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Big Data in Supply Chain Management: A Systematic Literature Review

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ABSTRACT: Big data analytics (BDA) have the potential to improve upon and change conventional supply chain management (SCM) techniques. Using BDA, organisations need to build the necessary skills to use big data effectively. Since BDA is relatively new and has few practical applications in SCM and logistics, a systematic review is needed to emphasise the most significant advancements in current research. The objectives are to evaluate and categorise the literature that addresses the big data potential in SCM and the current practises of big data in SCM. The Systematic Literature Review (SLR) was conducted to analyse several published papers between 2017 and 2022. It follows four steps: the literature collection, descriptive analysis, category selection, and material evaluation in a systematic review. The finding reveals that BDA has been applied in many supply chain functions. Furthermore, integrating BDA in SCM has several advantages, including improved data analytics capabilities, logistical operation efficiency, supply chain and logistics sustainability, and agility. Finally, the study emphasises the importance of using BDA to support the success of SCM in businesses.

KEYWORDS: Big data analytics; supply chain management; systematic review; business

1. Introduction

Industrialization, globalization, and technological advancement have been increasing in today's society, influencing businesses including Micro Small, and Medium Enterprises (MSME), large corporations, manufacturing industries, and even people's daily lives. Therefore, it is no surprise that "Industry 4.0," or "Fourth Industrial," is widely used in literature and business. Due to growing interconnectedness and intelligent automation, Industry 4.0 is the term that refers to the technology, industry, and social patterns and processes that are changing quickly in the 21st century. Suggesting that the Fourth Industrial Revolution is about to begin, "Industry 4.0" is a concept that describes the fundamental change in the industry as a result of integrating modern technology. Industry 4.0 aims to make it possible for intelligent companies to generate customised goods using cleaner, more effective methods. One of the methods to generate greater effectiveness within companies is implementing better supply chain management integrated with the Industry 4.0 system. Industrial and service sector business operations rely heavily on their supply networks. The goals of supply network partners are significantly

impacted by supply chain management, which is a systematic method of regulating asset movements from sourcing raw materials to product production and delivery to end customers [1]. The operational operations that make up the firms' supply chains for businesses participating in the global market are characterised by an excessive volume of data and information interchange. Businesses must leverage and transform existing data into valuable information for decision-making and coordination in purchasing and supply chain management if they want to increase their competitiveness. Supply chain management attempts to increase the flow of products and materials by exchanging and evaluating data about the supply chain operations in internal and external business transactions [2]. Therefore, exchanging data and information is also one of the most critical aspects of manufacturing.

Companies are improving at organising and using technology to extract value from data, giving them an edge over competitors. However, analysts have significant challenges determining whether the collected data or information were valuable. The value derived from the data is determined by the organisation's capacity to gather, store, and analyse it using analytical tools and methods like big data analytics [3]. In order to enhance decision-making, data analytics, which comprises data inspection, cleaning, transformation, and modeling, can help detect trends and patterns in the data. As a result, the core of big data analytics is massive data and data analytics. Big Data analytics can improve the performance of the entire supply chain, mass customization, services, and digital marketing in situations where there is a lot of competition [4].

Integrating 4.0 into SCM and big data requires a continual data exchange among all the subsystems. A central computer oversees the responsibilities and operations of all the various units, from the supply chain to distribution, and runs the business [5]. Industry 4.0-related, growing information and communication technologies are essential for improving supply chain efficiency. So-called smart supply chains have resulted from the use of smart technology. The academic and practical communities must fully grasp how Industry 4.0 and related technologies affect smart supply networks and how such chains advance with cutting-edge technology [1]. The interconnectedness between technology and supply chains via smart objects equipped with intelligent systems, RFID, automated activities, integrated SC activities, and innovation is a characteristic of supply chain 4.0. In addition, supply chain 4.0 offers decentralisation, modularity, interoperability, virtualization, and service orientation [6]. The capacity of the organisation to utilise both internal and external data in its business operations is referred to as its "data analytics capabilities." Digital procurement capabilities are a company's ability to set up and use different e-procurement processes to improve how well its supply chain works [7].

