The role of big data analytics in the footwear supply chains: a multiple case study perspective

Journal of Science and Technology Policy Management

Freeha Maryam Arshad
Go Global International Office, Superior University, Lahore, Pakistan, and
Asher Ramish
Department of Operations and Supply Chain, University of Management and Technology, Lahore, Pakistan

Received 2 December 2023
Revised 19 May 2024
14 August 2024
Accepted 21 August 2024

Abstract

Purpose – This paper aims to analyze the importance of big data analytics (BDA) and supply chain analytics for sustainable supply chain management in all types of enterprises in the footwear industry. The importance and implementation of BDA in supply chain management have been discussed in this research paper, and a conceptual framework is proposed for the implementation.

Design/methodology/approach – The previous research indicates that the application of BDA and supply chain analytics is the key point to establishing sustainable supply chain management. Even though there are several types of research on the implications of BDA, there is still a gap in practical implications in organizations. For a better understanding, comparison of frameworks has been done for literature support. Further, 11 in-depth, semi-structured interviews have been conducted with four organizations from the footwear industry, and a conceptual framework has been proposed.

Findings – This research demonstrates an important gap in the literature through a thorough investigation of how firms can improve operational efficiency and productivity through the framework application and whether it is feasible to apply this within the global footwear industry or not. In conclusion, the research has denoted that despite lack of understanding related to sustainability agendas and not having proper ERP or BDA systems, the organizations operating in Pakistan still met some standards of sustainability and are moving toward achieving more.

Research limitations/implications – The research has pointed out the importance of the integration of all stakeholders in the supply chain through a proposed framework that aligns and guides the stakeholders so that the policies and other constraints may be taken into consideration while revising sustainable supply chain strategies.

Practical implications – This study will help increase sustainability through the application of BDA technology, which will benefit various stakeholders, particularly those in the footwear industry.

Originality/value – This study has proposed a framework based on three stages of the implementation of BDA in the existing supply chain to maintain and achieve sustainability in the organization in the footwear industry. This three-stage framework covers many aspects that were not covered in the literature before.

Keywords Big data analytics, Supply chain analytics, Sustainability, Internet of things, Business intelligence, Footwear industry, Multiple case study

Paper type Case study

1. Introduction

Big Data is derived from the collection of some useful data from the initial stages and the process of that extracted data to some useful meaning. Big Data is not the only source of providing huge information; it also provides the mentality set of people who are using a

Journal of Science and Technology Policy Management

2053-4620
DOI 10.1108/JSTPM-12-2023-0214

particular product (Kache and Seuring, 2017). Big data is a rapid updating technique to find out the latest and innovative techniques for the business-related category. Specifically, the focus is on the manufacturing sector (Cui *et al.*, 2020). Big data is a rapid updating technique to find out the latest and innovative techniques for the business-related category. Specifically, the focus is on manufacturing (Cui *et al.*, 2020). Six key factors are identified by researchers that can be used for the implementation of big data in enterprises. System integration, data, sustainability, resource sharing and hardware are the identified key factors (Mageto, 2021).

The supply chain is a field that is interlinked with many equally important activities. The activities that are involved are material, information and finance flow. These all-mentioned activities are interdependent, so an organization can achieve the benchmarked goal for long-term success in the corporate sector (Liu *et al.*, 2020). Intending to achieve long-term benefits, companies have to focus on aligning supply chain activities with sustainable management. Supply chain management activities can avail beneficial results by sharing information, with all stakeholders, received from different resources. It is easier these days to bring the latest developments in product planning with the help of using the quick flow of information, data integration and reverse information throughout the supply chain (Liu *et al.*, 2020).

Over the past few years, organizations have been more focused on automated manufacturing. Additive manufacturing has brought the concept of energy-saving and a cleaner environment. The main reason to shift to automated manufacturing is to reduce energy consumption and extra resource utilization and to lessen the process tenure (Majeed *et al.*, 2021). The Internet of Things (IoT) is a technology that assumes that it will be part of every organization and every operation of the organization. In supply chain management, IoT enables organizations to enhance productivity and efficiency. Because IoT will help the organization to receive the data, which helps the decision-makers to make the decisions with less time (Idwan *et al.*, 2020). The latest manufacturing technologies enable organizations to make their production department more sustainable and effective. Big data analytics (BDA), additive manufacturing and sustainable supply chain management (SSCM) are advanced manufacturing technologies that are part of the 4.0 additive manufacturing. These technologies apply to any manufacturing firm (Majeed *et al.*, 2021).

It has been approved that many areas remain unidentified for big data to be an industry-friendly concept; the future research would be on change management aspects and challenges. There is a huge gap that requires more systematic methods of examining and tackling the challenges in the implementation of BDA for businesses, as there is a need for change management in the existing operating systems (Sundarakani *et al.*, 2021).

It is suggested that future research should be expanded by collecting data from different regions other than the already conducted regions. It is recommended to collect data from nonmanagerial staff along with the middle managers and junior managers. The final analysis considered all data, such as respondents' perceptions and documented facts that included annual reports. It will be a source of authentication in the final findings (Fu *et al.*, 2022).

Concerning the influence of BDA-enabled sensing capability and analytics culture on organizational outcomes (which includes customer linking capability, revenue results, market stability and strategic business values), as well as the significance of the analytics culture of the organization as a mediating factor in the relationship between BDA-enabled sensing capability and organizational outcomes, there is still a significant gap in the literature (Fosso Wamba *et al.*, 2024).

A major role is played by the huge amount of information, with the possibility of exploring the latest knowledge, which is implacable in multiple aspects, such as behavioral dynamics of the demand which is critical and relevant. The data has been collected from

Twitter and other major social networks, which contributes to conducting the research in the most complex environment. Therefore, it is suggested to use such data to develop and organize another research with a similar theme by using a qualitative approach, such as in-depth interview techniques, which will ultimately help to find possible results with the emergence of existing findings (Polese *et al.*, 2019).

The objective of this study is to analyze how companies can use BDA in their system to achieve sustainability in supply chain management. These days, innovation is the basic factor for organizations to meet a competitive advantage in the industry (Evans *et al.*, 2017).

In this research paper, dynamic capability theory has been implemented to create the relationship among AI capabilities, agility and competitive advantage. It provides a conceptual lens to elaborate the competitive advantage of organizations along with the processes that organizations can develop and configure their AI capabilities so they can respond to the rapid changes happening in the marketplace (Eisenhardt and Martin, 2000). The analysis of organizational agility and growth is supported by dynamic capabilities, which are defined as a combination and configuration of managerial processes, adaptability within the process and resource capabilities. The core concept of dynamic capabilities indicates that the internal performance of the organization is based on the variance in dynamic capabilities of the firm over time to deploy resources to compete with the expeditious changes in the market (Mohiuddin Babu *et al.*, 2022).

This research study is based on the following research questions:

RQ1. What are the hurdles and challenges in the implementation of BDA for the achievement of sustainable supply chain?

RQ2. What would be the framework and guidelines for the implementation of BDA in the footwear industry for the achievement of a sustainable supply chain?

2. Literature review

Theoretical support depends on the resource-based view of the firm, expanded by the dynamic capabilities perspective (Irfan *et al.*, 2019). The study depicted how IT capabilities impact supply chain capabilities along with the agility of the firm that is based on the perspective of dynamic capability (Cadden *et al.*, 2021). The significance of BDA-enabled dynamic capability has already been the leading topic of research that supports information system management, operation management and strategic community (Wamba *et al.*, 2020).

BDA is the updated data received from customers, which can help any organization design their product directly according to the demand of the customer. This process will help the company to achieve higher satisfaction from the customer. One of the key factors that are responsible for the survival of companies in the modern era is the level of innovation in the product produced by the company (Niebel *et al.*, 2019). It has been observed that the performance of any company is based on the key buyer–supplier relationship (BSRs). The previous research analyzed that supply chain analytics capability can strengthen the key BSR, which ultimately will add value to all operations. It is difficult to implement SCA in firms where a culture of independent decision-making exists (Ahmed *et al.*, 2022). For supply chain analytics, predictive machine learning has become a notable field of investigation. The reason for such techniques is the rise of the artificial intelligence paradigm in the business industry. But at the same time, there are various hurdles while implementing artificial intelligence technology (Brintrup *et al.*, 2020). The implementation of BDA in the supply chain indicates a major gap in operation improvement, cost reduction and accurate decision-making for supply chain management (Lee and Mangalaraj, 2022).

