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Big Data Analytics Capability and Green Supply Chain: Does Supply Chain Visibility and Agility Matter?

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ABSTRACT

In recent years, scholars and practitioners have been more interested in big data analytics capabilities. Though typically understudied, research in this new sector is growing. An enhanced green supply chain can be achieved, according to this article, provided businesses adopt and restructure some of the big data resources and capabilities inside their supply function. 332 managers of supply chain, production, and information systems from shareholder manufacturing companies listed on the Amman Stock Exchange participated in a survey employing a questionnaire. To examine the data, structural equation modeling (SEM) was used. The researched hypotheses were evaluated using Amos V.22. The empirical findings demonstrate how supply chain visibility and agility, as well as green supply chain, are influenced by big data analytics capability. Green supply chains have an impact on supply chain agility and visibility. Additionally, the influence of big data analytics capabilities on green supply chains is mediated by supply chain visibility and agility. Additionally, the results provide managers with concrete evidence that enhancing supply visibility and agility via BDAC development can increase the degree of GSC.

Keywords Big data analytics capability, Green supply chain, Supply chain visibility, Supply chain agility.

Introduction

Due to changes in the business climate and increased pressure from competitors, businesses are becoming more interested in green environmental practices and improving sustainable performance [1,2]. To address emerging and distinct environmental concerns, businesses across various industries are now interested in strengthening and improving their environmental performance [3].

To generate a "win-win" scenario, green supply chain (GSC) aims to develop solutions that boost corporate profitability and enhance the environment [4, 5]. Additionally, the GSC reduces waste by promoting product returns to reduce energy and raw material consumption and stop waste streams from entering the environment [6]. Ideas from fields like data science, predictive analytics, and big data which include mathematical, machine, and statistical analysis—have profound implications for supply chain management, and specifically for green supply chain management, because of the extraordinary

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magnitude, variety, and speed of data created daily within supply chain networks [7, 8]. Big data models in process control, for instance, can be used to manage natural resources sustainably and reduce pollution, creating the best possible plans to increase the sustainability of green supply chain management [9, 10, 11, 5].

In recent years, the GSC has attracted the attention of many experts and scholars as a result of consumer awareness and legislative pressure. According to many scholars, companies can gain a competitive advantage by integrating environmental issues into the supply chain [3]. The advent of technology and the arrival of the fourth industrial revolution have made it essential to use big data (BD) to extract new insights and discoveries that can provide economic value for these companies [12]. Businesses' adoption of BD-based information has enhanced manufacturing firms' production capacities [13], increasing production process efficiency and decreasing waste and product life cycle [14].

Organizational enhancements and major commercial gains could be supported by big data analytics capability (BDAC) technologies [15]. BDAC offers current data to support economic performance and decision-making within organizations. To ascertain its significance in promoting economic growth through sustainability-related instruments like the green supply chain and ongoing enhancement, an organization's BDACs must be examined [16].

Even though BDAC enables the use of large-scale data to make evidence-based decisions, BDAC technologies can continuously analyze data and exchange findings in real time to help produce novel insights and make decisions that address complex challenges across the supply chain [17, 18]. The application and potential impact on manufacturing supply chains' of green supply chains (GSC) are still limited, nevertheless. By adopting sustainability goals, businesses that use GSC are likely to monitor their environmental behaviors, lower operating expenses, and enhance their reputation [19]. Furthermore, data-driven choices are probably going to improve the efficiency of supply chains as well as individual businesses in implementing and tracking GSC objectives [20]. Applying BDAC is anticipated to increase operational performance by facilitating faster and more accurate decision-making in the supply chain, particularly when real-time data is available [21]. To support the sustainability agenda, BDAC can increase supply chain management's efficacy and efficiency through better demand management, quicker new product development, improved risk management in the supply chain, improved supplier management, and the creation of strong and reliable supply chain designs [18].

Scholars and industry professionals are paying close attention to big data analytics (BDA) as a key facilitator of GSC. Although there is a growing body of research in this new area, it is still mostly unexplored [22]. The relationship between BDAC, greening e-procurement [23], supply chain integration (24, 14], supply chain performance [1], green supply chain integration [25, 26], supply chain preparedness [27], and sustainable supply chain performance [1, 2, 28, 29] have also been covered in the literature. To improve the degree of green supply chain management from the standpoint of BDAC, several research has offered insights [30, 31, 18, 32, 5].

