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THE ROLE OF BIG DATA IN SUPPLY CHAIN RISK MANAGEMENT: EVIDENCE FROM THE LITERATURE

Annotation. This study examines the role of Big Data in supply chain risk management by reviewing recent academic and industry literature. Rapid developments in digital technologies and artificial intelligence are reshaping business operations, requiring firms to adopt more adaptive and data-driven approaches. The review highlights that modern supply chains generate vast amounts of structured, semi-structured, and unstructured data, which—when properly analyzed—enhance decision-making, operational efficiency, and competitive advantage. Historical and contemporary evidence demonstrates that Big Data has long been used to predict risks and optimize resource allocation, evolving today into a strategic tool for mitigating disruptions, forecasting demand, and strengthening supply chain resilience. The COVID-19 pandemic significantly accelerated global data generation and digitalization, further increasing the relevance of Big Data analytics for managing supply-chain uncertainties. Overall, the literature underscores that Big Data integration is now a critical component of effective supply chain risk management in an increasingly volatile and data-intensive business environment.

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Keywords: Big Data; supply chain risk management; digital transformation; artificial intelligence; structured and unstructured data; data analytics; operational efficiency; COVID-19 impact; supply chain resilience; decision-making systems.

INTRODUCTION.

The rapid advancement of digital technologies, artificial intelligence, and data analytics has transformed global business operations, reshaping how organizations design, monitor, and optimize their supply chains. In an era characterized by heightened uncertainty, rising customer expectations, and complex global networks, firms are increasingly compelled to adopt flexible, data-driven strategies to sustain competitiveness. Among these technologies, Big Data has emerged as a critical enabler of intelligent supply chain management, allowing companies to convert massive volumes of structured, semi-structured, and unstructured data into actionable insights. As noted by Runtuk et al. (2022), modern organizations depend heavily on their supply networks; therefore, the ability to leverage data effectively has become essential for enhancing decision-making, improving visibility, and mitigating operational risks.

The historical roots of Big Data stretch far beyond its contemporary commercial applications. Although the term gained prominence in the late twentieth century and is often associated with John Mashey (1997), evidence shows that large-scale data collection and analysis were used even in ancient civilizations such as Egypt and the Roman Empire to anticipate risks and allocate resources more strategically (Big Data Framework, 2023). Today, Big Data encompasses the

integration of structured, semi-structured, and unstructured datasets that organizations utilize to strengthen forecasting accuracy, optimize logistics, enhance customer engagement, and support strategic planning (Botelho & Bigelow, n.d.).

LITERATURE REVIEW

Technological advancements and artificial intelligence are changing our life unimaginable and influencing businesses more than ours. However, fast changes in technology require to be more flexibility and adaptation. On the other hand, these technologies enable intelligent companies to generate customized goods using more effective methods. One of the methods to create effectiveness within companies is implementing supply chain management integrated with these new technologies. Business operations rely heavily on their supply networks; thus, they must leverage and transform their data into valuable information for decision-making and supply chain management to increase competitiveness (Runtuk et.al, 2022). Therefore, this literature review aims to study the function of Big data in supply chain risk management.

Big data is a well-established knowledge in academia and industry, and this phrase has been used for over thirty years. Although the original author is unknown, most people link this with John Mahsey, a Silicon Graphics employee (Mashey, 1997); however, the history of the Dig data roots more early years of human civilization. It has been used to gain a competitive military advantage from the early beginnings of our society, such as in ancient Egypt and the Roman Empire. For

example, the Roman army used statistics to predict the likelihood of an enemy insurgence and deploy their troops most efficiently, providing them an advantage over the enemy army (Big Data Framework, 2023).

Modern understanding of Big data combines three types of data organizations collect: 1. Structured data – formed in a certain way, making it easy to search and use. 2. Semi-structured – with some structure but not rigidly defined as structured data. 3. Unstructured with no structure and format, making it difficult to mine and analyze. Companies use Big data to improve operations, provide better customer service, initiate focused marketing campaigns, and others that enable profitability (Botelho & Bigelow, Nd).

METHODOLOGY

This study employs a structured literature review methodology to investigate the role of Big Data in supply chain risk management. The approach integrates systematic identification, selection, and analysis of scholarly and industry sources published over the past two decades, reflecting the rapid technological evolution in supply chain systems. Academic databases such as Scopus, Web of Science, ScienceDirect, IEEE Xplore, and Google Scholar were used to retrieve relevant peer-reviewed articles, while industry reports were collected from organizations including McKinsey, Deloitte, Gartner, and the Big Data Framework. Keywords such as *Big Data*, *supply chain risk*, *data analytics*, *digitalization*, and *AI-driven SCM* were applied to ensure comprehensive coverage.

