.3% (207) were male and 44.7% (167) were female. The findings reported that the majority of the respondents were aged from 26-45 years. The survey accounted for 67.1% (251) of individuals being in that age group. While 24.9% (93) were of ages up to 25 years old, the remaining 8% (30) belonged to the age group of 46-55 years. In terms of qualification, 74.6% (279) of participants had bachelor's degree, followed by 21.4% (80) with master's degree, 2.4% (9) fell in the others' category (Diploma or Professional Qualification), and the remaining 1.6% (6) had obtained their Ph.D. Meanwhile, 56.7% (212) of respondents had permanent job positions, while 40.1% (150) were on the contractual nature of employment and the remaining 3.2% (12) of leaders were Internees in their respective organizations. The results relating to the length of service found that 21.1% (79) of individuals had up to one-year job experience, 47.9% (179) of respondents had 2-5 years of experience, while 19.3% (72) had 5-10 years of experience, and remaining 11.8% (44) had 10+ years of job experience in their respective organization.

Table 1
Demographics

Insert Table 1 here

4.2 Measurement Model Assessment

The measurement model was evaluated and convergent validity was assessed by using loadings, average variance extract, and competitive reliability. Refer to Table 2, except for a few values; factor loadings exceeded the recommended value of 0.60 for both countries. Similarly, all values of composite reliability (CR) also exceeded the recommended value of 0.70. All the values of average variance extract (AVE) for all under-study constructs exceeded the recommended values of 0.50 (Hair Jr, Hult, Ringle, & Sarstedt, 2021). Items were deleted with the lowest factor loadings (<0.50).

Table 2
Convergent Validity

Insert Table 2 here

4.3 Discriminant Validity

Henseler, Ringle, and Sarstedt (2015) proposed a new and advanced criterion (HTMT ratio) to assess the discriminant validity, and they agreed that the Fornell-Larcker criterion was one of the effective methods to evaluate discriminant validity, but this approach had not detected the lack of discriminant validity in various research situations. Therefore, the HTMT ratio was used to assess the discriminant validity of constructs. As shown in Table 3, all the HTMT ratio values were given in Malaysian and Pakistani contexts. All the values are less than 0.90 as recommended by Gold, Malhotra, and Segars (2001); hence discriminant validity had also been established for all constructs.

Table 3

Discriminant Validity (HTMT Ratio)

Insert Table 3 here

4.4 Structural Model Assessment (SEM)

A structural model was also assessed after the evaluation of the measurement model. For this purpose, the significance of the model was assessed based on path coefficients, t-values, and standard errors. The hypotheses were tested for the main and indirect effects through the bootstrapping procedure in Smart PLS 3(Hair Jr, Sarstedt, Ringle, & Gudergan, 2017). Refer to Table 4, Table 5, and Table 6, direct, indirect, and, moderating hypotheses were empirically tested. Hypotheses were supported based on the critical ratio (t>1.645; P<0.05). It was found that all the hypotheses are supported except few relationships.

