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Big data and sustainable supply chain management of hypermarkets in Jordan: An experimental study using structural equation modeling approach

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The objective of the study is to identify the impact of big data on sustainable supply chain management. The current research was conducted on hypermarkets in Jordan. Many of these hypermarket brands are widely scattered in Jordan, for instance, Carrefour, Kareem, Safeway and more. Accordingly, the target population in the current research was hypermarkets managers in Jordan as they are responsible for formulating such strategies in the companies they work for. A convenience sample was selected from the target population that included 770 managers based on the sample size formula. The study hypotheses were tested by covariance based structural equation modeling (CB-SEM). The study results showed the impact of each big data dimension on sustainable supply chain management. Based on this result, the researchers recommend the hypermarkets in Jordan to use modern and diverse methods for accurate collection of reliable data and save it in organized ways, and to employ advanced programs to analyze it and extract information of high value.

1. Introduction

Organizations are compelled by ongoing technology innovation to alter their established procedures, embrace new information systems, and maintain their current ones (Miklosik & Evans, 2020). Companies have taken notice of the big data revolution occurring in the 21st century, especially in light of the valuable data they have been storing for many years (Srivastava & Gopalkrishnan, 2015; Alshawabkeh et al., 2022; Yaqoob et al., 2016). The volume of data generated and saved in the digital world has increased over time. Data-driven decision-potential making is now widely acknowledged (Al-Alwan et al., 2022; Labrinidis & Jagadish, 2012). The supply chain is the main artery for companies and organizations in doing business, and academics and practitioners are increasingly interested in it (Al-khawaldah et al., 2022; Al-Nawafah et al., 2022). In the past years, the topic of sustainable supply chain management was an important topic of discussion, as sustainable supply chain management is a widespread term in many parts of industry and academia. Seuring & Müller (2008) has known sustainable supply chain management as “the management of materials, information, and capital flows as well as collaboration between firms along the supply chain taking objectives from all three dimensions of sustainable development, i.e. economic, environmental and social, derived from customer and stakeholder requirements”. According to Wolf (2013), sustainable supply chain management (SSCM) enhances an organization's sustainability performance. (Wang & Sarkis, 2013; Tariq et al., 2022; Aityassine et al., 2021) found a positive correlation between integrated sustainable supply chain management and a company's financial performance. This includes collaborative social and environmental supply chain management. According to Ni & Sun (2019), export sustainability was directly associated with business performance, whereas inbound sustainability

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and internal sustainability had an indirect impact. This suggests that sustainable supply chain management (SSCM) has an impact on business success. According to (Xu & Gursoy, 2015; Alolayyan et al., 2022) investigated how customer behaviors and attitudes, such as customer satisfaction, loyalty, and willingness to pay more for sustainable hospitality goods and services, are impacted by sustainable supply chain management actions for the hospitality industry. Ciampi et al. (2021) show that the capabilities of big data analytics BDAC have direct and indirect positive effects on business model innovation (BMI). Hasan et al. (2020) indicates that big data has significant impacts on financial products and services. Adopting advanced analytics for big data will also positively affect revenues and reflect gross domestic product (GDP) (Nwanga et al., 2015; Al-Awamleh et al., 2022). Big data will have significant implications for research, development, and innovation management, as demonstrated by Blackburn et al. (2017) through a literature review, expert interviews, and case studies for organizations using big data. However, the nature and scope of this impact varies somewhat across industry sectors. Kshetri (2014) indicated that big data contains some intrinsic features that are closely related to several consumer privacy, security, and well-being concerns. (Ferraris, Mazzoleni, Devalle & Couturier, 2018) also showed that companies that developed BDA capabilities more than others, both technologically and administratively, increased their performance, and that directing knowledge management plays an important role in amplifying the impact of data analysis capabilities of Mega BDA. Based on the above, it was found that there is a scarcity in the Arabic literature that dealt with the study variables, so this research came with the aim of identifying the impact of big data on sustainable supply chain management.