This study investigates the use of big data analytics to improve supply chain performance in general and in each supply chain dimension as well. Several previous studies have discussed the application of big data analytics to SCM. For example, [8] discusses analytical methods and tools in big data analytics. The previous studies conducted a literature review on the relationship of big data analytics to firm performance [9,10]. More specifically, [11] discusses the implementation of BDA in various areas of operations management. This research is a continuation of the research conducted by [12], using the latest research references. This study also shows how BDA is used in different parts of the supply chain and what benefits each area gets from it.

Developing smart and resilient supply networks is a crucial but difficult challenge for manufacturers and stakeholders. Smart supply chains may be created thanks to new

technologies like big data analysis, the internet of things, blockchain, etc. Industry 4.0 offers a fresh framework for intelligent production and puts suppliers closer to the consumer. A cyber-physical system may be provided by Industry 4.0 to incorporate client requests into the various manufacturing phases. One characteristic of Industry 4.0 is horizontal integration throughout the whole value-generating network [13]. Supply chains frequently intersect with the overall value creation network.As a result, supply chain management significantly influences how well smart manufacturing performs under Industry 4.0. Supply networks must adapt to Industry 4.0 [1].

2. Materials and Methods

2.1. Material collection.

To capture the synthesis of the body of literature already written on the subject of our research, it is crucial to choose a convincing collection of keywords before looking for articles. As a result, we divided the terms into two categories:

- Category 1: BDA terms include big data, data mining, data analytics, machine learning, predictive analytics, descriptive analytics, and prescriptive analytics.
- Category 2**:** Some SCM terms are supply chain, procurement, purchasing, inventory, manufacturing, order picking, storage assignment, logistics, and transportation.

On renowned academic databases including ScienceDirect, Emerald, and Springer, a search based on all conceivable pairings between those two categories of terms throughout the time frame from 2017 to 2022 was undertaken.

2.2. Descriptive analysis.

In general, descriptive analysis offers characteristics of the literature being analyzed. Figure 1 indicates the number of papers published each year from 2017 until 2022.

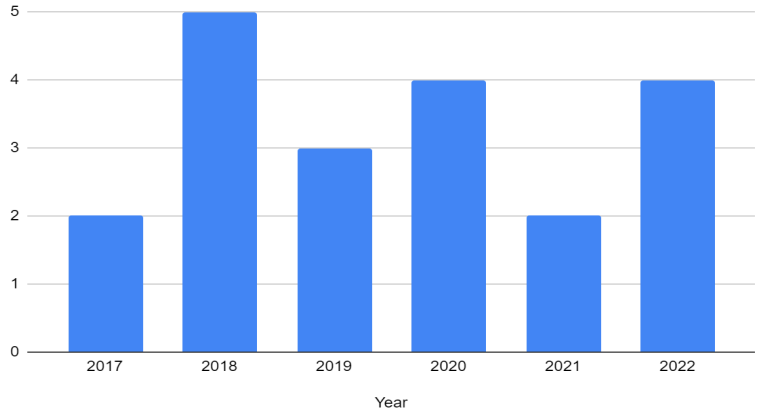

Figure 1. Distribution of Papers by the Year 2017 – 2022.

2.3. Category selection.

To conceptualise a classification framework consisting of structural dimensions and analytical categories is the objective of the category selection stage. Select four structural dimensions for hierarchizing the classification framework's SCM function in order to solve the provided

research questions. Several additional categories, such as "general SCM," ensure a complete classification of each item reviewed. Table 1 shows the classification of the literature review.

Table 1. Literature review classification.

Structure Dimension		Analytics Categories
SC Function	Procurement	Supplier selection, sourcing cost improvement, sourcing risk management
	Manufacturing	Product research and development (R&D), production planning and control, quality management, maintenance and diagnosis
	Logistics/Transportation	The intelligent transportation system, logistics planning and in-transit inventory management
	Warehousing	Storage assignment, order picking, inventory control
	Demand Management	Demand forecasting, demand sensing, demand shaping

2.4. Material evaluation.

The goal of material evaluation is to analyse the papers based on the classification as explained in the category selection step, after which the results are interpreted. Figure 2 shows the percentage of the number of papers based on the supply chain area.