The IoT is an upgraded system that helps an organization to work over a proper network with the identification and transformation of data among all interconnected parties related to everything, such as machines, devices or anything else (Mishra and Tyagi, 2022). The research literature highlights the significance of implementing technologies, specifically information technology, e-commerce and digital platforms, that strengthen strategic alignment. Specifically, IT advancement and alignment can expedite the development of supply chain capabilities and foster an interactive effect between supplier and customer integration (Pessot *et al.*, 2023). The competition in the global market has become more competitive for the firms to survive the implementation of sustainable production operations has become a basic need of the manufacturing industry (Dwivedi *et al.*, 2022). The supply chain that is linked with manufacturing is one of the sectors that is contributing to the production of a harmful environment, which ultimately impacts the societies and economies in which such industries are operating their systems (Mageto, 2021). This is the main reason the researchers and professionals are contributing to Industry 4.0 (I4.0), big data and circular economy (CE) concepts. They have concluded that it will help the manufacturing industry in many ways (Dwivedi *et al.*, 2022). For the analysis and decision-making process, it has become crucial for the stakeholders to manage such complex and huge data. AI technology can be used in such scenarios to contribute to the value chain, from the process of product discovery to robotic manufacturing (Mohiuddin Babu *et al.*, 2022).

To be competitive in this global market, organizations are required to implement sustainable practices. A comprehensive picture of sustainability can be obtained by combining the layers of economic, environmental and social performance. The attributes of sustainability have gained immense importance in response to the growing consciousness of environmental issues, globalization, changing demographics and pressing economic issues, among other factors (Narwane *et al.*, 2021). Table 1 classified sustainability benefits from the perspective of the triple bottom line approach of social, economic and environmental. Minimization of manufacturing time and maximization of recycling and reuse of components belong to the social aspect of sustainability. Economical aspects are involved in the reduction of all those activities that are involved in the manufacturing process, e.g. maintenance and recycling costs. Environmental aspects are related to the reduction of carbon dioxide emissions, electric consumption, packaging and other activities that contribute to the stability of the environment. Based on three triple bottom lines, the researcher has stated the importance of BDA in sustainability (Kumar *et al.*, 2021).

2.1 Sustainability in the footwear industry

Since data reveals that SSCM has greatly aided in the development of more socially and environmentally responsible supply chains, SSCM has gained popularity as a research topic among academics. On the other hand, supply chain operations can attain operational excellence by integrating SSCM methods (Kumar *et al.*, 2020). Climate change is the major reason that supply chain management has gained importance in research in the past two decades. Even globally, the United Nations has presented sustainable development goals (SDGs) that lead toward sustainability (Mageto, 2021). In the past few decades, the concept of sustainability in every sector has arisen, specifically in the footwear industry, where various involvements have originated to create a specific response for the adoption of sustainable practices (Polese *et al.*, 2019). Manufacturing industries need to tackle the uncertainties that happen due to human relations. Moreover, they needed to handle the complex relations and dependencies among all stakeholders (Mohiuddin Babu *et al.*, 2022). the SDGs of the UN, which aim to “meet the needs of the present without compromising the ability of future generations to meet their own needs,” are at the center of the current attempts

Table 1. Sustainability benefits

Benefits	Description	References	Sustainability aspects		
			Economic	Social	Environmental
Enhanced production recovery and reuse (EPRR)	Refers to increase in the production rate of a manufacturing system that is achieved through the implementation of various techniques	Amui *et al.* (2017), Lee and Lee (2015), ElMaraghy *et al.* (2017)	✓		✓
Energy-efficient and safe processes (EESP)	Reduce the amount of energy required to provide products and services	Raut *et al.* (2019), Wang *et al.* (2019), Das *et al.* (2020)	✓	✓	✓
Improved customer satisfaction (ICS)	Continuous change in expected performance by accurate forecast to meet organization targets	Dubey *et al.* (2016), Raut *et al.* (2019), Gawankar *et al.* (2019)		✓	
Improvement in profit margin (IPM)	Refer to increasing the amount of profit made from the sale	Gawankar *et al.* (2019), Wang *et al.* (2019)	✓		
Waste minimization (WM)	Systematic method for the minimization of waste within a manufacturing system without sacrificing productivity, which can cause problems	Song *et al.* (2020), Manavalan and Jayakrishna (2019), Cui *et al.* (2020)	✓		✓
Resources optimization (RO)	Refers capacity to intricate resources in an efficient way to accomplish a sustainable goal	Amui *et al.* (2017), Singh and El-Kassar (2019), Song *et al.* (2020)	✓		✓
Developing sustainable capabili-ties (DSC)	Ability of firms to respond to their short-term financial objectives as well as future goals	Singh and El-Kassar (2019), Amui *et al.* (2017)	✓	✓	✓

Source: Adapted from Kumar *et al.* (2020)

to achieve sustainable development (SD). Various players have made varying efforts to attain the SDGs. When it comes to organizations, sustainability has mostly focused on the widely acknowledged notion of how the environment, society and economy – the three primary impacted areas – intersect (Lynch and Ferasso, 2023).

The fashion industry always works for novelty in response to fast-moving consumer demand (Hur and Cassidy, 2019). The fashion industry is counted as one of the largest economies, contributing 38% to the Asia Pacific, 26% to Europe and 22% to North America (Giri *et al.*, 2019). The research indicates that the fashion industry has never taken enough responsibility to address the issues related to sustainability. Sustainability issues related to the change in climate or unplanned overconsumption of natural resources have never been raised by the fashion industry because of its production and marketing strategies (Thorisdottir and Johannsdottir, 2019). The fashion industry is also nominated for the production of huge waste globally. The reasons for such waste products are overproduction and reverse logistics. And the major reason for the overproduction of returned goods is the customer's dissatisfaction with the articles that are provided by the industry, the reasons could be included such as size, color and style (Giri *et al.*, 2019). In the existing competitive situation, the other important factor is the digitalization economy. The fashion business is well interlinked with digitization. In the fashion market, digital platforms and digital marketing strategies are gaining popularity. Many businesses and brands have emerged with the e-commerce development, which ultimately helps the firms to make customers virtually (Gazzola *et al.*, 2020). Therefore, it is a basic need of the industry to be customer-centric for introducing and implementing environmentally friendly manufacturing practices (Giri *et al.*, 2019).

In every aspect of business management, BDA has been gaining significant popularity. This is prompted by the existence of large-scale data and also by the management's perception to make decisions based on collected data. Extant research concluded that in any organization, supply chain and operations management are the most prominent sources and consumption functions (Jha *et al.*, 2020).

2.2 Big data analytics and sustainable footwear industry

There is no denying that the fashion industry has a unique opportunity to pursue growth and profit while simultaneously bringing something fresh to the table. It also means that management must act quickly to give environmental protection first priority. The hazard of environmental pollution is increasing annually due to the current rate of production and consumption (De Ponte *et al.*, 2023). The footwear industry faces multiple interoperability challenges. The reasons are the high-level heterogeneity of the firms, the software system and the resources that the industry uses (Chituc *et al.*, 2008). Hence, this is the reason that decision-making processes will be enhanced by the utilization of BDA technologies. However, there is a gap of understanding in organizations related to establishing a company's structure that will support the creation of BDA capability, which will ultimately help the company to achieve a competitive advantage (Jha *et al.*, 2020). Due to customer demand for sustainable practices and increased awareness of the environmental impact of traditional production methods, the footwear industry is undergoing a significant shift. This change stipulates a thorough strategy to lessen the industry's impact. The production of footwear has several environmental issues, such as its high water consumption, considerable chemical use, substantial carbon footprint and generation of solid waste. Concerns over how the things they buy may affect the environment are growing among consumers. Due to this, there is an increasing need for environmentally friendly footwear solutions that reduce damage to the environment over the course of the product's life (Chen *et al.*, 2024).

2.3 Footwear industry of Pakistan

The tanning industry of Pakistan is well-established and produces high-quality leather. Talking about the craftsmanship of shoemaking, Pakistan has inherited these skills and has introduced well-known articles and brands. Khussas and handcrafted footwear from leather are popular examples. Pakistan's footwear industry is producing a wide range of products that are fulfilling the needs of customers from different markets. Such as men, women, sportswear, formal wear and hawkers are the key examples of the target market. The total production for Pakistan has been estimated at approximately 400 million pairs per year. Pakistan's footwear industry has made a specific market in the international footwear industry. They are exporting to more than 60 countries on five continents.

UK, in Europe, France, Netherlands and Germany; in Middle East Dubai, Saudia Arabia and Yemen. During the year 2013–13, the total export was US$105m , and during the year 2014–15, it was US$131.2m . The growth rate of the Pakistan footwear industry has exceeded 250% in the past few years (Pakistan Footwear Manufacture Association 2021).

2.4 Comparative analysis of various frameworks

A comparison of 8 frameworks from different research articles has been done in Table 2. The purpose of comparison was to find the gaps in previous frameworks, and based on the gaps, a revised conceptual framework is proposed in Figure 1. Planning is the major part of BDA implementation in any organization. Planning related to the market research and organizational structure; how much organization is flexible to adopt the change. A goal should be settled so that after implementation evaluation can be done.

The resources of BDA are from different platforms; BD can be collected by the application of IoT, BI or AI. After the implementation of the framework, an organization will be able to make decisions effectively and efficiently according to the trends and demands of customers. A quick flow of information will enable the existing supply chain to have resilient and SSCM.