2. literature and developing hypotheses

2.1 Big data

Big data refers to vast, intricate, and expanding data sets having numerous, unrelated sources. Big data is presently developing quickly in all sectors of research and engineering thanks to the quick growth of networking, data warehousing, and data collection capabilities (Wu et al., 2013; Muda et al., 2022; Harahap et al., 2022; Khalayleh & Al-Hawary, 2022). Online clicks, mobile transactions, user-generated material, social media, as well as purposely generated content from sensor networks or business operations like sales inquiries and buy transactions, are all sources of big data (Attiany et al., 2023; George et al., 2014). The term “big data” refers to a data environment in which scalable architectures meet the needs of analytics and other applications that handle massive volumes of data at high speeds, which may involve high-speed data capture and may contain a variety of data types (Al-Rwaidan et al., 2023; Emmanuel & Stanier, 2016; Zahran et al., 2023). Big data (Rahamneh et al., 2023; Trifu & Ivan, 2014; Akour et al., 2023) also arose as a combination of unstructured and multi-structured data that is evaluated collectively to produce more knowledge and information for the firm than is possible utilizing the customary techniques and infrastructure. Moharm et al. (2018) indicates that when the data becomes very large and complex, and it is impossible to deal with it in traditional ways, this data is called Big Data. Kapil et al. (2016) defined big data as a collection of data sets or a combination of data sets. Goldstein et al. (2021) defined the phenomenon of “big data"” as a combination of three features, namely, large volume, high dimensions, and complex structure. Chebbi et al. (2015) highlighted big data as an evolving term that describes any huge amount of structured, semi-structured and unstructured data that can be extracted to obtain information. Chavan and Phursule (2014) considered big data as the term given to any group of the data sets which are so large and complex that they are difficult to process using traditional data processing applications. Sagiroglu and Sinanc (2013) indicated that raw data can be measured using the 3V model (volume, variety, and velocity). Li et al. (2015) agreed and included Variability, and Value as well. Shukla et al. (2015) added Veracity, Variability, and Visualization. Emani et al. (2015) used Volume Variety, Velocity, Value, Veracity, and Visualization to describe big data. Al-Mekhlal & Khwaja (2019) identified fifteen characteristics associated with big data, including what was previously mentioned, with the addition of Complexity, Venue, Vocabulary, Vagueness, Validity, Volatility, Exhaustive, Fine-grained, Vulnerability. Kapil et al. (2016) indicated that the characteristics of big data include the following: Volume, Velocity, Value, Variety, Veracity, Validity, Volatility, Visualization, Variability, Venue, Vocabulary, Vagueness, Complexity, Vitality, Viscosity and contributed by adding three other characteristics represented in Verbosity, Voluntariness, and Versatility. Based on the above, big data is measured in terms of its characteristics such as volume, variety, velocity, variability, value, and veracity.

The size of the data refers to the space occupied by the huge amount of data from the storage unit, as it is measured in gigabytes / terabyte / petabytes / exabyte / zettabytes. The diversity of data is represented in the many different forms of data such as images, videos, sound recording files, written files, Geographical location, software updates, various wired and wireless signals, and many more. It also means data speed in obtaining data, processing it, analyzing it, providing access to it, and extracting information from it in real time to include it in the decision-making process. Data variance is defined as the inconsistent rates of data flowing over time; it is possible for a large volume of data to flow in time (1) while less volume flows in time (2). Data value refers to the total benefit gained from analyzing large amounts of data, as not all data provide the required benefit. The validity of the data is represented in the validity and accuracy of the collected data, as the data must be taken from its original reliable sources to ensure that there is no shortage or distortion.