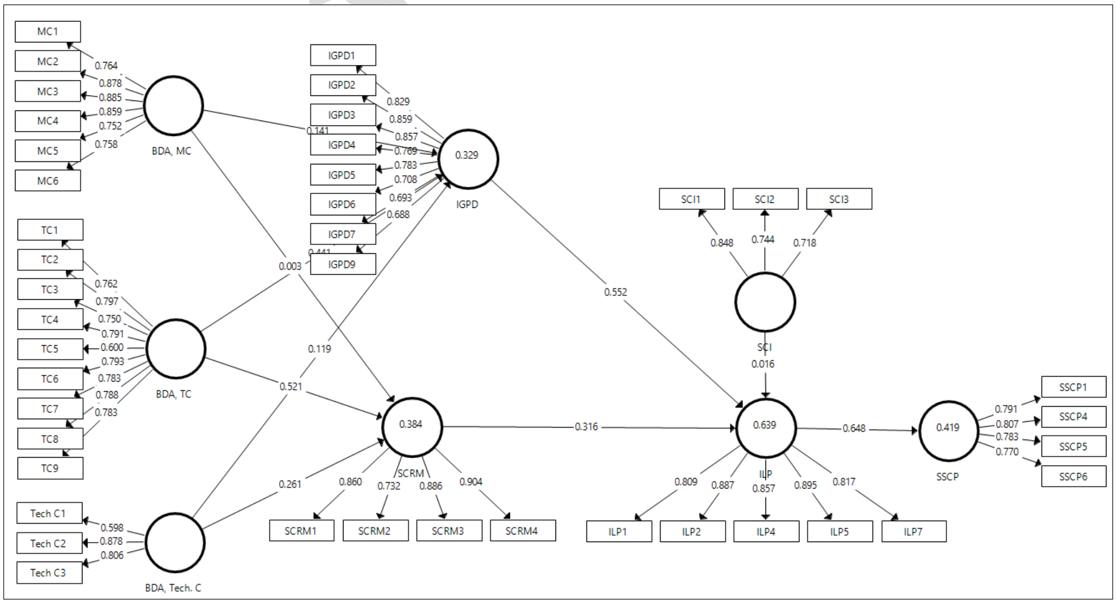

Figure 2: Measurement Model Assessment

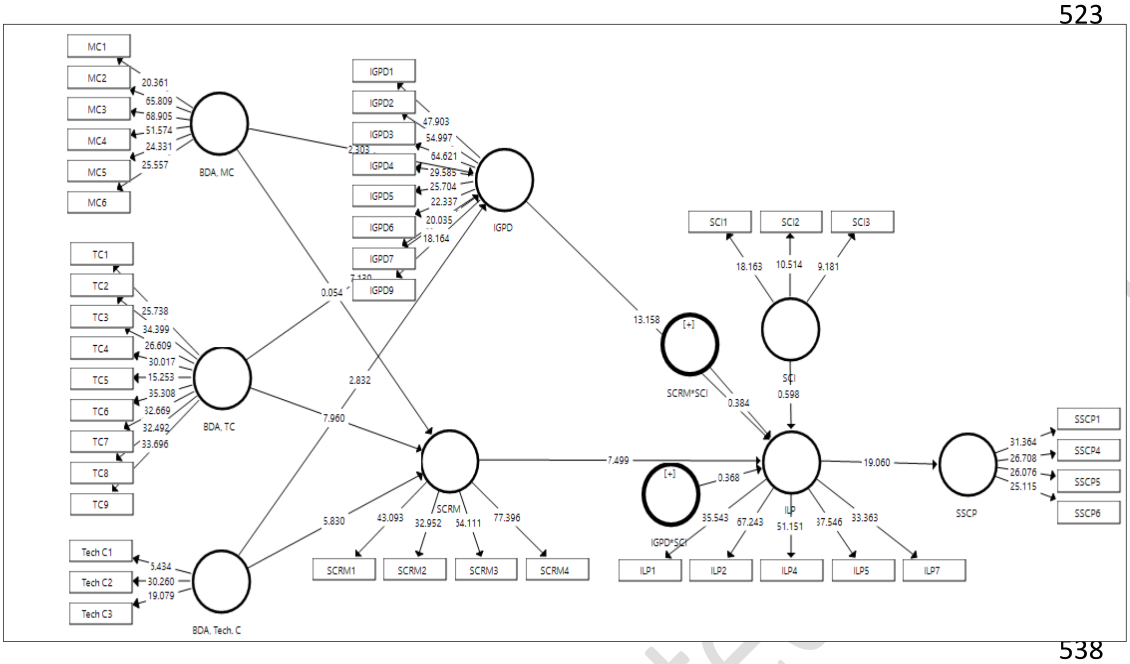

Figure 3: Structural Model Assessment

Table 4

Path Analysis

Insert Table 4 here

Table 5

Indirect Effects

Insert Table 5 here

Table 6
Interaction Term

Insert table 6 here

5. Discussion

This study discusses the importance of sustainable supply chain management; it is one of the most important firms' necessities. Sustainability is a major issue for organizations because every activity rotates around the organizations' operational activities. The current study aims to investigate how BDA plays a vital role in enhancing supply chain management's performance. However, this study also enhances the understanding of the implementation ways. The conceptual work is based on the novel concept involving BDA management, talent management, and technological capabilities to enrich how BDA enhances sustainable supply chain performance. The present model also discusses operational performance and supply chain risk management and shows that it will positively enhance supply chain performance sustainability. The empirical findings support the assumptions of the current study.