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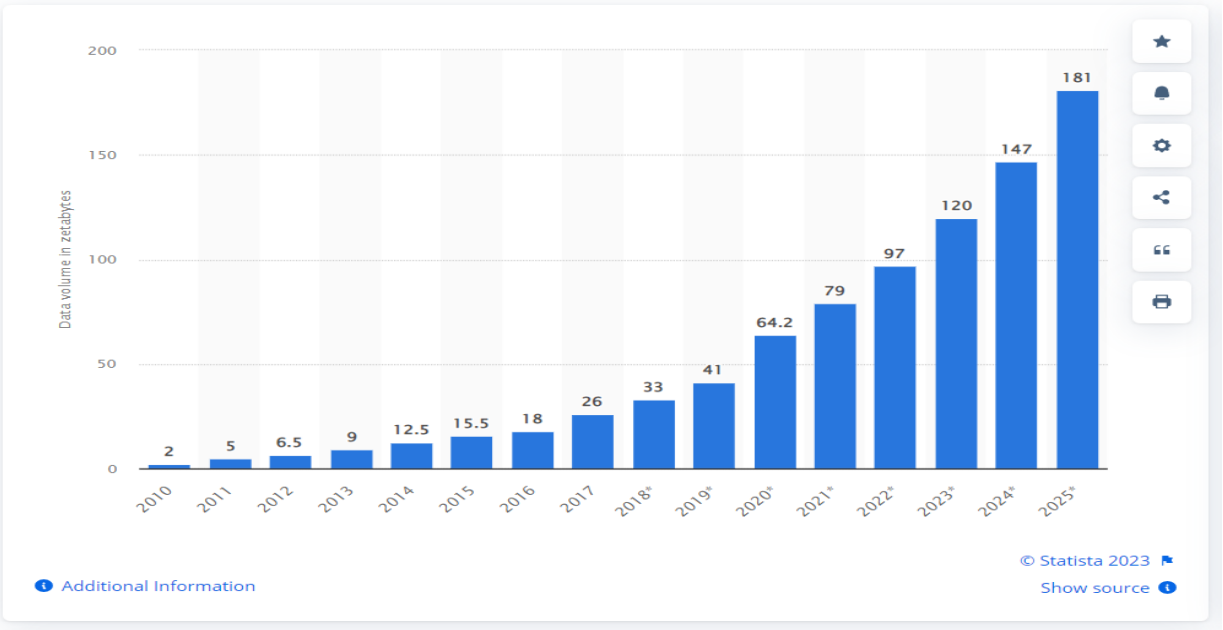
ANALYSIS

The COVID-19 pandemic has sped up the growth of data creation and usage due to remote working and home quarantines. As a result, the sum amount of data created and consumed is predicted to increase by 64.2 zettabytes (1 zettabyte = 1 000 exabytes = 1 billion terabytes) in 2020. Moreover, up to 2025, more than 180 zettabytes of raw data are anticipated to be created worldwide. Due to COVID-19, data creation hit a record in 2020, and the rise was more significant than expected (Taylor, 2022). According to McKinsey Global Survey, this phenomenon led companies to accelerate the digitalization of their customer and supply-chain interactions (LaBerge et.al, Nd).



**Indicators between 2021-2025 are forecast.*

Figure 1. The volume of data created worldwide (in zettabytes).

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Big data in Supply chain management. Big data analysis is essential for supply chain management, addressing strategic and operational issues. It helps to reduce communications gaps, boost delivery times, increase operational efficiency, monitor performance, and improve service levels. Combining three characteristics of Big data, "volume," "velocity," and "variety," supply chain analysis helps supplier networks collaborate in real-time (Dutta, 2021). In addition, Big data analysis can provide the correct answer and simplify the process (Crayon, 2021), affecting every supply chain stage, moving from one to another.

Methodology. The five-step systematic review method from Khan et al. (2003) was used for this literature review. The procedure is as follows:

Step 1: Framing questions for a review.

Step 2: Identifying relevant work.

Step 3: Assessing the quality of studies

Step 4: Summarize the evidence.

Step 5: Interpreting the findings.

Developing review question. Managers can use Big data to identify risk in the supply chain by enabling real-time risk assessments, providing insights into potential risks. Risk sensing (Brunekreef & Pournader, 2018), developing Big data analytics capabilities (Singh & Singh, 2019), sustainability using big data analytics, and identifying and mitigating supply chain risks are all ways that Big data can be used to identify and mitigate supply chain risks (Manganello, 2019). Thus, this literature

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review aims to answer the open-ended question, "How can big data be used to mitigate risks in the supply chain?"

Identifying relevant work. The articles in this review were chosen using "Elicit," the abovementioned question was used as a "prompt" for the scientific paper search. The literature search was also restricted to publications from 2010 to 2022 to increase relevance with the high volume of data creation globally. The articles were selected based on "Supply chain risk management" keywords followed by "Big data." Figure 2 illustrates the prompt and criteria for selecting relevant articles from the databases.