2.2 Sustainable Supply Chain Management (SSCM)

Implementing sustainable supply chain management (SSCM) is a crucial enabler that can motivate businesses to concentrate on reducing environmental issues and delivering positive economic and social outcomes (Zailani et al., 2012; Aityassine et al., 2022). Carter & Rogers (2008) defined sustainable supply chain management (SSCM) as "the strategic and transparent integration and achievement of an organization's social, environmental, and economic goals in the systematic coordination of key inter-organizational business processes to improve the long-term economic performance of an individual firm and its supply chain". According to Fritz (2019) sustainable supply chain management (SSCM) "is the management of supply chain in such a way as to integrate sustainability goals and requirements set by the business, suppliers, customers, and external stakeholders (such as consumers, policy makers, and associations), whereby all members of Accessible supply chain in order to make the supply chain sustainable". By fusing the idea of sustainability with fundamental business operations that fall under the purview of supply chain management (SCM), such as purchasing, logistics, and knowledge management, Morali & Searcy (2013) defined sustainable supply chain management (SSCM). Using environmental and social supply chain practices, Wang & Sarkis (2013) examined the effects of sustainable supply chain management (SSCM). According to Martins & Pato (2019), SSCM, which incorporates the economic, environmental, and social viewpoints, adopts the triple bottom line perspective. Seuring & Müller (2008) established the components of SSCM in the context of the economic, environmental, and social dimensions of sustainable development, which are drawn from stakeholder and consumer demands. The environmental, social, and economic components of sustainable supply chain management were employed by Xu & Gursoy (2015) and Carter & Rogers (2008). Economic, social, environmental, and ethical goals were all included in Fritz's (2019) list of sustainability goals. Three aspects of sustainable supply chain management (SSCM), including inbound sustainability, internal sustainability, and outward sustainability, were proposed by Ni and Sun (2019). According to Mageto (2021) the elements of sustainable supply chain management comprise transparency, sustainability culture, company objectives, and risk management.

The environmental dimension, economic dimension, and social dimension are thus adopted as the three aspects of sustainability. The environmental dimension of sustainability is represented in protecting the environment and trying to reduce, as much as possible, the negative impact on the environment that is formed through the activities of supply chains, such as the consumption of non-renewable resources, and the contribution to pollution of all kinds (air, water, and soil), and other activities that may cause an imbalance in the system (AL-Zyadat et al., 2022). The economic dimension means preserving the financial resources of the institutions located along the supply chain line and developing them by increasing revenues and reducing costs in a way that helps them continue their work for the longest possible period. The social dimension also refers to the promotion of social and cultural life in managing supply chains in ways that positively affect the conditions of stakeholders, such as applying the principle of social justice by ensuring equality in opportunities and resources, increasing the level of well-being, improving the quality of life, strengthening relations with various stakeholders, and contributing to the development of communities.

2.3 Big Data and Sustainable Supply Chain Management (SSCM)

Big data analytics capabilities (BDAC) have a strong impact on supply chain sustainability, and he developed a theoretical model to explain the impact of BDAC on a CSCS (Shokouhyar et al., 2020). Mageto (2021) has demonstrated that big data analytics (BDA) enhances SSCM for manufacturing supply chains. Benzidia et al. (2021) showed that the use of Big data analytics and artificial intelligence (BDA-AI) technologies has a significant impact on the integration of environmental operations and cooperation in the green supply chain. Zhang & Zhao (2019) indicated that there is a direct relationship between big data and supply chain flexibility, and big data also enhances supply chain flexibility by improving visibility. Cheng & Lu (2018) developed a conceptual model to study how the use of big data analytics affects supply chain performance in an omnichannel and highlighted the importance of efficiency and adaptability as a mediator to ensure supply chain performance by promoting the use of big data analytics. So, the study hypotheses could be as the following and Fig.1.