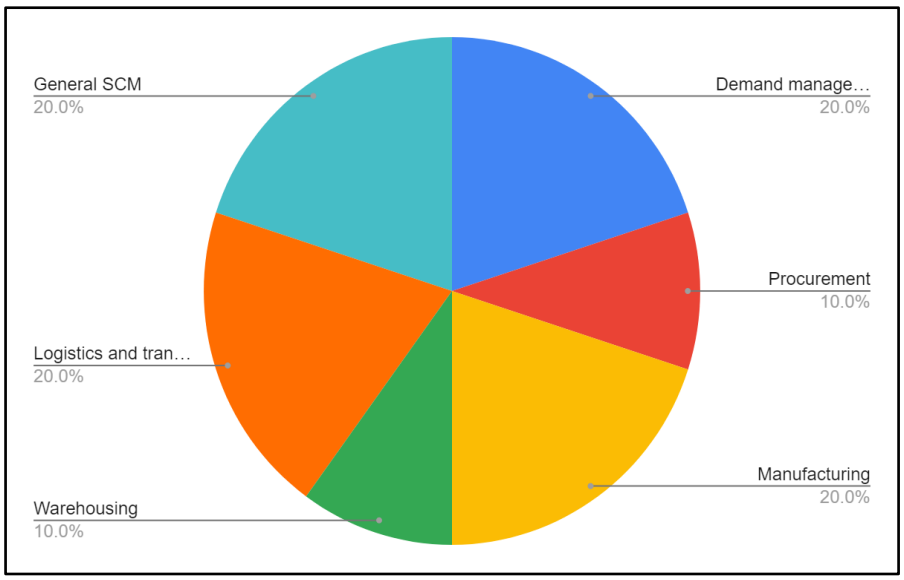

Figure 2. Distribution of supply chain area.

From the table and figure above, we can conclude that the most significant percentage of papers distributed is on general SCM, demand management, logistics and transportation, and manufacturing, which is 20%, and the lowest is on procurement and warehousing, which is 10%.

3. Results and Discussion

3.1. Big Data Analytics (BDA) review.

BDA has become one of the most interesting topics for researchers, practitioners, and business people to study in recent years. Big data and cutting-edge analytical tools are recognised in the market as being important for enhancing commercial, financial, and sustainability performance. Additionally, to reduce costs, boost productivity, and consolidate the impact of big data, Insufficient and indirect studies have been done on the relationship between consumer

purchasing patterns and the Internet as a source of information. Despite the fact that these studies showed that the internet has a significant impact on how consumers make purchases, they did not forecast consumer purchases based on actual consumer internet search activity. To predict disease-related activity indices, several research studies have used data from internet search queries. According to the findings of several academics, macroeconomic indices may be predicted using internet search terms. The interaction between general consumer behaviour and internet search terms has been studied.Despite the fact that such a study suggests that it may be used to foresee customers' collective behavior, no studies have used internet search query data to assess and predict how new product models spread in diverse marketplaces. Therefore, in this study, we investigate the connection between consumer online search behaviour and the spread of new products as well as whether it is possible to predict new product diffusion in various markets using internet search queries [14].

In order to examine the effectiveness of manufacturers' actions regarding the manufacturing and repackaging of a fixed and discriminatory collection charge system, Xu studied the impact of big data. It was discovered that the manufacturer favours different collection payment methods depending on how highly customers value the products they use and how much big data gathering costs [3]. Additionally, Addo Tenkorang observed that BDA may provide "value"—a fifth dimension—based on their applications across various market categories. BDA's four traditional dimensions are diversity, velocity, volume, and truthfulness [15].

3.2. Supply chain management review

Supply chain management (SCM) is concerned with transporting products, services, and information from origin points to consumers through an integrated network of organisations and activities. Capacity, demand, and cost are taken into account as known factors in typical SCM challenges. However, there are uncertainties in practise as a result of variations in customer demand, supplier transportation, organisational risks, and lead times. The main factor affecting SC performance is demand uncertainty, which has wide-ranging effects on scheduling production, managing inventories, and transportation. In this way, predicting demand is a key way to deal with uncertainty in the supply chain [16].