In Figure 2, the authors have presented a big data SCM framework. The precedent of big data has been presented as value; however, the only focus of value is too basic a view, whereas big data needs to be understood with more complex dimensions of value discovery, value creation and value capture:

- Value discovery depicts the ability to generate location data. After the collection of data, it needs to be stored and governed by trustworthy data;
- Value creation represents the use of big data in a specific business domain and then utilization of the generated information from big data for strategic or operational decision-making using in the business; and
- Value capture indicated the utilization of big data for better improvement and value creation in the process (Brinch, 2018).

In Figure 3, the quality of the solution is determined by the goals being pursued, which may be one or more, with the option to maximize or minimize each. Furthermore, as previous authors have noted, these goals can be connected to the three facets of sustainability – economic, social and environmental. For the sake of this work, additional factors (flexibility, robustness and resilience) connected to the system's dynamism and unpredictability that had not yet been noted in earlier works are recognized. These last goals can be greatly aided by the online data that I4.0 technologies provide in addition to improved process management.

Table 2. Comparative analysis of previous frameworks

Sr #	Articles	Authors	Contribution	Outcomes	Gaps
1	Understanding the value of big data in supply chain management and its business processes: towards a conceptual framework	Brinch (2018)	Value creation addresses the capacity to create, find, gather, store, and administer reliable information that depends on a straightforward, yet unpredictable, organization of frameworks that ultimately supports the decision-making process	The supply chain integration model, emphasizes the need to control materials and information flows through value-adding processes globally	Companies are developing digitalization strategies in which the utilization of big data is a component in improving current supply chain practices, but there is a gap between research and implementation
2	A comprehensive review of big data analytics throughout product lifecycle to support sustainable smart manufacturing: a framework, challenges, and future research directions	Ren *et al.* (2019)	As per diverse application necessities, the connections introduced in the structure will help the administrators to distinguish the fundamental lifecycle stages that affect sustainable smart manufacturing SSM Following the information stream, including rules found through BDA, can give significant bits of knowledge to chiefs to meet the application necessities to accomplish SSM	Reduction of waste resources and environmental impacts with the improvement of digitization	BDA has been extensively acknowledged by numerous associations, as another idea, the examination of BDA in SSM is as yet in its beginning phases because of a few key challenges
3	Big data-driven supply chain performance measurement system: a review and framework for implementation	Kamble *et al.* (2019)	No change in the performance measures and targets leads to non-contributing or insignificant measures: Revision of existing measures by replacing them with more appropriate measures	Improvement in the decision-making process by aligning strategies according to modern trends	BDA implementation requires the latest technology, all organizations are not ready to initiate such changes with high investment

(*continued*)

Table 2. Continued

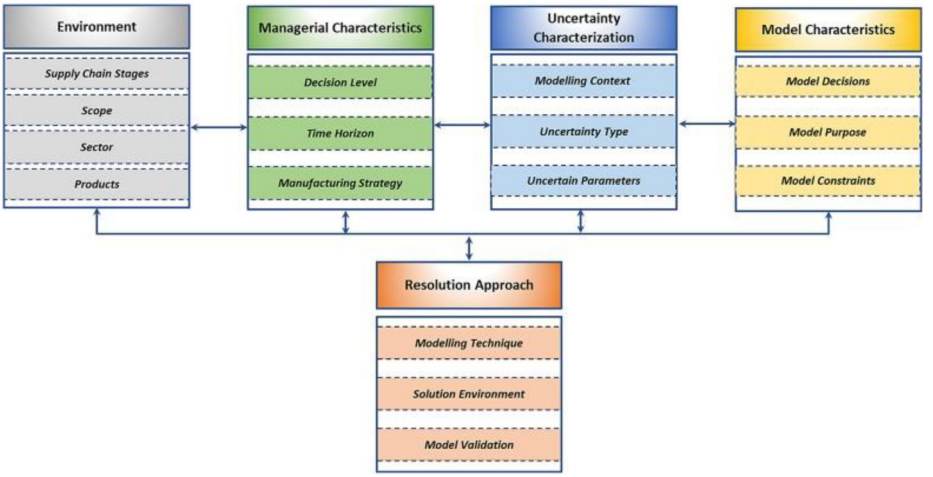
Sr #	Articles	Authors	Contribution	Outcomes	Gaps
4	Big data analytics and IoT in logistics	Hopkins and Hawking (2018)	Implementation of BDA improved the logistics operation, including freight and time management. Eco-driving,' including practices like moderate speed increase, and better expectation of traffic streams and signals	IoT-driven BDA initiatives were in achieving process and performance improvements in the areas of safety and environmental impact	A gap was found in the relationship between researchers and industry practitioners
5	Implementing sustainable supply chain management: Reactive, cooperative, and dynamic models	Zimon *et al.* (2019)	The proposed cooperative model builds on the reactive model for sustainable supply chain management. Change the mindset to initiate a cooperative model and align all the members involved in the supply chain. SSCM has been treated as a business opportunity rather than and strategic business responsibility rather than simply meeting the external requirements	Processes according to ISO 140001 environmental management system, to attain sustainability throughout the supply chain. Integration throughout the supply chain and moving towards a green supply chain	There is a gap in creating the policies and developing the infrastructure to attain environmental and social performance which will contribute to economic growth and support the businesses to change their current model to a dynamic model
6	Big data-enabled large-scale group decision-making for a circular economy: an emerging market context	Modgil *et al.* (2021)	The framework proposed to maintain transparency throughout the supply chain. It also contributed to the implementation of big data analytics as a dynamic capability to enable the circular economy. It has encouraged the involvement of larger stakeholders in the decision-making process throughout the supply chain	Involvement and transparency of all stakeholders throughout the supply chain. Implementation of environmental management ISO 14001;2015	The framework has not been tested empirically. Resources are not similar in all firms to implement the latest technologies. The systems of firms are unable to involve stakeholders in the whole supply chain

(*continued*)

Table 2. Continued

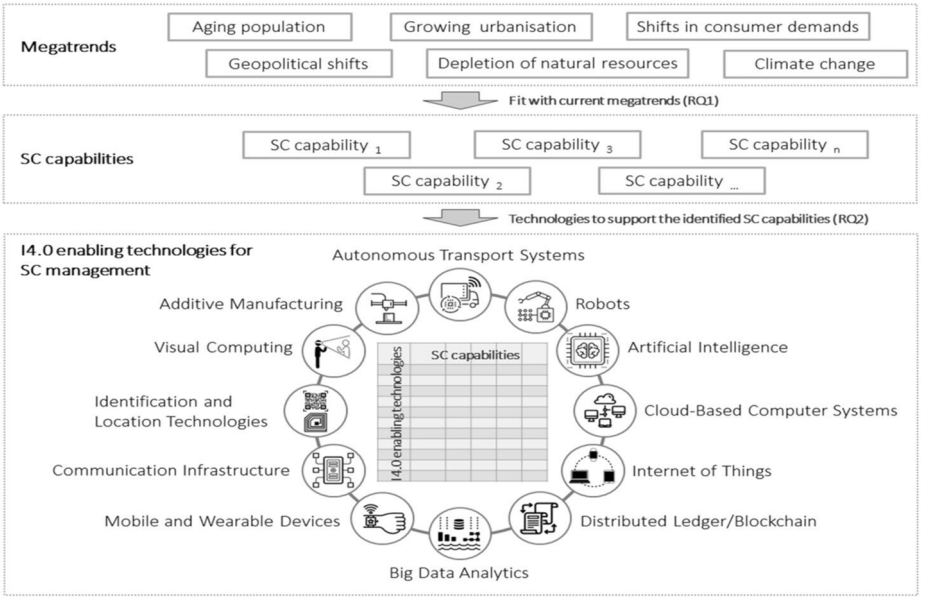
Sr #	Articles	Authors	Contribution	Outcomes	Gaps
7	A conceptual framework for the operation planning of the textile supply chains: Insights for the sustainable and smart planning uncertain and dynamic context	Lorente-Leyva *et al.* (2024)	The framework summarizes the main themes discussed in this section and the rationale supporting the study in an effort to link the pertinent megatrends considered, the supply chain capabilities required, and the role of I4.0 technologies in supporting them according to a contingency view	The model elaborate the implementation of sustainability in already existing supply chain infrastructure, at the decision make level	There is no model that covered the three sustainability dimensions simultaneously. The majority of research that has been done so far has focused on economic goals; very few has taken environmental or social goals into account, and even fewer has included goals that are flexible and robust
8	Empowering supply chain with industry 4.0 technology to face megatrends	Pessot *et al.* (2023)	In an effort to develop a connection between the pertinent megatrends taken into consideration, the supply chain capabilities needed, and the part I4.0 technologies play in supporting them from a contingency perspective	Developed a framework for analyzing I4.0 technologies in the supply chain and the effects of the disruption risk that could lead to structural dynamics and the knock-on effect	There is gap, when it comes to adapt the revised policies for sustainability according to the dynamic trend. There is no such pathways showed in the model to monitor the implementation and evaluation process