H_1: *There is an impact of big data in managing sustainable supply chains.*

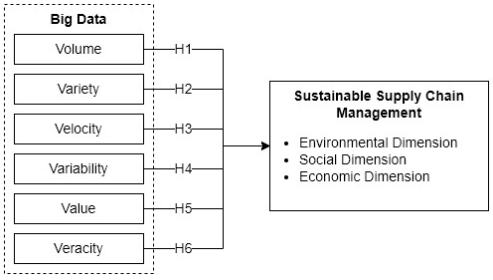

Fig. 1. Research model

3. Method

3.1 Sample and participants

Confirming factor analysis (CFA) was performed as a pre-analytical procedure of hypothesis testing through structural equation modeling. CFA provides foolproof indicators for assessing the validity and reliability of a multi-dimensional measurement model, as well as multi-ordering based on the covariance estimation (Marsh et al., 2020; Pallathadka et al., 2023; Majdy et al., 2023; Crede & Harms, 2019). The results of CFA reported in Table 1 to determine the extent to which the impact model of big data dimensions on sustainable supply chain had validity and reliability.

Montoya and Edwards (2021) stated that the observed variable loadings with a value greater than 0.50 are an indication to preserve them without deletion. Therefore, all the research observed variables were preserved. The average variance extracted (AVE) for the research latent constructs was above 0.50 the minimum convergent validity threshold (Cheah et al., 2018). Regarding the discriminant validity, the results indicated that maximum shared variance (MSV) was less than AVE, as well as the square root of AVE was greater than the correlation between all latent constructs. According to Franke and Sarstedt (2019), if AVE value exceeding the MSV value of the same latent variable along with the square root of AVE exceeding the correlation coefficients are evidence of the discriminant validity achievement. Hence, the measurement model used in this research had an appropriate discriminant validity. McDonald's Omega coefficients were used to evaluate the composite reliability (CR) of first-order research constructs. Watkins (2017) mentioned that McDonald's Omega coefficients are robust metrics of composite reliability when their values are above the 0.70 minimum threshold. It was noticed from the results of Table 1 that the coefficients used to determine the composite reliability were within the range (0.763-0.877), thus the measurement model had convenient composite reliability levels.

3.2 Measures

The cross-sectional approach was applied based on quantitative data in this paper. The research included two key variables: big data and sustainable supply chain management. To collect the primary data related to these variables, an electronic questionnaire was used, where its items were formulated in Arabic after being translated from English by specialists, to enable the respondents to understand them accurately.

Big data: it was the exogenous variable in the structural model. This construct contained 25 items that were developed based on (Al-Mekhlal & Khwaja,2019; Shukla et al., 2015). Variety is measured by three items. Volume, variability, and value were measured by four items for each of them. Velocity and veracity were measured using five items for each of them.

Sustainable supply chain management: it was the endogenous variable in the research structural model. This variable contained 12 items that were borrowed from (Martins & Pato, 2019; Xu & Gursoy, 2015; Carter & Rogers, 2008). Environmental dimension, social dimension, and economic dimension. Each of these constructs was measured by four items.

4. Research Results

4.1 Test of Confirmatory factor analysis

Confirming factor analysis (CFA) was performed as a pre-analytical procedure of hypothesis testing through structural equation modeling. CFA provides foolproof indicators for assessing the validity and reliability of a multi-dimensional measurement model, as well as multi-ordering based on the covariance estimation (Marsh et al., 2020; Pallathadka et al., 2023; Majdy et al., 2023; Crede & Harms, 2019). The results of CFA reported in Table 1 to determine the extent to which the impact model of big data dimensions on sustainable supply chain had validity and reliability.

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Table 1
Reliability and validity of the measurement model