Furthermore, despite BDAC's importance, many businesses that invest money in it are unable to raise the GSC level [33]. Businesses using GSC should be mindful that BDAC may not increase GSC directly. Therefore, more research is required to identify the fundamental mechanism by which BDAC influences GSC. The incapacity to offer real-time information availability may impede green collaboration among supply chain participants, as [30] states that GSC entails a significant volume of green-related information [26]. Therefore, we suggest that the BDAC–GSC relationship may be mediated by supply chain agility and visibility. A company's ability to receive accurate and useful supplier information is reflected in its supply chain visibility (SCV) [34]. The ability to quickly adapt to changes by rearranging necessary processes is known as supply chain agility (SCA) [27].

Enhancing customer happiness, raising service standards, boosting quality, launching new goods, cutting expenses, shortening lead times, and speeding up delivery are all components of supply chain

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management [35]. SCA improves flexibility in response to shifts in the business environment and facilitates the timely settlement of conflicts in decision-making [36]. By achieving SCA, businesses can improve their capacity to adjust to shifts in the market, quickly satisfy customer demands, simplify inventory control, and form fruitful alliances [37]. Through efficient resource reallocation and the smooth integration of best practices, SCA enables businesses to provide customer-centric goods and services in an ever-changing setting [38]. SCA is crucial for generating value throughout the supply chain and promptly meeting consumer demands [35]. Furthermore, businesses can increase supply visibility by using BDAC to visually present supply data, including online inventory, consumer demand, sales, markets and procurement, and logistics information [17]. Furthermore, by decreasing uncertainty and information asymmetry, supply visibility improves GSC's efficacy [39]. There aren't many studies in the literature right now that address how BDAC affects green supply chain management and how SCA and SCV play a mediating role, particularly in poor nations. Therefore, this study aims to close the research gap left by earlier studies to increase the theoretical and practical accomplishments and the recommendations that allow managers to use BDAC to raise the GSC level in their manufacturing organizations. The pharmaceutical manufacturing industry is one of the most important areas of the Jordanian economy [1]. Therefore, by examining the mediated model, we want to empirically contribute to the understanding of the direct connection between BDAC and GSC as well as the mediating function of SCV and SCA.

Theoretical background

Green supply chain

These days, environmental awareness and green initiatives are highly valued worldwide. Green supply chain management techniques have improved businesses' performance in many areas in Asian emerging economies [40, 41]. Many nations have adopted green development as their economic development strategy in response to the escalation of environmental issues and green trade obstacles. In this sense, a lot of businesses prioritize putting green supply chain management into practice as a strategic necessity to get over both business and environmental obstacles [42].

GSC requires business processes like marketing, manufacturing, logistics, and purchasing, to work together in a well-coordinated and integrated manner [43, 44]. To satisfy end users and other stakeholders, GSC needed a business plan that was in line with the process of supply chains [43, 45]. Businesses are motivated to implement green business practices to minimize pollution, waste, and energy consumption, use renewable resources, and integrate and execute resource shelter measures to guarantee that goods and services are delivered in an environmentally friendly way [43].

Customers who care about the environment are pressuring supply chains to offer eco-friendly goods and services as environmental consciousness rises in local communities [44]. Thus, by incorporating environmental, social, and economic objectives into supply chain operations, sustainable supply chain management has worked to boost social, and environmental outcomes sustainably over the past few decades [42].

Big data analytics capabilities

Understanding how this data can be turned into innovation is crucial because a significant portion of technology spending is allocated to digital transformations, and businesses worldwide have invested trillions of dollars in implementing digital technologies [46]. As a result of their interactions with clients, many businesses accumulate a substantial amount of data, which they then utilize to inform their innovative decisions [47]. This means that businesses have a lot of chances to gain advantages and add value by creating fresh, creative solutions for their clients and increasing productivity by cutting costs [48]. BDAC is defined as a comprehensive process that includes the gathering, analysis, utilization, and understanding of data for several functional divisions to produce actionable insights, create business value, and build competitive advantage [34].