Source: Authors' own work



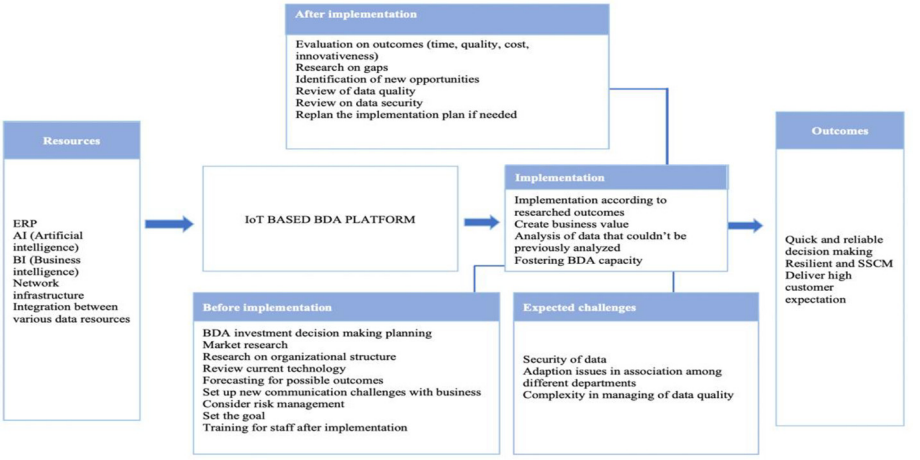
Source: Authors' own work

Figure 1. Conceptual framework



Source: (Brinch, 2018)

Figure 2. Big data SCM framework



Sources: (Lorente-Leyva et al., 2024)

Figure 3. Goals indicating the quality of the solution

As a result, the prospective goals are divided into the following six groups, with some examples presented below:

(1) *Economic*: profits maximization or costs minimization;

(2) *Social*: maximization of customer satisfaction along with service levels or employment opportunities;

(3) *Environmental*: reduction of water pollution, gas emissions, wastes or energy use;

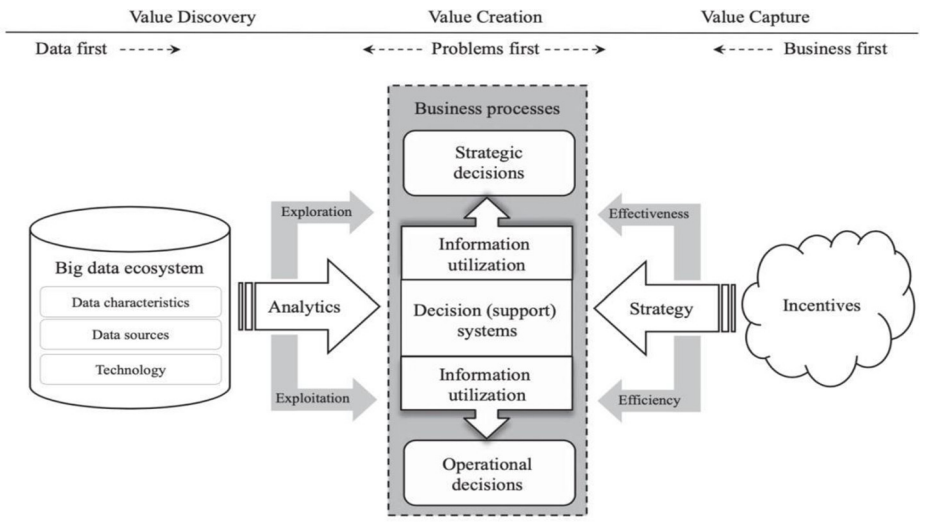
(4) *Flexibility*: improve the ability to quickly and economically manage and adapt to changing circumstances, as well as to respond correctly and quickly adjust in the event of an unforeseen incident;

(5) *Robustness*: improve stability and the capacity to withstand changes or disruptions; and

(6) *Resilience*: optimize the system's capacity to bounce back from disruptions or optimize its tenacity, flexibility, capacity for learning and agility (Lorente-Leyva *et al.*, 2024).

Figure 4 has summarized the main themes discussed in this section and the rationale supporting the study in an effort to link the pertinent megatrends considered, the supply chain capabilities required and the role of I4.0 technologies in supporting them according to a contingency view.

By establishing a framework for analyzing I4.0 technologies in the supply chain and the effects of disruption risk, which could lead to structural dynamics and the knock-on effect. The authors examine five categories of disruption risks: supply disruption risk (e.g., price fluctuations, unstable quality); demand disruption risk; time risk associated with delays in supply chain processes; and information disruption risk. Examples of external risks include fire accidents, natural disasters, economic downturns, legal disputes and strikes. As per research, smart systems can boost the performance and resilience of the supply chain and help it cope better with unforeseen events.



Sources: (Lorente-Leyva et al., 2024; Pessot et al., 2023)

Figure 4. Main themes and the role of Industry 4.0 technologies

3. Methodology

3.1 Data collection

Purposive sampling procedures steer clear of any sort of random sampling and strive to ensure that particular types of cases of people who might be included are represented in the research study's final sample. The rationalizations for using a purposive strategy are predicated on the idea that, given the goals and objectives of the study, certain types of people may have distinctive and significant opinions about the theories and problems under consideration, necessitating the inclusion of the sample of those individuals (Campbell *et al.*, 2020).

Saturation has been implied in this research article for data collection. One of the most acceptable guiding principles to assess the sufficiency of purposive sampling is saturation (Morse, 1995). In qualitative research, saturation has grown into a widely accepted methodologic paradigm. It is usually considered to imply that additional data collection and analysis is not required considering the data have already been gathered and analyzed according to the context. Such as when the researcher tends to analyze that answers are being repeated with the same comments, data saturation is being reached. The research concluded that it is the point where the researcher should stop collecting data and move on to the next step, which is data analysis (Saunders *et al.*, 2018).

3.2 Interviews

The literature review has guided us to find out the specific pointers to conduct further research. Which emphasized perusing the research by following the pattern of semi-structured questions for the interviews with industry experts. Semi-structured interviews are based on a deep research analysis on a specific topic, as the pattern of interview questions is prepared on the basis of previous studies. Before the interview, an interview-based questionnaire was established. The interview guideline was used as a source of question development. Very first, the interview guide consists of the main topic of the research. It

helped to stay on a path while conducting the interview; there were no hard and fast rules to be followed during the discussion. Rather, the main purpose of semi-structured interviews was to conduct the interviews by collecting identical conclusions from multiple professionals. For such purpose, the interviewee has given the interview guidelines before the start of the discussion (Kallio *et al.*, 2016). During the semi-structured interviews, the main focus of the conversation and interrogation was to observe and interpret the experiences of the interviewee. However, each person answers the question according to their personal experience, which would be different. In this sort of interview, the researcher and interviewee were involved in the discussion based on personal experience, which ultimately contributed to sharing information. The semi-structured interviews contributed to enhancing the information while exchanging dialogues. After the conduct of interviews, the responses were exploited. It was ethically compulsory to inform the respondent about the conclusion of the interview reference (Husband, 2020).

3.3 Interviewee selection

In this research paper, 11 semi-structured interviews (see Tables 1 and 2) have been conducted with the professionals of different companies in the footwear industry operating in Pakistan. The collected data was used for coding thematic analysis for analyzing data collected. The interviews were based on three sections (Appendix 1);

Professional employees were selected from each organization for the interview. The triangulation method has been used to address a phenomenon from various sources. According to the research, triangulation is based on the use of various methodological resources or practices. The word triangulation has been adopted from the area of navigation, where it means that multiple points of observation might help establish a specific location (Oliver-Hoyo and Allen, 2006).

Once the purpose and interview guidelines for the study have been decided, the next step was to finalize who has given the accurate answers to the questions. Those interviews are considered to be useful in which interviewees are willing deliberately to share their information based on their personal experience. The qualitative study is based on the detailed understating and accurate interpretation of the information provided by the respondent (DeJonckheere and Vaughn, 2019).

We have selected professionals from each organization for the interview on the following mentioned criteria, which are based on the previous qualitative interview practices. Primarily, the interviewee should have experience in the related supply chain field. The experience may be relevant to operation management or distribution management. Moving on, the person must have been in a leading position in the relevant field of practice. Further, they should have informative experience in technological products that might be used for the management of division and planning process. Next, they must be working in medium- to large-size firms. The reason for such professionals is that we will have secondary information that could be used for data triangulation. Finally, the most important and ethical point is that the interviewee must be willing to share the information that will be based on the organizational issues. The purpose of the will is that after the interviews it will need more information that will be helpful for the study in the decision-making process (Jha *et al.*, 2020).

This information has also been used other than the interviews. Other resources that have been considered for information are newspaper articles, supply chain reports (Jha *et al.*, 2020) and company reports that have helped in the analysis.

3.4 Nature of organizations

For the interview, four organizations were selected from the footwear industry (Appendix 2).

(1) Service Industries Ltd.;
(2) Hush Puppies;
(3) Borjan; and
(4) Service Sales Corporation (Pvt.) Ltd.