Variables	Items	Loadings	AVE	MSV	√AVE	CR
Volume	VOU1	0.718	0.576	0.371	0.759	0.844
	VOU2	0.703				
	VOU3	0.795				
	VOU4	0.813				
Variety	VAR1	0.671	0.519	0.297	0.720	0.763
	VAR2	0.735				
	VAR3	0.752				
Velocity	VEL1	0.846	0.589	0.409	0.767	0.877
	VEL2	0.648				
	VEL3	0.823				
	VEL4	0.744				
	VEL5	0.760				
Variability	VAB1	0.771	0.593	0.355	0.770	0.853
	VAB2	0.793				
	VAB3	0.826				
	VAB4	0.683				
Value	VAL1	0.706	0.548	0.316	0.740	0.829
	VAL2	0.750				
	VAL3	0.722				
	VAL4	0.781				
Veracity	VER1	0.634	0.570	0.428	0.755	0.868
	VER2	0.662				
	VER3	0.793				
	VER4	0.758				
	VER5	0.716				
Environmental dimension	END1	0.773	0.565	0.473	0.752	0.838
	END2	0.671				
	END3	0.803				
	END4	0.754				
Social dimension	SOD1	0.811	0.603	0.505	0.777	0.859
	SOD2	0.775				
	SOD3	0.792				
	SOD4	0.726				
Economic dimension	ECD1	0.803	0.596	0.482	0.772	0.855
	ECD2	0.761				
	ECD3	0.758				
	ECD4	0.766				

4.2 Descriptive analysis

The basic information related to descriptive statistics for determining respondents' attitudes towards the dimensions of both big data and sustainable supply chain management is reported in Table 2. The means were used to indicate the overall trend of the responses, while the standard deviation was calculated to reveal the dispersion of the responses from this trend. Pearson correlation coefficients were extracted to verify the multicollinearity relationship between the dimensions of big data.

Table 2
Descriptive statistics and correlation

Variables	M	SD	1	2	3	4	5	6	7	8	9
1.Volume	3.51	0.771	**1**								
2.Variety	3.62	0.834	0.418	**1**							
3.Velocity	3.43	0.816	0.443	0.502	**1**						
4.Variability	3.55	0.922	0.460	0.403	0.438	**1**					
5.Value	3.64	0.734	0.458	0.525	0.411	0.531	**1**				
6.Veracity	3.48	0.956	0.535	0.479	0.468	0.492	0.484	**1**			
7.Environmental dimension	3.66	0.840	0.615	0.638	0.592	0.615	0.588	0.681	**1**		
8.Social dimension	3.78	0.913	0.681	0.656	0.663	0.672	0.609	0.628	0.552	**1**	
9.Economic dimension	3.71	0.975	0.622	0.674	0.692	0.639	0.671	0.547	0.673	0.635	**1**

Note: all correlation coefficients were significant at the level $P<0.05$

The results of Table 2 indicated that the big data dimensions had a moderate relative importance level. However, the dimensions of a sustainable supply chain ranged between high and moderate relative importance levels. Senaviratna and Cooray (2019) stated that the highest bound of the correlation between the independent variables is 0.80 for judging that the research data is free of multicollinearity. Pearson's correlation coefficients for big data dimensions ranged within the domain (0.403-0.535). Accordingly, the research data did not include multicollinearity problems.

4.3 Impact analysis

The research hypotheses suggested that the dimensions of big data had a statistically significant impact on sustainable supply chain management of hypermarkets in Jordan. These hypotheses were tested by covariance based structural equation modeling

(CB-SEM) using IBM-AMOS software. SEM depends on determining the suitability of the data to the proposed research model according to the covariance through the maximum likelihood estimation (Civelek, 2018; AlBrakat et al., 2023; Dwijendra et al., 2023; Mohammad, 2020). Fig. 2 demonstrated the values of goodness-of-fit indicators extracted to estimate the suitability level of the data to the structural impact model.