Simulations of events in the supply chain are connected to intelligence. With the aid of technology, it is possible to develop future-based scenarios in advance, resulting in more efficient and effective supply chain control and the capacity to analyse and remove risks in advance. Okada stated that he supports the simulation and supply chain modelling approach because it allows him to outline possible future scenarios and their impact on procurement and supply chain digitization [17].

3.3. BDA and SCM Recent Research Review

The section below discusses the findings of the selected articles identified in Emerald, Springer, and ScienceDirect. Table 2 summarises the findings and includes the author's name, the area of the supply chain where big data is used, and the research objectives.

Table 2. Literature review research objectives recap.

No	BDA & SC Area	Research Objectives	Reference
1	Demand management	To research supply chain demand forecasting applications of predictive BDA	[16]
2	Demand management	to create a big data harvest model that uses big data as inputs to help the food supply chain's producers make better decisions	[18]
3	Demand management	To look at how demand planning for automotive aftermarket services may employ product-in-use data to enhance performance	[19]
4	Demand management	To study if big data may be utilised to anticipate new product diffusion by analysing the association between new product diffusion and consumer internet search habits.	[15]
5	Procurement	To determine the influence of digitisation on procurement and its role in supply chain management	[17]
6	Procurement	To study the role of data analytics in the digitalisation of procurement	[8]
7	Manufacturing	To put out a comprehensive framework for big data analytics to improve the performance of the additive manufacturing (AM) process in terms of production	[20]
8	Manufacturing	To provide a theoretical, analytical foundation for big data-driven technologies that may be used to assist decision-making in intelligent manufacturing.	[21]
9	Manufacturing	To identify challenges and barriers related to Big Data Analytics implementation.	[3]
10	Manufacturing	to provide the architecture and system components for a big data analytics platform that used to set up smart factories in small and medium-sized organizations	[22]
11	Warehousing	To present a simulation-based approach for optimising automated refreshment systems in a retail setting utilising big data	[23]
12	Warehousing	To construct medical supply inventory models using deep learning and big data technology.	[24]
13	Logistics and transportation	To analyse the application of Big Data and Data Mining technologies in logistics	[25]
14	Logistics and transportation	To develop a novel conceptual model based on the assessment of the e-commerce distribution operation	[26]
15	Logistics and transportation	To research the cloud-based big data analytics-based intelligent cold chain logistics distribution optimization technique	[27]
16	Logistics and transportation	To investigate how big data analytics (BDA) and the internet of things (IoT) may help a multinational logistics organization advance its strategy	[28]
17	General supply chain management	To investigate how big data may be used to anticipate technical advancement, supply chain performance, and the performance of SMEs	[29]
18	General supply chain management	To study the significance of big data analytics in the retail supply chain	[30]
19	General supply chain management	To determine the effects of management capabilities for big data analytics on the elements of supply chain resilience	[15]
20	General supply chain management	To investigate how "big data analytics" functions as a mediator between Supply Chain 4.0 corporate performance and nine performance parameters	[6]

Big data analytics is extensively employed in demand management to offer accurate forecasting, particularly demand forecasting, and lower the bullwhip effect [16]. A study [14] uses big data to show the connection between consumer internet search behaviour and the dissemination of new products and to determine whether such data may be utilised to anticipate the diffusion of new products. Product diffusion is the process through which a certain service or product gets accepted by the target market and becomes a part of the overall market share. Forecasting is critical, especially for new products, because market data is not fixed.The data

used in the study includes internet search query data, which is successfully used for forecasting the demand for new products. Besides new product development, big data can also be used in aftermarket demand planning, as examined by a previous study [19]. The authors provide a case study where the process behind demand planning for spare parts uses product-in-use data, including fault codes, install bases, sensor data, item usage, and operational-related data. In the food supply chain, big data can be used to inform production decisions and forecast market demand [18]. As market demand must be predicted in forecasting, demand management frequently employs predictive analytics.