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Supply chain agility

One essential component of the capacity to react quickly to changes for market disruption is SCA [49]. Because of the more complicated regulatory environment in the pharmaceutical sector, a supply chain with agility is necessary to guarantee that all quality criteria are fulfilled and that medicines are supplied on schedule [50]. Pharmaceutical agility is distinct due to its capacity to adjust to cyclical variations in demand, reduce the risk of supply chain interruption, and guarantee smooth operations. Agile supply chains give a business a competitive edge and allow for quick responses to the shifting supplier environment, both of which are critical in rapidly changing markets [49].

The dynamic capacity of the company to effectively alter operating states in reaction to erratic and shifting market conditions is another definition of agility [51]. The contingency theory states that businesses need to figure out how to handle supply chain risks in both internal and external circumstances [4]. Additionally, SCA should address supplier requests in addition to consumer requests. SCA, according to [52], is the firm's power to swiftly modify its supply chain operations and strategies, including production and/or capacity for service. Additionally, it incorporates strategic agility, which enables businesses to adjust their operations procedures to accommodate new advances and maintain flexibility in the face of them [51].

Supply chain visibility

According to [53], SCV is a company's capacity to efficiently manage informational resources to guarantee access to high-quality data pertinent to a range of supply, demand, and market aspects. The usefulness and significance of the information transmitted among supply chain partners determines the level of high-quality information, which is defined by correctness, usefulness, and completeness [54]. Businesses can acquire supply-related data, such as levels of inventory, lead times/delivery dates, and upfront shipping alerts, accurately and promptly when there is a high level of SCV [55]. Through the collective collection and analysis of demand projections, customer inventory levels, and actual sales data, SCV helps businesses promptly detect and respond to changes in demand [34]. SCV helps businesses retrieve and aggregate market-level data to have a better understanding of real market trends by efficiently managing resources (such as sharing information based on information linkages) [54].

Research framework and hypotheses development

Big data analytics capability and supply chain visibility

According to [34], developing data analytics capabilities requires supply chain insight, and vice versa. BDACs and SCV work in tandem, supporting one another [15]. According to [56], SCV is a valued organizational skill to reduce the risk coming from supply chain interruptions. In line with the claims made by [34], businesses that want to increase their SCV capabilities are likely to invest in BDAC. Thus, we might contend that managers might create plans for business continuity that enable them to react swiftly to changes by using data technology to detect quick changes in their surroundings. Thus:

H1. BDAC has a significant impact on SCV

Big data analytics and supply chain Agility

The use of data analysis, agility, and big data in supply chains and organizations can significantly improve many organizational performance factors, from green capacity and overall firm performance to agile and environmental sustainability. It has been proven [57] that enhancing organizational agility requires business analysis and big data. Through data collection and analysis, they demonstrate business analysis and big data's ability to support effective demand planning, which is essential for the quick creation of networks of supply chains, goods, and procedures. According to later research, agility is based on the capacity to quickly adjust and react to market demands. Supply chain managers may benefit from BDAC's assistance in identifying and analyzing the swift changes in technology, as well as

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in developing and implementing adaptable plans to deal with these developments [39]. Likewise, SCA, according to [58], enables managers to react swiftly to supply chain interruptions and so reduce the expenses brought on by them. [35] deepen the cooperative relationship between BDAC with SCA, building on the foundation established by [57].

Their research demonstrates how implementing BDAC can enhance the efficiency and environmental friendliness of an agile supply chain. In addition to demonstrating how supply chain integration positively impacts the interaction between green capabilities and the company's operational success, a well-integrated supply chain is crucial for maximizing the benefits of agility and sustainability. [59, 60] broadened this focus by discussing the significance of thorough data analytics for sustainability, particularly in supply chains for manufacturing[60].

Agile supply chains lower the holding and ongoing costs of inventories and logistics by improving the synchronization of demand and supply processes [61]. Additionally, by modifying the products, agility allows businesses to boost production output, reduce replacement time, and modify operations [38]. A growing body of studies has demonstrated a connection between cost-effectiveness and SCA. [61, 52]. According to [27], BDACs are crucial in facilitating SCA. Information systems are significantly correlated with all aspects of SCA, according to [60]. Thus, concentrating on the previously indicated arguments, the following is our next hypothesis:

H2. BDAC has a significant impact on SAG.