Further details about the selected organizations have been summarized in the following Table 3:

4. Data analysis

The data has been analyzed to create categories within the data by following the pattern-matching technique. The problem that enables researchers to do research from the start in new research is based on how to reconcile the diverse data types and the worldviews they depicted after analysis, as a result of what outcomes to be an epistemic conflict. The typical method used in this research to reconcile the various collected data is pattern matching methodology (Yin, 2009). After discussing the general principles of pattern matching, in this research paper, those principles have been incorporated. The classification indicated a major problem organizations are facing while implementing BDA for the sustainable supply chain in the footwear industry of Pakistan.

Analyzing textual, visual or auditory data qualitatively spans a range from confirmation to investigation. Qualitative research can be guided by a conceptual framework, which suggests a deductive approach in part, or more by the data itself, which suggests an inductive approach. The term "generic" or "basic" qualitative research describes an approach where researchers merely want to solve a problem, bring about a change or identify pertinent themes without trying to place their work inside a specific epistemological or ontological paradigm (Mihas, 2019).

With their consent, all phone interviews were recorded. Subsequently, once they had provided their responses in Urdu and English, the audio interviews were translated and transcribed. The interviews were done in simple Urdu, and as a result, I received arbitrary responses. I informed them about my study before the interviews. They have been informed of the intended use of the data by me. They helped me, and they did understand my situation. Further, the data was translated into academic English for further analysis.

Table 3. Introduction of organizations

Sr #	Organizations	ERP system for data collection	Analysis software	Other initiative toward AI
1.	Servis	Microsoft Dynamics 360 AX	Power BI	Working to move on the OMNI channel
2.	Hush puppies	Microsoft Dynamics 365 AX	Power BI	Active on the OMNI channel Working on software that specifically meets the demands of the physical supply chain
3.	Borjan SSC	Microsoft Dynamics 365 Oracle	Power BI Oracle	– –

Source: Authors' own work

Along with carrying out interviews, data is additionally acquired from qualitative and quantitative secondary sources, including news articles, archived data and company records. Data has also been acquired from company reports, historical data and required papers, in addition to interviews. These sources have been used to analyze the study problem from the perspective of the past.

Validity of qualitative research refers to scrutinizing the accuracy of the findings that are obtained by the implementation of specific procedures. Whereas qualitative reliability depicts the consistency of the research that the author has conducted through multiple methods and plans of action (Gibbs, 2018).

To enhance the construct validity, the data was collected from multiple resources. Triangulation is the prominent and authentic method. Data could be collected by the triangulation of interview tapes, documented information, artifacts and many other options that could be considered that must give the protection related to the contradiction of the researcher (Riege, 2003). Development of a series of evidence that has been collected while conducting interviews. Such as precisely copied points during the interview and the observations that were perceived during the interviews and discussions. Proofread the draft of the case study during the phase of report writing. Review the basic points noted during the interview, after editing if there are some unclear aspects, and then finalize the findings obtained from the report (Yin, 1994). See Table A3) for a summarized version.

With the findings of the problems, a few factors were identified that can help the organization restructure its strategies according to modern trends so it can compete globally.

4.1 The uncertain political and economic conditions of Pakistan

Footwear companies, usually have 60%−40% of in-house production and outsourcing. Also, for manufacturing, they require materials from different countries. The political and economic condition of Pakistan does not support import and export, as many factors affect it because of sudden changes in policies. As the Director Merchandising Supply Chain from firm B explains:

> "We have multiple issues in Pakistan like taxes and economic problems. In our company, there is no significant impact. As our company is international and the apparel brand is US-based. This brand is operating in 160 countries around the globe. We have to make sure that product must be there which is in Africa and Europe. Since 2019 when the government changes the policies entirely change. One government imposed equal taxes, one increased the import taxes and now they are saying to promote local government and import is banned, but practically it is not happening in the industry". He further added: "As we are an international brand, we are offering a premium product and we have to have provided good quality. If we move to export, we have much more taxes and duties and if we rely on the local market our quality is compromised. We do plan one year prior and if there is no government visibility, we cannot plan in advance accurately". So, this is a major factor that the footwear industry of Pakistan couldn't groom.

This point has also been discussed in the literature that conventional decision-making was considered philosophical. The major parameters in supply chain network (SCN) were related to the supply capacities of the manufacturer, the demand generated by the retailers and the competency of the transportation sector. Due to the uncertain economic development and complex social modification specifically in the context of the big data environment, which results in the high uncertainty in previously mentioned parameters. The ultimate effect of uncertainty was the late product delivery time, and the quality of the product was ultimately reduced in SCN and so with the demand generated from a customer (Peng *et al.*, 2022).

4.2 Lack of government policies

There is a lack of government focus on the footwear industry; as footwear is one of the oldest industries of Pakistan, the government should have to make/impose policies that support it in critical economic conditions. The director, heading merchandising supply chain from firm B, added:

> As China is ahead in R&D our industries mostly go there. Both our government and industries are not serious about development and they are not willing to make strategic decisions.

4.3 Skilled ERP team

To support the BDA framework in Pakistan's footwear industry, organizations need to manage human resources carefully. Assistant Manager Purchase from firm C added:

> A right person should be hired for the right job. Work force should be maintained for better outcomes.

Further comments are added by Leading Analytics from firm A:

> For the implication of BDA company should have an active ERP team, Equipment should be latest, and system and server's backup. Staff should be highly trained and those who are going to deal with the data.

It is very important to have a skilled team to run the IT setup accurately and efficiently. Further suggestions are given by planning manager from firm A:

> We need IT team for the implementation of BDA framework. If a company does not want to invest, they can outsource the team for the implementation such as Systems is providing such a facility to retailers. A company can make their own software as well if they are playing on a small scale.

In the literature, the ERP selection has been discussed thoroughly. The selection and implementation of the ERP process involve the proper research and study of business processes. The availability of ERP software and the configuration of ERP to provide accurate training for employees and customization. The major difference between current and upcoming ERP evolution is the sustainability factor. Sustainable ERP (S-ERP) is the basic need of the current system. Many business models are working on maintenance to achieve sustainability to survive and to be compatible at local and international levels (Qureshi, 2022).

4.4 Synchronization or link between different technologies

As mentioned in Table 3, companies are using two software, Microsoft Dynamics for data collection and analysis and reporting; they are using Power BI (business intelligence), so it is important to get linked to all the technologies in the organization for better use of the technology. As a senior business analyst has guided:

> Technologies must be interlinked/coherent with each other that support BDA. Also, the vision of the company towards BD.

Also, planning manager from firm D has explained:

> We should focus on BD as it is modern technology. In the supply chain, all nodes should be connected and interlinked with each other to have better planning. Data should be received timely and accurately.

The literature has also shed light on the synchronization of different technologies to make accurate decision-making. BDA, the IoT and other technological innovations enable the organization to collect significant data, which enables the organization to move toward an innovative organizational culture based on the collected data-based decisions. Data is abundant and diverse and plentiful in volume in the manufacturing industry as a result of the spread of smart technology, devices and applications. Also, the expansion and simplicity of cloud computing have made it possible for businesses to access, store and retrieve large amounts of data. In addition, manufacturers may access a lot of usage, conditional and application data from their manufactured smart devices thanks to the IoT, which converges many technologies, objects, integrated technologies and semantic approaches. The organizations' ability to support data-driven innovation is made possible by the vast amount of data and computational power available (Babu *et al.*, 2021).

4.5 Awareness-related needs of adapting the big data analytics model for sustainability

The awareness of environmental degradation and its harmful effects is rapidly growing at the global level. The entire world has banded together to focus on the protection of the environment. Businesses can gain a competitive edge by capitalizing on consumers' growing sensitivity to the environmental effects of their consumption patterns by making green products and brands available to them. Therefore, it is crucial for marketers to comprehend how other elements that contribute to customers' pro-environmental behavior are affected by rising sustainability knowledge (Panda *et al.*, 2020).

"I cannot address the term BDA specifically related to IT," quoted by Senior Category Head Ladies Shoe from firm A. Along with the interviews, it is concluded that people do know about related IT terms such as BI, AI and BDA, but they do not know well about sustainability and how to upgrade their existing IT infrastructure so they can implement the BDA framework.

Further added by Director Heading Merchandising Supply Chain from firm B:

> We are not offering any particular program for SSCM. But for factories the wastage of cloth we do make bean bags, we are recycling the waste. Our factory is running on solar energy. So, these are small initiatives. We have almost removed the plastic bag and moved to the paper bag but we are moving towards recycling. Labor sustainability is totally based on government policies. We rejected child labor and taxes are transparent. Our live sale is shown on FBR.

The factor of environmental reporting (ER) cites the disclosure by organizations linked to the broad concept of accepting and promoting eco-friendly practices. ER accommodates the firms to openly introduce stakeholders regarding their eco-responsible business decisions. The initiative about the declaration of environmental practices of stakeholders contributes to the effective evaluation of the firms' activities. Moreover, consumers, products and actions are responsible for a green environment (Rustam *et al.*, 2020).