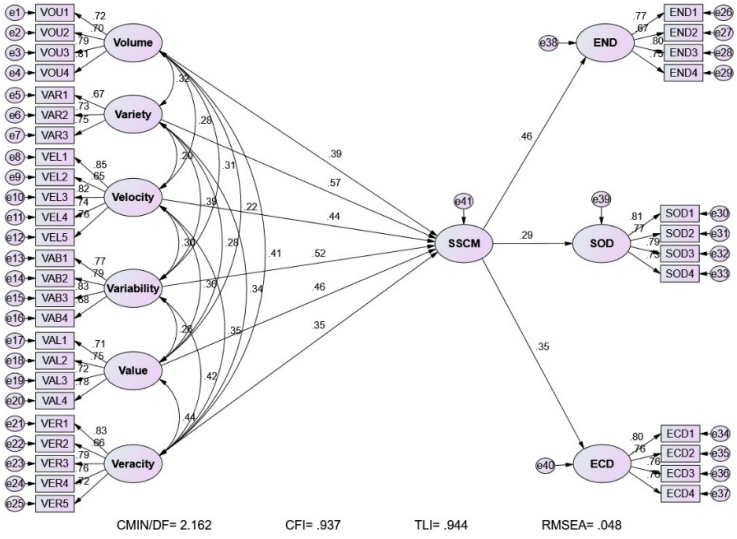

Fig. 2. SEM for big data impacts on sustainable supply chain management

Fig. 2 shows that the chi-squared to the degrees of freedom (CMIN/DF) was 2.162, which indicates that it was within the permissible limits as it did not exceed 3 (Niemand&Mai, 2018). CFI and TLI were respectively 0.937 and 0.944, which was above the minimum threshold of 0.90 for both indicators (Padgett&Morgan, 2021). Moreover, the results of RMSEA which was 0.048 indicated that it was an appropriate value because it did not exceed 0.080 the highest approved value for this indicator (Xia&Yang, 2019; Boudlaie et al., 2022; Mukhlis et al., 2022). Through the results indicated in Fig. 2, the structural model for examining the impact of big data on sustainable supply chain management was considered to have appropriate construct validity. The construct validity made the results of path coefficients listed in Table 3 have accurate values that enable the impact interpretation and identification of the hypothesis test result.

Table 3
Standardized and unstandardized path coefficients

Path			B	S.E.	β	t	P	Result
H1: Volume	→	SSCM	0.406	0.064	0.391	6.34*	0.04	Accepted
H2: Variety	→	SSCM	0.613	0.047	0.568	13.04***	0.000	Accepted
H3: Velocity	→	SSCM	0.461	0.065	0.443	7.09*	0.02	Accepted
H4: Variability	→	SSCM	0.537	0.055	0.517	9.76**	0.008	Accepted
H5: Value	→	SSCM	0.489	0.059	0.464	8.29**	0.003	Accepted
H6: Veracity	→	SSCM	0.550	0.052	0.532	10.58***	0.000	Accepted

The results of Table 3 assured the acceptance of all hypotheses that argued the impact of each big data dimension on sustainable supply chain management. The results pointed that variety (β= 0.568, t= 13.04, P= 0.000) has the highest impact, followed by veracity (β= 0.532, t= 10.58, P= 0.000), then variability (β= 0.464, t= 8.29, P= 0.003). Value (β= 0.443, t= 7.09, P= 0.02) acquired the fourth impact rank, velocity (β= 0.391, t= 6.34, P= 0.04) had fifth rank, and volume (β) had the last rank in terms of impact on sustainable supply chain management.

5. Discussion

Based on the study results of the means, it seems that there is an adoption of big data by the hypermarkets in Jordan, as the hypermarkets in Jordan stores huge amounts of data related to the subsidiaries of the private supply chains in the hypermarkets in Jordan, as this data varies in different forms and formats between local, regional and global data based on the nationality of the companies The supply that the hypermarkets in Jordan deal with, and this data is collected from an increasing number of various sources, and the hypermarkets in Jordan also provides a package of data analysis programs to organize the data and extract useful information from it, and uses modern information systems to store information that the company may need later to conduct its business, as shown employees rely on this information to make decisions during the performance of their work, as it is considered accurate and truthful information.