The digitization of procurement in the supply chain may provide various benefits, including helping everyday business and administrative chores and aiding complicated decision-making processes by mediating the positive relationship between supply chain performance and external data analytics capabilities [7,17]. This way, the supply chain organisations are digitally connected via a cloud-based IoT architecture, which enables real-time communication and the application of artificial intelligence to analyse supply chain performance. As indicated by [17], Big data is one of the core elements in procurement to automate operational processes and make room for more human-driven strategic initiatives because external data analytics skills, such as big data use, strengthen the firm's digital procurement competence.

Concerning manufacturing operations, big data can be applied to different types of manufacturing, such as intelligent manufacturing [21] and additive manufacturing [3]. One study [21] develops an intelligent manufacturing paradigm that focuses on real-time dynamic perception and accurate decision-making in a manufacturing setting using big data-driven analysis. In this way, ancient industrial methods are given new vitality, laying the groundwork for future sustainable production. Another study by [3] proposes a framework for big data-driven manufacturing process optimization for additive manufacturing, which provides a suitable foundation for implementing BDA in the AM process as a large quantity of big real-time data is created. In modern manufacturing, big data can also be used in small and medium manufacturing enterprises, which presents a big data analytics platform for implementing smart factories [22]. The study [3] also discusses the barriers to big data analytics implementation and presents the four most significant obstacles, including a lack of top-level management support, financial assistance, expertise, and processes.

Big data analytics, according to Hopkins and Hawking [28], is used to improve truck routing, identify the best times and locations for fuel purchases, and estimate predictive and proactive maintenance schedules.In the case of cold chain logistics, a previous study [27] discusses that cold chain logistics firms can complete the same calculation and processing procedure using the big data cloud computing service model for a cheap service fee, lowering costs and improving processing efficiency. As studied by Hurtado et al., big data can also be applied in e-commerce distribution to allow for predictive product distribution planning [26]. Mitroshin et al. [25] make a prediction model for road transport logistics by putting together statistics about traffic at a certain time, weather, and traffic accidents.

In terms of warehousing and inventory management, big data can be used to construct a simulation-based model for optimising automatic refreshment systems in a retail setting. The results show that the inventory level was successfully decreased while maintaining the service level [23]. Big data is also useful in the medical field, especially when it comes to keeping track of medical supplies during emergencies, as discussed in Liu et al. [24]. The study uses

deep learning and big data technologies to optimise the medical supply inventory control structure and improve management efficiency. Thus, the optimised management structure may play an outstanding role in emergency material supply.

Furthermore, the association between big data and firm performance was investigated by Saleem et al. [29], who investigated big data in small and medium-sized enterprises. The study concludes that successful use of big data necessitates a high degree of information exchange across all stakeholders for long-term business operations and improved performance. Another study [9] also found that big data analytics management capabilities are essential to supply chain resilience. In another study [1], an integrated SEM-ANN analysis is developed based on the data collected from 40 manufacturing firms. The findings show that big data has a positive impact on supply chain 4.0 performance and identify eight characteristics that promote big data adoption [6]. According to other research, for big data practises to improve the supply chain's overall performance, qualitative and quantitative factors with various scales must be combined in the same technique. The interactive multi-criteria decision-making approach may eliminate uncertainty and ambiguity in the judgments made by businesses and produce more accurate data and more effective decision-making [29].

4. Conclusions

The study found that big data analytics can improve upon and change conventional supply chain management techniques. The results indicate that BDA could be advantageous if businesses can build the necessary skills to use big data successfully. The use of BDA in SCM can have several advantages, such as improvements in data analytics capabilities, operational efficiency of logistical operations, and supply chain and logistics sustainability and agility. Big data analytics is widely used in demand management to provide accurate forecasting, particularly demand forecasting, and to mitigate the bullwhip effect. Big data can be utilised to create a simulation-based model for autonomous refreshment systems optimised for warehousing and inventory management in a retail context. The results indicate that the inventory level was successfully decreased while maintaining the service level. Big data can be used in various manufacturing processes, including additive manufacturing and intelligent manufacturing. Big data analytics forecasts predictive and proactive maintenance schedules, determines the best times and places to buy fuel, and improves truck routing. By mediating the beneficial relationship between supply chain performance and external data analytics capabilities, the companies may facilitate complex decision-making processes and assist with routine business and administrative tasks.

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