4.6 Traditional organization culture

By discussing the basic issues of the footwear industry, a few points were discussed related to the traditional culture; they have used the word *seith culture*, which means all the decisions will be taken by the top management. This is the main issue: they are making decisions on guts, mostly focused on cost and profit, and to them, this is called sustainability. It is further explained by Assistant Manager Purchase (women category) firm C:

> Because they are reluctant to realize the need for the R&D department. It is very important these days as we are facing climate change. We need to align our supply chain, but we are not doing it. e.g., we are using solvent chemicals. We are ignoring all basic pointers to maintain sustainability.

> Portugal has used water-based chemicals to promote human health. But the organization has not realized the importance of meeting the global trends.

4.7 Investment in IT machinery

It is concluded from interviews that many organizations are still reluctant to accept the importance of IT and AI in the manufacturing and retail industries. They are not willing to make investments in IT setups. The problem has been discussed by Assistant Manager Purchase from firm C:

> Latest computers are required to run the latest software. There is no learning in this organization related IT. As many people have resigned from the organization as they are not moving towards AI.

Further comments are added by assistant manager purchase (gents' category) from the same firm:

> Our culture is reluctant to move towards technology. Every decision will be taken by the top management. They are more focused on investment and cost-beneficial scenarios. But they do discuss this with the key heads of different departments

Further point added by planning manager, firm A:

> We don't have much knowledge related BDA even though it is really important for any company but companies do not want to invest in the IT setup.

The importance of ERP system has been highlighted by researchers. Setting up an enterprise system is a difficult task that requires expensive and risky investment. Moreover, ERP systems may have an impact on core company operations and auxiliary procedures, particularly in advanced and cyber-physical domains like the Industrial Internet of Things and smart factories. For merging the advantages of Cloud and Edge Computing, there are two alternatives to the classic, centralized, monolithic ERP implementation: Cloud ERP (C-ERP) and Edge ERP (E-ERP). Easy usage, resource balancing, bandwidth, cost savings and increased privacy and security are some of their key advantages (Panda *et al.*, 2020).

4.8 Data synchronization issues

This issue is internet-related when retail shops are operating in different cities, they might face issues in data quality because of a lack of time synchronization. This problem was discussed by the planning manager of firm D:

> We are not facing any issues related to data security. Quality issues may appear because of synchronization due to technical issues such as Wi-Fi issues.

The distinctive feature of big data and BDA has generated refined factors for research such as a solution of the generated data, storage, visual representation and proceeding challenges. Still, there are notable gaps in extracting the desired information from collected data relevant to the industry by using BDA tools. This factor has grabbed the attention of researchers and practitioners. Despite several academic studies and research projects that have recently been conducted on the use of BDA to enhance industrial performance; there is still a need for a systematic data-driven analysis, comparison and evaluation of various approaches, data sources, applications and suitable solutions (Ikegwu *et al.*, 2022).

4.9 Unmechanized footwear industry

This point has been explained by assistant manager purchase (gents' category) from firm C. The footwear industry is categorized as follows:

- *Mechanized*: In this category, the setups involved are fully automated; they are using software and proper IT setup;
- *Semi-mechanized*: This category is based on the setups that rely on the customer's demand (those firms that outsourced their finished goods). They might use ERP software that is on a small scale or maybe they are based on Excel; and
- *Cottage sector*: This is an unorganized and unstructured sector.

Further planning manager from Firm D has verified it by explaining that:

> Only the organized sector in the footwear industry is using the ERP system.

4.10 IT setup in the upstream supply chain

It is not possible to synchronize our system with our suppliers as their IT setup is not up to the mark. Also added by Manager Planning and Distribution from firm B:

> It is in the process of implementation of BD in both streams. There is a huge gap in adoption on the downstream and upstream sides. Because we do not have access to implement our system on suppliers as we have done in our retail shops. The major gap is that we can control downstream but we can control the supplier side. The major recommendation is that we need to manage our suppliers to smoothen our whole supply chain.

Also added by the planning manager of firm D:

> There is a gap in upstream and downstream. Our suppliers have too many gaps during the implementation of BDA.

4.11 Planning does not support the physical supply chain

The Director of Merchandising Supply Chain from firm B explains why automation does not support our supply chain:

> In Pakistan right now no ERP will work 100%. Because the system will require the company to move hard our physical supply chain will not support working within lean time. Most of the time we have to bypass the system. We need to do most of the things manually to meet the current situation of the supply chain. The physical supply chain does not support the automated system. We are working on it but it doesn't mean we are not trying and not working on it.

4.12 Involvement of stakeholders in the Decision-Making process

Still, companies have issues related to the involvement of stakeholders in decision-making, which is explained by Assistant Manager Purchase (women category):

> They do not involve vendors. In my point of view vendors are our major stakeholders but we are unable to be involved. Stylo is working on it they have a meeting with the CEO and top management.

In literature, till now researchers have given importance to high-power stakeholders such as employees. Only specific importance has been given to the low-power stakeholder's engagement. It has a negative effect to influence corporations by low-powered stakeholders. The involvement of all stakeholders is very important, who are contributing to providing critical resources for major decisions. It has been studied that organizations can create strategies that empower all stakeholders from most leading stakeholders' engagement, which allows low-power stakeholders into active business associates (Civera *et al.*, 2019).

4.13 Self-Evaluation

All major brands in Pakistan use the same software. For this situation, the Director Merchandising Supply Chain from firm B has added:

> A few points to keep in mind, everyone has the basic platform and people are working on it. But we don't know what types of tools we can use to have a specific result. It depends on the need and what type of solution we need. I talk about merchandising planning we have a very basic solution that doesn't help me. But if move to high software it costs a lot and it also doesn't support our physical supply chain. So, it depends on the political environment that how much investment an organization wants to do.

To implement and attain sustainability, organizations are actively contributing to create a revolution that will ultimately support all the goals of sustainability, such as economic, environmental and social goals. However, the achievement of these goals is not as easy. The previous study has concluded that understanding "sustainable innovation" is still lagging (Cillo *et al.*, 2019).

4.14 Coordination between academic and industry

As in the literature, it is discussed that there is a major gap in the researcher's solution and its implementation in the industry, so while discussing it, it was observed that the best solution which we can implement to have better solutions in the future. Senior business analyst from firm C has guided:

> There is a wide gap between academia and industry. The government is a kind of bridge between academia and industry. We should promote, that if the industry has any problem, they should go to university instead of consultancy firms. This is already in practice in Western countries.

4.15 Revised solution discussion with all stakeholders

The importance of stakeholders' interest and involvement has been discussed in the literature. It has been studied that government-generated frameworks or policies are not enough for the organization to pay attention and make financial feasibilities for green technology, but the engagement and compulsion from supply chain stakeholders play a vital role to maintain or implement a green supply chain. The industry should take the initiative to engage stakeholders. Organizations need to pay attention to the development of technologies for the interlinked supply chain. Although too many factors are affecting the participation of stakeholders in the supply chain, many industries are not contributing to communicating their products and processes to stakeholders (Rane *et al.*, 2021).

It was suggested that the revised solution framework should be discussed with all stakeholders instead of only with top management. It was suggested by Assistant Manager Purchase (women category):

> The researcher is usually discussing the problem with the CEO or the top management. They should be aligned with the front-line management as well. The framework should be created in easy and understandable language.

4.16 Awareness related to sustainability and big data analytics

While doing the interviews, it was concluded that many experienced employees do not have proper information related to BDA and sustainability:

> Big data analytics is related to AI for better decision-making. Sustainability varies for different organizations. e.g. SSC we are surviving for 40 years which means we are sustaining. But now sustainability has different dimensions.

The above statement was quoted by the planning manager of firm D. This demonstrates that experienced supply chain employees are not well aware of relevant practices.

The government should also take initiatives toward sustainability. In literature, there is research on the Chinese government, as they have experienced uncertain growth in environmental degradation caused by excessive carbon dioxide (CO_2) emission in the last three decades. It is reported that the consumption of energy is not only considered an environmental issue but is grabbing the attention of political economy and sociocultural global implications. To control such issues, the Chinese Government has implemented strategies for the reduction of emissions such as taxes. However, the outcomes have been limited in certain cases, which results in distortions (Sarkodie *et al.*, 2020).

5. Discussion

The purpose of the research is to analyze key issues faced by footwear organizations in Pakistan while implementing BDA to achieve SSCM. After analysis, a conceptual framework has been proposed in Figure 3 with the personal experience and guidance of industrialists and literature on how firms can overcome these issues in the coming era.

While conducting interviews, it was concluded that experienced people do not know about sustainability. To make the supply chain sustainable, it is important to create awareness. By implementing the framework, all the stakeholders will have proper information about sustainability, and so they can work on it. Senior Category Head (women category) from firm A has shed light by answering the question of what should be the benchmark of organizations to attain sustainability, he said:

> If we talk about the local benchmark, in Pakistan the product leader in footwear is Bata. We follow different brands for different purposes. Such as for the high-volume selling department is Stylo, so we have followed Stylo for the sales and operation department. For HR we follow Bata because they follow international practices. For inspiration, we always follow international brands because it keeps us ahead of the local brands.