Big Data Analytics Capability and Green Supply Chain

According to OIPT, building a BDAC improves the level of environmental information exchange and makes it possible for the focus firm to collect and analyze green-related data from its suppliers [24]. This could potentially reduce the risks and difficulties associated with uncertainty and information asymmetry. Additionally, creating BDAC aids the focal business in tracking and optimizing production schedules, inventory levels, and distribution lead times [54], helping it reach additional supplier collaboration and green-related objectives. BDAC could therefore lead to a more environmentally friendly supply chain. BDAC can assist the focal firm in processing and analyzing a lot of green-related data, including data on environmental performance and pollutants during production, marketing, and procurement [62]. BDAC encourages various functions to efficiently share green-related information by integrating richer, more up-to-date information into greener operations, which speeds up the development of superior green solutions [26]. Additionally, to accomplish multidisciplinary collaboration on the environment and collaboratively assess environmental concerns, BDAC helps to shape a collective environmental sagacity [63].

Several research papers [1, 4, 30, 22, 31, 26, 5] show that BDAC can improve sustainability and GSCs. As demonstrated by [28, 29, 17, 32), BDAC can improve GSCs. Thus, we propose:

H3. BDAC has a significant impact on GSC.

Supply Chain Visibility and Green Supply Chain

GSCs have progressively been integrated into the SCV. A cause-and-effect theory for awareness is GSCs. It was described in a comprehensive review of the literature on SCV by [64]. Visibility levels can exhibit a significant context dependency when seen through the lens of GSCs. To tackle environmental concerns among its suppliers and consumers, the focal firm in the GSC process needs to understand supply visibility. Several academics have suggested that visibility is important for enhancing cooperation in the supply chain ecosystem [26]. Failure to give real-time visibility in the GSC context may impede the development of trust between external collaboration and internal procedures, increasing risks within the GSC [60]. Therefore, we contend that the degree of GSC may be enhanced by supply visibility. We assume that GSC can be improved by supply visibility. Thus:

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H4. SCV has a significant impact on GSC

SCA addresses things like how quickly the company introduces new items to the market, how quickly it can cut production times, how long it takes to develop new products, and how quickly it can improve customer service [65]. Companies proactively addressing risks are essential to SCA [66]. Additionally, GSC agility raises the GSC level. The improvement of GSC initiatives, including SCA, has not received much empirical attention [51]. According to [67], agility and a GSC are positively correlated. Therefore,

H5. **SCA** has a significant impact on GSC

The mediating role of supply chain visibility and Agility

We propose that supply visibility and agility may act as mediators in the BDAC–GSC interaction. The focal firm can employ various analytical techniques to extract and evaluate critical real-time data collected from partners in the supply chain by constructing BDAC to harvest greater supply and awareness of customers [35]. In turn, high-level supply visibility makes information flow amongst supply chain participants easier, enabling them to make information-based choices on environmental issues more quickly and intelligently across functional departments, suppliers, and customers [26]. Additionally, a particular firm may more effectively manage environmental activities both internally and externally with high-level supply visibility, which raises the degree of GSC. Low-level supply visibility, on the other hand, might make it possible for the focus firm to gather erroneous or skewed information, which could lead to subpar environmental management and strategic cooperation. According to [26], the association between BDAC and all three GSC parameters is mediated by supply chain visibility.

H6. SCV mediates the impact of BDAC on GSC

Furthermore, scholars contend that BDAC benefits supply networks by lessening the effects of demand fluctuations [38]. This promotes value creation [68] and boosts the efficacy and efficiency of procedures and operations by making supply chains more responsive [69] and flexible [39, 70]. The results suggest that BDAC has a considerable and positive impact on SCA.

H7. SCA mediates the impact of BDAC on GSC.

Study Model and Hypothesis:

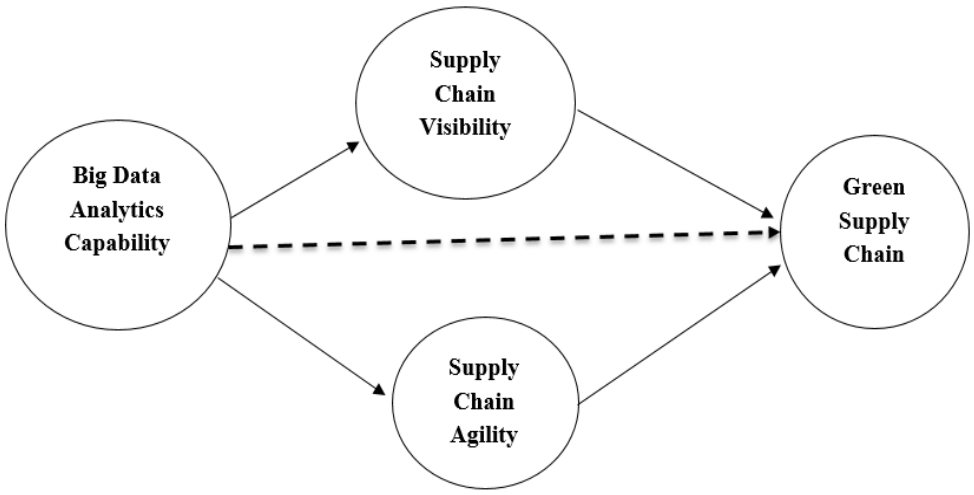

Figure 1(study Model)

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Methodology

Procedures & respondents

The quantitative questionnaire design is used in this study to gather information from Jordanian manufacturing companies. Since they are likely to have pertinent knowledge about materials and information flow as well as GSC activities, top managers of supply chain, manufacturing, procurement, and information systems functions were the focus of this study. We started by getting in touch with HR managers of thirty industrial companies that were listed on the Jordan Stock Exchange and had shareholders. Within three weeks, the appropriate responders were found and the required data was gathered via an email questionnaire after taking into account the previously described situations. We sent reminder emails one week following the first round, and in the third week, a second round was issued. Out of the 550 surveys that were distributed, 350 questionnaires were retrieved; after deleting a few partially received responses, 332 usable responses were recovered, indicating a 60.36% response rate.

Measures

Using a Likert scale with five points, where 1 means "strongly disagree" and 5 means "strongly agree," each scale item was rated separately.

BDAC: was assessed by earlier researchers using a six-item scale (2, 35]. Among other things, it included "invests in BDAs software." creates a big data-based information technology architecture that incorporates information integration. hires experts in BDACs and makes investments in procedures that guarantee timely access to high-quality data. Offers a learning environment where staff members can share their expertise in big data analytics. The company has the administrative capacity to act appropriately on insights from BDACs.

SCV: was examined using five items, supplier inventory data, and sales data following the recommendations of [34, 26]. Respondents were asked to rate the degree to which they could see the information of their main supply chain partners.

SCA: was assessed by the earlier researchers using a six-item scale (13, 27]. Rearranging SCA resources to handle unforeseen demand variations is one example. To cut down on lead time, modify SCA procedures. Allow for modifications to SCA procedures to improve on-time delivery. Align SCA procedures to cut down on non-value-added tasks.

GSC: A six-item scale used by earlier researchers was used to measure this variable [71]. This incorporates a production technology that uses less energy. The management consistently pushes suppliers to enhance environmentally friendly transportation procedures. Regarding environmental issues and considerations, management offers suppliers ongoing assistance and training. The management wants to improve its connection with its primary clients and inform them of the most recent environmental advancements at the company. Over the previous time frame, the stock levels have dropped. Over the past few years, the cost of buying materials has gone down.

Reliability and validity

Table (1) Confirmatory factor analysis and reliabilities

Construct	Items	Loading factor	t-value	AVE	CR	*a*
BDAC	BDAC1	0.735		0.588	0.894	0.896
	BDAC2	0.869	15.643			
	BDAC3	0.877	15.774			
	BDAC4	0.699	12.459			

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	BDAC5	0.652	11.57			
	BDA6C	0.742	13.298			
SCV	SCV1	0.806		0.606	0.860	0.859
	SCV2	0.832	15.631			
	SCV3	0.731	13.629			
	SCV4	0.74	13.824			
	SCV5	0.587				
SCA	SCA1	0.736	10.403	0.595	0.878	0.868
	SCA2	0.882	11.58			
	SCA3	0.873	11.522			
	SCA4	0.741	10.443			
GSC	GSC1	0.776		0.594	0.897	0.900
	GSC2	0.724	15.81			
	GSC3	0.828	15.84			
	GSC4	0.767	14.486			
	GSC5	0.777	14.717			
	GSC6	0.747	14.052			

A confirmatory factor analysis (CFA) was performed using AMOS to assess the reliability, convergent validity, and discriminant validity of the multiple-item measures. The model's goodness-of-fit index is deemed acceptable based on the findings of the CFA, which in turn assesses the model's goodness-of-fit index [72]. Chi-square/df = 2.111 < 3, CFI = 0.951 > 0.90, IFI = 0.95.1 > 0.90, TLI = 94.3, and RMSEA = 0.058 < 0.08 are all values that meet the requirements.