First, The learning capabilities and performance enhances the firm performance financially (Akgün et al., 2014). Similarly, the current study's findings also revealed that learning capabilities and performance also support the implementation of a sustainable supply chain. The study's findings explained that innovative product development enhances the learning capabilities and performance of the organization. On the other hand, BDA capabilities improve employee development and BDA talent management capability and have a significant relationship with the organization's innovative performance and learning performance (Akter et al., 2016). Moreover, this paper also adds the connection between talent management, employee management, and competitive performance by emphasizing sustainable supply chain management. Second, to achieve the benefits of BDA projects, many firms focus on supply chain innovativeness. Many firms used other factors in place of supply chain innovativeness; for that reason, they cannot get the full benefits from BDA projects (Marshall et al., 2015). Third, for gaining a competitive edge, BDA plays an important role and enhances the firm performance. Similarly, this study's assumptions are also supported by previous research (Dubey et al., 2019). Although, the linking between BDA has been improved the performance of the organizations and supply chain (Papadopoulos et al., 2017). However, operational performance sustainability is also improving through BDA.

Furthermore, Janssen et al. (2017) stated that the learning and innovation process leverage the BDA and big data would support sustainable operations. Previous work supports the assumption related to the talent management of BDA and the relationship with employee development (Marshall et al., 2015). Similarly, the supply chain innovativeness work as a moderator under this study also shows significant results. The result suggests that BDA management capabilities, talent management, and technological Management show sustainable outcomes.

The study results have presented evidence that the supply chain risk management results in the innovation and learning leading towards the sustainable supply chain performance. It is very crucial to manage the supply chain risks to ensure the organizational or industrial sustainability in long-run. It is necessary to identify the supply chain risks so that the mitigation strategies can be applied to have the sustainability in long period of time (De Silva et al., 2021). The sustainable supply chain can be accomplished by enhancing the green knowledge resulting in the green innovations (Agyabeng-Mensah, Afum, & Baah, 2022). Moreover, sustainable supply chain can be accomplished by mitigation strategies for supply chain risks (Ali, Gongbing, & Mehreen, 2021) such as big data analytics, and innovativeness (Kalyar, Shafique, & Ahmad, 2019).

5.1 Conclusion, future direction, and limitation

The study attempted to examine the influence of big data analytics capabilities on the sustainable supply chain. In this regard, the study has considered the role of innovative green product development, supply chain risk management, and innovation and learning performance as mediators. Additionally, the supply chain innovativeness is considered as a moderator. The data were collected from multinational companies working in Pakistan. Based on the results of the study it is concluded that the big data analytics capabilities serve as an important factor that leads towards the development of sustainable supply chain performance. Organizations can accomplish sustainable supply chain performance by investing their resources in developing the big data analytical capabilities in different domains namely; management, talent, and technologies. Resultantly, this capabilities jointly serve as a dynamic capability resulting in sustainable supply chain performance. We conclude that BDA capabilities are essential for supply chain risk management. We propose that manufacturing firms are dependent on supply chain innovativeness to effectively manage innovation and learning performance to achieve sustainable supply chain management. We concluded that higher levels of supply chain innovativeness reduce the supply chain risks, which implies greater learning and innovation is more dependent on supply chain innovativeness.

Our results provide significant evidence; supply chain innovativeness appears a key signal for the firms to generate a high level of innovation and learning performance while reducing the supply risk management. According to the research design, a few limitations must consider by future researchers. The primary rule is the utilization of cross-sectional data. Secondly, only multinational companies are considered under this study, which provides regulations in outcomes, and future research, drawing from more extensive areas may reduce the limitation. Third, the research group grounded the hypothetical system utilizing dynamic capacity see hypothesis. Future research can improve by working with these outcomes as a base. Additionally, create complex models by adding other variables which affect green product development. Aligned with the previous study suggestions it is suggested that future studies should examine the leadership role towards creating sustainable development performance outcomes (Awan & Khan, 2021).

5.2. Theoretical Implications

From a theoretical perspective, the present study has several implications which are as follows; this study is the first to investigate the moderating impact of supply chain innovativeness between the relationship between supply chain risks and innovation learning and performance. Despite the increasing interest in green or sustainable supply chain management, little research exists on how firms their supply chain risk management and innovative product development in the presence of the BDA capabilities. Our study addresses this research gap by developing a conceptual framework in the post-COVID-19 in an emerging country context. Additionally, the study has advanced the literature on sustainable supply chain performance and its indicators. More precisely, it has presented evidence on of how big data analytics capabilities can result in sustainable supply chain performance through mediators as process explanators. Additionally, it is one of the few studies that advanced the literature on the big data analytical capabilities and sustainable supply chain performance while considering the boundary condition of supply chain innovativeness. It advanced the literature by considering the innovations in supply chain and risk management from the supply chain perspective.