Sustainable ERP (S-ERP) is the basic need of the current system. Many business models are working on maintenance to achieve sustainability to survive and to be compatible at local and international levels by using benchmarking practices (Qureshi, 2022).

In the literature support, it has been discussed in detail that there is a huge gap between academia and industrial practices. The proposed framework will help to bridge the gap between academia and industry by conducting mutual research for specific problems. A business analyst from firm A added:

> If top management wants to implement the latest trends researchers should sit with the management to tell them they will have this much profit.

Researchers and professionals are contributing to Industry 4.0 (I4.0), big data and CE concepts that will help the manufacturing industry in many ways (Dwivedi *et al.*, 2022). The organizations' ability to support data-driven innovation is made possible by the vast amount of data and computational power available (Babu *et al.*, 2021).

The director of Merchandising Supply Chain from firm B, added by saying:

> Organizations do not want to invest in people and resources for example if I need more space in the warehouse, they will not invest in it and the same goes with human resources, we have always

> a shortage of employees in our team and there is no proper solution. We have to correct the process first and then we need to move to advanced systems.

In the current era where organizations are moving toward industry 4.0 at the global level, organizations operating in Pakistan are not working on employee training and development so they can meet the standards of the supply chain globally. By implementing the framework, the major benefit will be the interlinked supply chain that ultimately contributes to sustainability. Planning manager (all categories) from firm A has been added:

> Supply chain management is interrelated with any software. Even excel is also used for our SC activities. If a company doesn't excel it is a major disadvantage for the company. 80-90% of decision-making depends on the analysis. For example, how many customers have visited the shop, so this is the data we need to make decisions about the articles that should be in the shop. So, it is important to have BDA in the company.

Successful organizations have achieved improvement in the decision-making process by aligning strategies according to modern trends, as highlighted by (Kamble *et al.*, 2019). The organizations' ability to support data-driven innovation is made possible by the vast amount of data and computational power available (Babu *et al.*, 2021).

Senior Category Head (women category) from firm A has been added:

> "Systems operate based on data, but if you talk about the manufacturing sector of our organizations the implementations of data collection and software are very low. There are no such standards of IT in manufacturing sectors, yes, we have control over them but not organized data practices implementation". He also added a few points about tier 1 development, "I will recommend you work on 1st tier by investing capital. To train them and give them clarity that we will have this much profit from such practices".

There has been a gap of understanding in organizations related to establishing a company's structure that will support the creation of BDA capability, which will ultimately help the company to achieve a competitive advantage (Jha *et al.*, 2020).

Forecasting is a major factor in the footwear industry, a yearly plan has been prepared one year prior. The framework will help organizations forecast priorly with accuracy. The implementation of the framework will ultimately bring sustainability with the help of BDA. As a result, company will be able to manage the lead time, as Manager Planning and Distribution from firm B has contributed by adding:

> The major problem in our SC is lead time. Due to certain changes, we have to change our plan accordingly. We can only change the plan and make quick decisions if we have accurate data. And we can manage the inventory and cost accordingly. Managing the lead time is the major point. Some points are unable to be monitored. The company needs to check all the points related to logistics and transportation and should work on the minimization of lead time.

This research specifically focused on the fashion industry and further categorized and chose the footwear industry from the perspective of implementation of BDA for SSCM. Interviews were conducted with the organized sector, and the result shows a relatable perspective as they have implemented ERP, and somehow, they are focused on sustainability as well. In conclusion, the research has denoted that despite a lack of understanding related to sustainability agendas and not having proper ERP or BDA systems, the organizations operating in Pakistan still met some standards of sustainability and are moving toward achieving more. The analysis is presented in Table 4.

Manager Planning and Distribution from firm B added:

> I don't have much information related to BDA implications. But we are dealing with modules that are dealing with BDA. Our sustainability is related to cost, time management, and availability of

Table 4. Big data analytics sustainability benefits for organizations operating in Pakistan

Organization	Sustainability aspects			Details	Future initiatives
	Economical	Social	Environmental		
A			✓	Reduction in paperwork Non woolen bags Recyclable packaging Moving toward solar production	Install RFID tracking in the warehouse Move towards the OMNI channel
B	✓	✓	✓	Manufacturing of bags from wastage Factories are operating on solar system Removal of plastic bags Operating on OMNI channel Labor laws implemented Child labor is restricted Tax transparency Registered with FBR Contribution to NGOs Launch “good shoe” produced from wastage	Software that could support Pakistan’s physical supply chain to meet lead time Training for employees
C	–	–	–	–	–
D	–	–	–	–	–

Source: Authors’ own work

> the product. We have launched a product called "good shoe" it was manufactured by wastage. For social sustainability, we are contributing to NGOs. In economical we are working on it. As per our current economic condition, import is reduced so we are managing cost and production to deal with lead time.

The attributes of sustainability have gained immense importance in response to the growing consciousness of environmental issues, globalization, changing demographics and pressing economic issues, among other factors (Narwane *et al.*, 2021). When it comes to organizations, sustainability has mostly focused on the widely acknowledged notion of how the environment, society and economy – the three primary impacted areas – intersect (Lynch and Ferasso, 2023).

As assistant manager purchase (women category) from firm C has also added:

> It is very important these days to have an R&D department that could research the latest trends and practices followed globally. As we are facing climate change. We need to align our SC according to it but we are not doing it. For example, we are using solvent chemicals, which are dissolvable in water which results in water pollution. We are ignoring all basic pointers to maintain sustainability. We can take the example of Portugal, they used water-based chemicals to promote human health.

The significance of sustainability practices has been highlighted by Polese *et al.* (2019). The hazard of environmental pollution is increasing annually due to the current rate of production and consumption; thereby, efforts related to environmental sustainability are inevitable (De Ponte *et al.*, 2023).

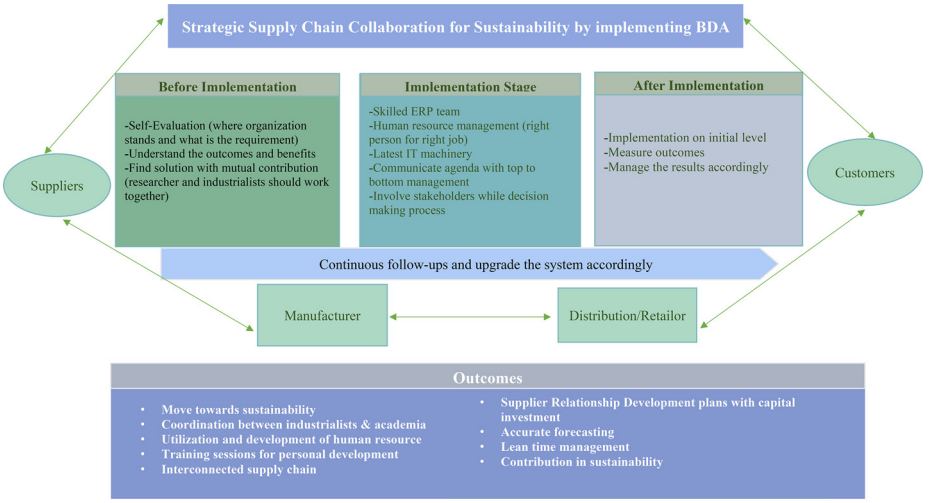
6. Conclusion

This research demonstrates an important gap in the literature through a thorough investigation of how firms can improve operational efficiency and productivity through the framework application and whether it is feasible to apply this within the global fashion industry or not (Benstead *et al.*, 2022).

The most prominent challenge in the implementation of 4.0 in the manufacturing industry is the environment, which includes legal restrictions. The other major challenge is the achievement of sustainable performance in the multitier manufacturing supply chain (Sharma *et al.*, 2021). The research pointed out the importance of the integration of all stakeholders in the supply chain. BDA helps stakeholders have live access to sales so they can forecast accordingly. Since its effectiveness depends on a desire to exchange the proper data, it requires work and commitment from all parties in the supply chain rather than being viewed as a quick solution for all sustainability problems (Benstead *et al.*, 2022). See Figure 5 for more details.

This research has shed light on the importance of stakeholders' engagement and contribution to the development of sustainable goals such as a green supply chain. The blockchain is IoT-interlinked and provides a framework to industries and researchers for industrial-based research and the implementation of research outcomes (Bond and Fischer, 2022).

Even though, the skill gap is a prominent issue for policy developers; it also indicates that a proper skill set is an important pre-requisite for technology circulation. It also indicates that a proper skillset is an important prerequisite for technology circulation. It is the basic demand or need of the industry for highly skilled analysts at the initial level. The team of policymakers and curriculum designers should consider integrating industrial requirements to create a suitable educational syllabus to reduce this gap (Oesterreich *et al.*, 2022).