The results of the investigation confirmed the convergent validity of each measurement scale, as proposed by [73]. According to Table (1) [74], statistically significant ($p < 0.05$) factor loadings of larger than 0.60 for every indicator in its respective constructs show convergent validity of the theoretical constructs. Additionally, the average variance extracted (AVE) for each construct is higher than the recommended minimum value of 0.5 [75]. The discriminant validity was assessed using the (AVE) values. The square root of AVE beyond the correlations indicates acceptable discriminant validity, as seen by the results in Table (1) [75].

Cronbach's coefficient is used to assess each construct's reliability. It measures the internal consistency of a multi-item scale. The results suggest measuring scales are adequately reliable, as each alpha coefficient level is greater than 0.7 [76].

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Results

Descriptive Statistics

Table (2) : Means, standard deviations, and correlations for the study variables.

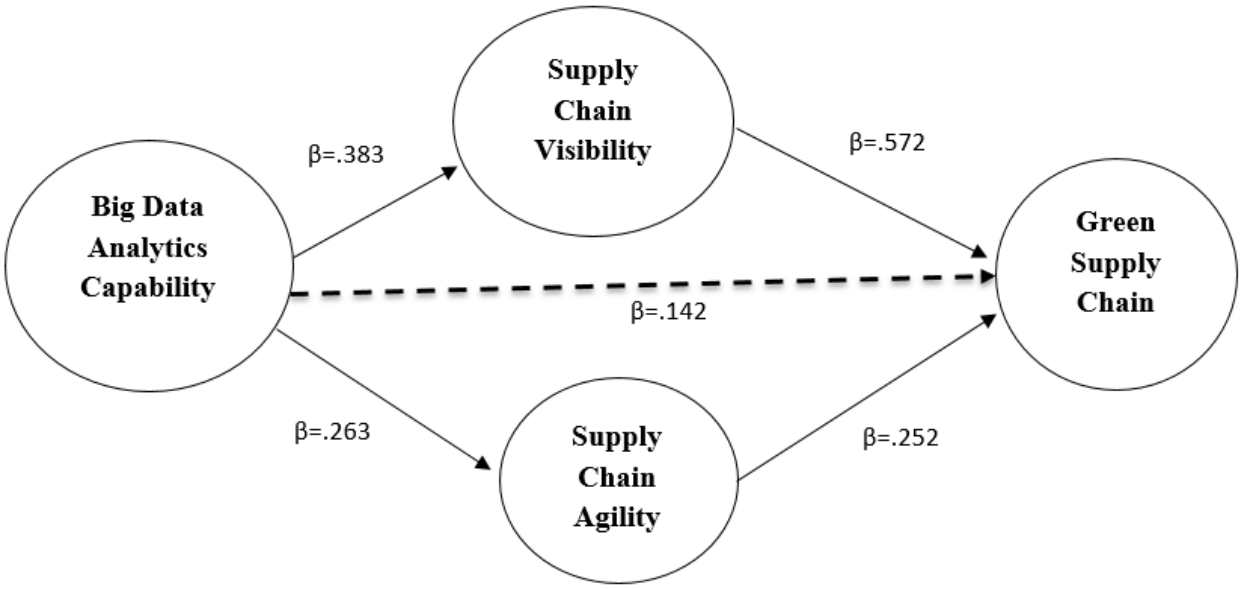
Variable	Mean	Std. dev	1	2	3	4
BDAC	3.79	0.666	**0.767**			
SCV	3.45	0.844	.215**	**0.778**		
SCA	3.85	0.687	.310**	.340**	**0.771**	
GSC	3.56	0.680	.322**	.421**	.628**	**0.770**

Notes: *p < 0.05; **p < 0.01; Square root of AVE is on the diagonal

The main statistical metrics used to describe study constructs are the matrix of correlations, the mean, and standard deviations. Table (2) displays the mean scores for the study model constructs, which ranged from 3.45 to 3.85. Additionally, the correlations, which ranged from 0.215 to 0.628, demonstrated a strong relationship between the study variables.