It has also been shown that hypermarkets in Jordan adopt sustainable supply chain management, and this is due to the fact that they manage their business and decisions related to their supply chain in ways that take into account the environmental impact, as they try to choose suppliers who have the green character in their companies and products, and they publish periodic reports showing the size of the environmental impact resulting from their activities, and the company, in cooperation with several companies within the supply chain, implements initiatives to develop and develop the local economy, and sets the necessary plans to achieve efficiency in work to invest existing resources in the best way, and strives to develop and prosper its economy by rationalizing expenses and increasing revenues, and the hypermarkets in Jordan also donates financial aid to specific parties in society to contribute to community development, the company and supply chain companies adopt a job ladder that guarantees fair promotions and workers' wages, and works to develop employees by providing them with advanced skills. The study showed the impact of big data on sustainable supply chains with its environmental, economic and social dimensions. Large databases and they are analyzed using special analysis programs for big data to produce a lot of valuable information that the decision-maker can invest in dealing with supply chains to work on making them sustainable in their environmental, economic and social aspects, such as information on the percentage of pollution caused by each company. It is dealt with in the supply chain and information on the environmental impact resulting from the manufacture, consumption and disposal of products and the preservation of the environment by the decision to continue dealing with this company or dealing with a better company or providing advice and conditions for continued dealing and this contributes to building an environmentally sustainable supply chain. The selection of supply chain companies based on the available information related to justice among employees, non-exploitation, work on developing employees, improving the standard of living, meeting needs and caring for health, as well as contributing to education, developing the local community and protecting society helps in improving social sustainability, and also helps in improving the economic situation. On the available information, such as choosing the lowest-cost suppliers, which increases the amount of profit for the organization, and this contributes to improving the society's economy, given that the organization's economy is part of the society's economy. According to a study by Bag et al. (2020), big data analytics management capabilities have a substantial and significant impact on the creation of innovative green products and sustainable supply chain outcomes. This study supports that finding.

BDA big data analytics relational knowledge, BDA business knowledge, and BDA management knowledge, according to Mandal's (2018) research, are significant enablers of SC supply chain resilience. It has also been proven (Mageto, 2021) that big data analytics (BDA) enhances sustainable supply chain management (SSCM) for manufacturing supply chains. (Cheng & Lu, 2018) developed a conceptual model to study how the use of big data analytics impacts supply chain performance in an omnichannel. Shokouhyar et al. (2020) developed a theoretical model to explain the powerful impact of BDAC capabilities on supply chain sustainability. Big data analytics has a favorable effect on supply chain performance and innovation capacities in the service supply chain, as demonstrated by Fernando, Chidambaram, and Wahyuni-TD (2018) and Zhang & Zhao (2019), who also found a direct correlation between big data and supply chain resilience. Benzidia et al. (2021) showed that the use of Big data analytics and artificial intelligence (BDA-AI) technologies has a significant impact on the integration of environmental processes and cooperation in the green supply chain.

6. Implications, limitations and directions expected research

The research showed the impact of big data on sustainable supply chains with its environmental, economic and social dimensions. Based on this result, the researchers recommend the hypermarkets in Jordan to use modern and diverse methods for accurate collection of reliable data and save it in organized ways, and to employ advanced programs to analyze it and extract information of high value from it, and to choose competent employees with appropriate skills to deal with it in the right ways to achieve the highest benefit from it, and to take the information generated from it. Analysis programs by decision makers to deal with supply chains in ways that help raise the level of sustainability in their environmental, social and economic aspects.

The study examined the impact of big data on managing sustainable supply chains, and future research may address the effect of big data on company performance, innovation performance, decision-making, privacy, digital transformation, sustainable manufacturing, business model innovation, or trust. customers, green supply chain, competitive advantage, marketing communications, or quality of reports. The study measured big data with its dimensions represented by its dimensions of volume, diversity, velocity, variability, value, and veracity. Another study can add visualization, complexity, place Venue, Vocabulary, Vagueness, Validity, Volatility, and Exhaustive. The study also dealt with the variable of managing sustainable supply chains with its dimensions (economic, social and environmental). It is possible for another study to add the dimension of governance, or to deal with one of the dimensions alone, or to deal with sustainability.

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