Source: Authors' own work

Figure 5. Proposed framework for the implementation of BDA in the footwear industry

6.1 Theoretical contribution

The results demonstrate that the organized sector in the footwear industry of Pakistan is following the BDA (ERP, Oracle, Power BI) in their system; they are encouraged to follow the global trends, but there is a gap in understanding of need, what ultimate results they want and about the concept of sustainability. The case companies have interpreted that the implementation of BDA in the systems brings transparency between organized suppliers, retailers and customers. That shows BDA supports the sustainable supply chain. This research pointed out the importance of the integration of all stakeholders in the supply chain. As BDA helps the stakeholders to have live access to sales, they can forecast accordingly. Since its effectiveness depends on a desire to exchange the proper data, it requires work and commitment from all parties in the supply chain rather than being viewed as a quick solution for all sustainability problems (Benstead *et al.*, 2022).

6.2 Managerial implications

The research has focused on the quality of effective management with a holistic view of the supply chain. The results of the research have persuaded managers to implement both frameworks for the internal and external supply chain to gain quality in the procedure. It has also encouraged managers to contribute toward effective intra and interfirm collaboration for achieving higher-ranked quality performance (Soares *et al.*, 2017). Managers can also take action for the involvement of all stakeholders to make the whole supply chain green and sustainable. Start the process with the collaboration of employees and suppliers and then move toward the customer. To grab the attention of customers, many companies are establishing environmental-friendly practices and using them as a unique selling proposition. Managers can also use IoT-integrated frameworks to accomplish the involvement of stakeholders in the generation of a green supply chain. It will result in a spectacular change in the perspective of supply chain management. It will enhance response speed, validity in the decision-making process, extraction of data and data storage. It will also contribute to issues related to data

accessibility, transparency, confidence strengthening and engagement opportunities, refining the quality of communication and safe payment procedures (Rane *et al.*, 2021).

6.3 Research limitations and suggestions for future research

Although big data implication in the logistics sector and supply chain management is still in the prior stage. There is a possibility that the conclusions from the business data analytics research have a different understanding from the exact meaning and potential that BDA has. Similarly, the perspective of the IT department toward BDA differs from the decision-making management department of the organization (Lai *et al.*, 2018). Even though BDA is a source of technological development in both sectors, academic and business, many organizations are implementing big data in their systems. However, there is still a gap in the understanding related to the potential of such technologies in business value (Mikalef *et al.*, 2019). The most prominent challenge in the implementation of 4.0 in the manufacturing industry is the environment which includes, legal restrictions. The other major challenge is the achievement of sustainable performance in the multitier manufacturing supply chain (Sharma *et al.*, 2021).

In the past few decades, researchers have worked on the revolutionizing linear economy into a CE by implementing the process of recovering and remanufacturing products. [The details are mentioned in literature to support the framework (framework # 6 and Figures 2 and 5)]. CE promotes the utilization of resources through the consumption of waste as new or raw materials. The collaboration among stakeholders in the industrial system enables the decision-makers to refine information and also the prediction of failures (Eldrandaly *et al.*, 2022). In future research, a CE can be considered to achieve sustainability in developing countries. The users of ERP with experience were facing fewer issues as compared to those who did not have any experience with ERP users. It is also concluded that employees with high expectations experienced refined benefits as compared to those with fewer expectations. In conclusion, employees should be skilled to gain the general expectancy of ERP systems. Further studies should research the importance of other BDA-based capabilities that can contribute to the development of SC resilience (Mandal and Khan, 2019). Real-time BDA and cybersecurity are two of the most promising directions for future work (Cui *et al.*, 2020).

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Appendix 1. Interview guide

Research topic: The role of big data analytics in the footwear supply chains: a multiple case study perspective

The collected information will be kept confidential. The name of the interviewee, organization and current practices will not be published with original names but will be indicated with categorized codes.

Basic introduction about the experience of the interviewee and organization:

(1) Please share a brief introduction about your experience related to your current designation and your organization.

(2) Please share your experience in supply chain management and your role in the current position.

(3) Please elaborate on your experience in the footwear industry, how long have you been working in this industry?

(4) How much knowledge or information do you have regarding big data analytics and sustainability?

Barriers involved in the implication of BDA for sustainable supply chain management:

(5) Please describe the current IT setup (ERP and planning system) in the footwear industry.

(6) As per your view, is it important to have a separate R&D department in the organization that works on the latest trends that are followed globally?

(7) In your opinion, how would the use of big data analytics impact the sustainability of supply chain management?

(8) In your view, how widespread is the adoption of big data analytics in the upstream and downstream supply chains?

(9) What other technologies are required to facilitate the implementation of big data analytics (interoperability, how easy is it to integrate with other technologies out there?

(10) Do the organizations have a culture that they are willing to replace traditional

- operating systems with modern ones?

(11) Do you think that the existing system specifically involves the stakeholders in the whole supply chain while implementing revised strategies in the operating system?

(12) In your opinion, what would be the benchmark for the organization to attain sustainability?

(13) What security issues does your organization have related to data security or quality?

Discussion regarding framework development:

(14) Could you please share your opinion on the current situation of the implementation of big data analytics in the Pakistan footwear industry?

(15) What factors do we need to focus on while implementing BDA in the existing operating system of the organization?

(16) How can we overcome the challenge of research work implementation in the organization's current environment?

(17) What would be the basic solution in an organization while adapting the BDA model in the existing system?

Appendix 2

Table A1. Interviewee details

Sr #	Organization	Interviewee details	
		Designation	Category
1.	Firm A	Service Industries Ltd.	Senior category head	Ladies
2.			Senior Category Head	Kids
3.			Leading analyst/ replenishment executive	Analysis reporting
4.			Planning manager	All categories
5.	Firm B	Hush puppies	Director merchandising supply chain	All categories
6.			Senior business analyst	All categories
7.			Manager planning and distribution	All categories
8.	Firm C	Borjan	Assistant manager purchase	Gents category
9.			Deputy sourcing manager	Gents category
10.			Assistant manager purchase	Women category
11.	Firm D	Service sales corporation	Planning manager	All categories

Source: Authors' own work

Table A2. Interview details

Sr #	Organization	Designation	Category	Experience in Footwear Supply Chain	Total Experience	Length of interview (mins)
1.	Service Industries Ltd.	Senior Category Head	Ladies	10	15	51:15
2.	Service Industries Ltd.	Senior Category Head	Kids	12+	12+	19:03
3.	Service Industries Ltd.	Leading Analyst/ Replenishment Executive	Analysis reporting	2	6	37:04
4.	Service Industries Ltd.	Planning Manager	All categories	10+	10+	38:57
	Hush Puppies	Director, Heading Merchandising Supply Chain	All categories	14	16	69:00
5.	Hush Puppies	Senior Business Analyst	All categories	1	5+	61:00
6.	Hush Puppies	Manager Planning and Distribution	All categories	6	6	42:00
7.	Borjan	Assistant Manager Purchase	Gents category	9	9	77:00
8.	Borjan	Deputy Sourcing Manager	Gents category	10+	10+	36:26
9.	Borjan	Assistant Manager Purchase	Women category	10	25	52:48
10.	Service Sales Corporation	Planning Manager	All categories	10	10+	51

Source: Authors' own work

Table A3. Methods of addressing research validity and reliability

Organization	Research Strategy	Research Stage
External validity	Used the existing literature to guide this thesis Developed proposed theoretical framework Outcomes: A proposed framework for footwear industry of Pakistan	Research design
Reliability	Employed case study protocol Built a case study data base, cross checking research findings from literature Recorded interviews Cross reference discussion during all interviews	Research design
Construct validity	Triangulation of multiple participants. People from different designation were chosen The supervisor guided and contributed during data collection and analysis stage Researcher from same field validates the findings Verify: submitted the report to the person in charge for checking and approving	Data collection Data analysis
Internal validity	Matched the conceptual model with research conclusion Result: Relationship between variables identified and validated	Data analysis

Source: Authors' own work

About the authors

Freeha Maryam Arshad has earned her MS in Supply Chain Management from University of Management and Technology, Lahore, Pakistan. Her current research is in the field of supply chain management and logistics management, with a particular interest in big data analytics domain. Her other area of research interest includes procurement, supply chain strategy and supply chain innovation. She is currently working in Superior University Lahore, Pakistan.

Asher Ramish is an Assistant Professor in the Department of Operations and Supply Chain at University of Management and Technology, Lahore, Pakistan. He has more than 20 years of experience both in academia and industry. His research interests are extended towards the fields of supply chain management, logistics, supplier relationship management, strategies in supply chain management, supply chain performance measurement, production and operations management and project management. Asher has authored a number of research papers in his ardent area too. He has been an AD-HOC member of the reviewer board of nine impact factor Emerald journals and one impact factor Taylor and Francis journal. Asher previously has done his MS in Production Management from Technical University of Hamburg-Harburg, Germany, on a full scholarship sponsored by a world-renowned German company, Koerber AG. He has also completed his doctoral studies at Putra Business School, University of Putra Malaysia, in the domain of service supply chain management area. Asher Ramish is the corresponding author and can be contacted at: asherramish@yahoo.com