Research model and hypotheses:

Results and findings



Notes: *p < 0.05; **p < 0.01

Figure (2): Structural model with parameter estimates

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Table (3): Path analysis for the constructs of the study

	Relation		Coefficients	CR	Support/ nonsupport
Path	Big Data Analytics Capability	Supply Chain Visibility	0.383	5.687	Support
	Big Data Analytics Capability	Supply Chain Agility	0.263	4.201	Support
	Big Data Analytics Capability	GSC	0.142	2.644	Support
	Supply Chain Visibility	GSC	0.572	7.829	Support
	Supply Chain Agility	GSC	0.252	4.858	Support
Explained variance proportion R^2 of SCV				0.146	
Explained variance proportion R^2 of SCA				0.069	
Explained variance proportion R^2 of GSC				0.552	

Notes: $^*p < 0.05$; $^{**}p < 0.01$

Structural equation modeling (SEM) was utilized to determine the relationships between the constructs. SEM estimates were computed using Amos V.22. The predicted links in the pathway to SCV have a coefficient of 0.383 (P<0.01). As a result, the positive association suggests that H1 is confirmed. Additionally, the results show that BDAC and SCA are significantly correlated (β = 0.263, P<0.01). As a result, the positive correlation suggests that H2 is verified.

According to the findings, SCA and SCV both significantly and favorably affect GSC (β = 0.252, P<0.01) and GSC (β = 0.572, P<0.01), respectively. The hypotheses H3 and H4 are so validated.

Additionally. The findings support hypothesis H5 by showing that BDAC significantly and favorably affects GSC (β = 0.142, P<0.01).

Mediating test:

Table (4). Indirect effects

Indirect effect	B	95% Bootstrap CI		P
		Lower Limit	Upper limit	
BDAC → SCA → GSC	0.063	0.02	0.142	0.003
BDAC → SCV → GSC	0.208	0.103	0.347	0.001

Note: (BDAC) Big Data Analytics Capability. (SCV) Supply Chain Visibility, (SCA) Supply Chain agility, (GSC) Green Supply Chain

Using bootstrap techniques, the mediating role of SCV and SCA on the link between BDAC and GSC was examined. With a 95% confidence level, 2000 bootstrap samples were chosen. The study model states that indirect effects can appear in two different ways:

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H6: BDAC → SCV → GSC

H7: BDAC → SCA → GSC

The indirect impact of BDAC on GSC was calculated by multiplying the route coefficients among SCV and SCA. The study model showed that SCV and SCA had a considerable indirect impact on both routes. We accept H6 and H7 because, more precisely, there is an indirect influence via SCV (β=0.208, P<0.05) and SCA (β=0.068, P<0.05).

Discussion

First, our study's findings indicate a strong positive correlation between the GSC and BDAC. These findings corroborate the claims made by several recent conceptual and empirical research that the implementation of BDAC improves cooperation among supply chain participants [30, 7]. One reason could be that the focal firm's big data technical competence is mostly comprised of its own systems and data analytics capabilities, which could facilitate information sharing and communication across various firm functions as well as with suppliers and customers. Additionally, our findings align with a previous studies [1, 2, 22, 26, 29]. According to the study's findings, BDAC helps to encourage suppliers and customers to share information in real time, giving focus enterprises access to vital data regarding environmental concerns. As a result, supply chain participants are better able to communicate and work together to address environmental concerns. This implies that the company with a more sophisticated BDAC has a higher chance of successfully enhancing GSC. For manufacturing companies, that function in a dynamic and unpredictable environment, this is a significant advantage of the BDAC.

Second, SCA and SCV significantly and favorably impact GSC. Rather, by gaining visible information about suppliers' misconduct, pollution, and waste levels, a high degree of supply visibility and agility allows the focal firm to reduce environmentally opportunistic behavior and reduce the selection of inadequate suppliers, thereby increasing the accuracy of green supplier integration. Furthermore, greener internal and customer integration—that is, GSC—may be made easier by high-level supplier visibility and agility. This includes previously published works [77, 26].

Third, our findings offer a clearer picture of how BDAC affects SCA and SCV, concluding that it has an important and positive impact on both. Our findings help develop and improve the theories of BDAC, SCA, and SCV and offer management practitioners empirically supported normative recommendations. Therefore, the findings enhance our comprehension of how managers may utilize data technology to detect fast changes in their surroundings and create plans for business continuity that could enable them to react swiftly to those changes. which is consistent with previous research [56, 57, 26].