5.3. Managerial implications

Our outcomes provide direction to consultants and managers in post-COVID-19 situations who are engaged in implementing BDA in firms. The findings present a few managerial associations seeking to accomplish operational distinction, especially in multinational companies. Managers of the organizations can achieve operational qualities from the significant relationship between BDA, the management capacity, and innovative green product development in the post-COVID-19 situation. Specifically, BDA has exhaustively changed the way of working of every association. Moreover, the entry of BDA has empowered associations to deal with voluminous information in a compelling and developed form. The study results recommend that effective utilization of big data analytics can bolster sustainable products in operation and organizational supply chain functions, providing help to fully utilize BDA. Sustainability must be emphasized extensively regardless of the organizational operational domains since it enables the organizations to maintain their corporate sustainability in the ecosystem (Kanwal & Awan, 2020).

Managers of the organizations can improve their resource development and redevelopment related to supply chains by incorporating the big data analytical capabilities such as managerial, talent, and technological respectively as the larger data sets will enable them to identify the previous trends and also forecast the future trends related to the supply chain, ultimately, leading towards the higher performance. Additionally, they can also seek resources development from the supplier perspectives as the larger data sets will enable them to see the shortages in the supply chain and also look for the future needs so they can timely take an action. The study has presented the findings from the dynamic capability perspective. So the managers must emphasize developing the organizational dynamic capabilities that will enable them to explore and exploit the opportunities resulting in sustainable supply chain performance. The managers are required to alter the existing supply chains by not only considering the financial aspects but environmental aspects (Rahman et al., 2020) and social aspects (Munny et al., 2019) as well for creating a sustainable supply chain management (Tumpa et al., 2019).

Declarations

- **Ethical Approval:** Not Applicable
- **Consent to Participate:** Consent to participate in the study was obtained from the respondents.
- **Consent to Publish:** All authors are agreed to publish this manuscript**.**
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- **Competing Interests:** The authors declare that there is no competing interest.
- **Availability of data and materials:** Data and relevant materials are available on request to corresponding authors.

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Table 4

Path Analysis

	Relationships	Std. beta	Std. Error	t-Value	L.L	U.L.	R^2	VIF	Decision
H1	BDA, MC -> IGPD	0.141	0.061	2.320	0.044	0.244	0.329	1.946	Supported
H2	BDA, TC -> IGPD	0.441	0.058	7.572	0.343	0.539		1.995	Supported
H3	BDA, Tech. C -> IGPD	0.119	0.044	2.691	0.039	0.184		1.063	Supported
H4	BDA, MC -> SCRM	0.003	0.056	0.051	-0.089	0.094	0.384	1.946	Not Supported
H5	BDA, TC -> SCRM	0.521	0.063	8.329	0.421	0.628		1.995	Supported
H6	BDA, Tech. C -> SCRM	0.261	0.043	6.055	0.187	0.322		1.063	Supported
H7	IGPD -> ILP	0.552	0.043	12.901	0.478	0.624	0.639	1.811	Supported
H11	SCRM -> ILP	0.316	0.043	7.349	0.248	0.386		1.081	Supported
H15	ILP -> SSCP	0.648	0.032	20.207	0.583	0.69	0.419	1.001	Supported

Table 5

Indirect Effects

	Relationships	Std. beta	Std. Error	t-Value	L.L	U.L.	Decision
H8	BDA, MC -> IGPD -> ILP	0.078	0.035	2.244	0.025	0.135	Supported
H9	BDA, TC -> IGPD -> ILP	0.243	0.035	6.884	0.183	0.299	Supported
H10	BDA, Tech. C -> IGPD -> ILP	0.065	0.025	2.64	0.023	0.102	Supported
H12	BDA, MC -> SCRM -> ILP	0.001	0.018	0.051	-0.028	0.032	Not Supported
H13	BDA, TC -> SCRM -> ILP	0.165	0.032	5.112	0.118	0.223	Supported
H14	BDA, Tech. C -> SCRM -> ILP	0.082	0.017	4.899	0.058	0.114	Supported
H16	IGPD -> ILP -> SSCP	0.358	0.031	11.664	0.306	0.408	Supported

H17	SCRM -> ILP -> SSCP	0.205	0.033	6.257	0.152	0.26	Supported

Table 6

Interaction Term

	Relationships	Std. beta	Std. Error	t-Value	L.L	U.L.	Decision
H18	IGPD*SCI -> ILP	0.117	0.040	2.925	0.168	0.257	Supported
H19	SCRM*SCI -> ILP	-0.031	-0.035	0.885	-0.084	0.109	Not Supported