The fourth is SCV. Based on our findings, it mediates the relationship between BDAC and GSC, provides more evidence that supplier visibility promotes the exchange of environmental information, and increases the degree of GSC among supply chain participants. The findings support BDAC's ability to improve supply visibility, which raises the level of GSC even more. The benefits of BDAC on supply visibility, in particular, show that the focus firm can improve supply visibility by acquiring and processing environmental data with the aid of BDAC development. This is consistent with the body of previous evidence [39, 15], but the results of [26] do not match those of the existing literature [64].

Lastly, SCA mediates the relationship between BDAC and GSC. The findings about the impacts of BDAC, SCA, and GSC, respectively, provide fresh perspectives on how each dimension contributes to improving GSC. Previous research [33, 25] showed that BDAC helps management make decisions and enhances supply chain agility, improving business performance and lowering environmental variability [21].

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Implications for theory

This work has several theoretical ramifications from a research and theoretical standpoint. First off, this study is regarded as one of the few that incorporates BDAC, GSC, SCV, and SCA in the literature. Second, by examining the mediating function of SCV and agility, our findings attempt to unlock the "black box" between BDAC and GSC. Since the exact method by which BDAC affects GSC is unclear, the study offers theoretical insights into how SCV and agility are impacted by BDAC. Third, the study expands on the idea that supply chain networks may benefit from increased visibility and integration due to big data. Fourth, the background history of Jordanian stockholder production enterprises has received little attention from big data researchers. This study contributes to our understanding of the conditions under which BDAC improves SCV and agility.

Managerial implications

For businesses using GSC, this study offers managerial consequences. In the first place, this study aids managers in better understanding the role that BDAC plays in raising the level of GSC. Therefore, we urge managers to think about devoting their time and resources to creating and utilizing BDAC. To assist the implementation of BDAC and achieve a successful GSC, managers could, for instance, develop technical capabilities, managerial abilities, infrastructural flexibility, and a data-driven decision culture. Second, managers ought to value the mediating functions of agility and supply visibility in the BDAC–GSC relationship. Our findings give managers actual proof that increasing supply visibility and agility through BDAC development can raise the degree of GSC.

This advises managers that while BDAC is important for increasing GSC, it's also critical to recognize that supply visibility and agility are also important for increasing GSC and connecting the BDAC–GSC relationship. Managers may, for instance, think about flexible collaboration with suppliers and consumers in terms of sharing environmental data and collaborative planning, which can foster supply chain visibility and boost GSC efficiency.

Conclusion

Even though BDAC for green practices has been more popular recently, improving environmental performance still calls for further practice and supply function innovation. Regarding BDAC technology, companies need to make sure that data infrastructures are compatible with other applications and systems and that there is readily available data for analysis. In a similar vein, BDAC's human resources department will concentrate on educating management and staff on information technology, analysis, and building technical and interpersonal skills to produce qualified supply chain analysts. Using their ICT facilities, data, and talent to achieve environmental performance, public and private businesses can concurrently benefit from big data and GSCs.

Limitations and Future Research

Despite its impressive findings, this study has some limitations that should be taken into account when extrapolating the findings. Initially, cross-sectional data were used to obtain the study's data; however, longitudinal or panel data would help understand the link between the study's dimensions.

Second, because we only looked at one country (Jordan) and one sector (shareholder manufacturing enterprises), our sample size is a little small. The size of the sample and sampling from particular businesses may help to clarify any relationships in the data, therefore future research that incorporates a greater number of sectors may be able to get around this restriction. Third, since the shareholder-owned manufacturing firm in Jordan was the focus of this study, it would be beneficial to carry out research in other industries, contexts, nations, and cultures to help academics and management professionals better comprehend the connections between BDAC and GSCs. Fourth, the study disregarded qualitative techniques like interviews in favor of using the quantitative data gathered from the questionnaire to test the study's hypotheses and goals. Therefore, future research that utilizes a qualitative approach would be intriguing. The study concludes by recommending that future research

concentrate on moderating roles like technological intensity and dynamic capabilities, or mediating constructs like knowledge management, supply chain inventiveness, and green innovation, and investigate more causal relationships between these constructs.

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