Figure 2.

Summary of Search Results.

Prompt and criteria	How can big data be used to mitigate risks in the supply chain?	Limit to articles (and exclude review articles)	Selected papers*
All Papers	**28**	**5**	**22**
2022	2		2
2020	3		3
2019	2		2
2018	4	1	3
2017	4		4
2016	3		3
2015	5	3	2
2014	2		2
2013	2	1	1

Selection of the studies. Articles were selected based on the review question from the search results based on keywords. The chosen pieces must have their central theme based on the role of Big data in supply chain management. In addition, articles

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must discuss identifying supply chain risks using Big data. Based on this principle, 22 articles were selected using Elicit.

Figure 3.

List of selected papers.

#	Authors	Publication Year	Journal
1	Park & Singh	2022	Benchmarking: An International Journal
2	Santos & Marques	2022	Business Process Management Journal
3	Dai & Liu	2020	Sustainable Computing: Informatics and Systems
4	Hung et al.	2020	Industrial Marketing Management
5	Sun & Shen	2020	E3S Web of Conferences
6	K. Gupta	2019	Journal of Mechanics of Continua and mathematical sciences
7	Li & Liu	2019	Procedia CIRP
8	Salamai et al.	2018	SPACCS
9	Liu et al.	2018	E3S Web of Conferences
10	Muhammed & Kulakli	2018	Journal of Business Research - Turk
11	Mani et al.	2017	Sustainability
12	Wu et al.	2017	Journal of Cleaner Production
13	Y. Tsao	2017	Transportation Research Part E: Logistics and Transportation Review
14	Niu & Zou	2017	Special Issue: Advances in Risk Analysis with Big Data
15	N. Sanders	2016	California Management Review
16	Biswas & Sen	2017	IUP Journal of Supply Chain Management
17	Benabdellah et al.	2016	International Conference on Computer Systems and Applications
18	Fan et al.	2015	Conference: HCII 2015
19	H. Ittmann	2015	Journal of Transport and Supply Chain Management
20	G. Schlegel	2014	The Journal of Business Forecasting
21	Leveling et al.	2014	International Conference on IEEE
22	Zage et al.	2013	International Conference on IEEE

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Based on the papers, we have analyzed the research methodology used in the papers, and we have developed two groups: in group 1, the authors used case study methodology, and in group 2, the authors used mathematical modeling methodology. Furthermore, regarding the data collection, two groups were divided between primary and secondary data collection methods. Finally, regarding the role of big data, we clustered findings into groups according to their characteristics.

Figure 4.

Data analysis methods used in selected papers.

#	Groups	Data analysis method	Number of papers
1	Group 1	Case study	2
2	Group 2	Mathematical modeling	20
	Total papers		**22**

Figure 5.

Data collection methods used in selected papers.

#	Groups	Data collection method	Data analysis method	Number of papers
1	Group 1	Primary data (Survey)	Case study	1
			Mathematical modeling	1
2	Group 2	Secondary data	Mathematical modeling	20
		Total papers		**22**

According to the clustering of the papers on their data collection and analysis methods, we have identified that only two studies out of twenty-three employed primary data collection methods to examine the function of Big data in supply chain management. Moreover, almost all authors (22 papers) used mathematical modeling

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methods to study the research objectives, while only one study used a case study method for the analysis.

Figure 6.

Challenges in the organization related to the supply chain management

Group	Challenges in the organization	Number of papers	Authors
1	To provide adequate supply chain risk management	14	Park & Singh (2022), Santos & Marques (2022), Dai & Liu (2020), Salamai et al. (2018), Liu et al. (2018), Muhammed & Kulakli (2018), Mani et al. (2017), Wu et al. (2017), Y.Tsao (2017), Biswas & Sen (2016), Fan et al. (2015), G. Schlegel (2014), Leveling et al. (2014), Zage et al. (2016)
2	To reduce supply chain costs	4	Hung et al. (2020), Sun & Shen (2020), Niu & Zou (2017), Benabdellah et al. (2016)
3	To enhance supply chain networks	2	K. Gupta (2019), Li & Liu (2019)
4	To create a competitive advantage	2	N. Sanders (2016), H. Ittmann (2015)
	Total papers	**22**	

According to the literature, we have identified challenges in the organization related to supply chain management and grouped them into four groups according to their characteristics. First, most authors found that providing adequate supply chain risk management is a more critical challenge in the organization. At the same time, four authors believe reducing supply chain costs is essential in supply chain management. In contrast, other authors believe that enhancing supply chain networks

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and creating competitive advantage are crucial tasks in front of supply chain managers.

Figure 7.

Challenges in the organization related to supply chain management and possible solutions using Big data.

	Challenges	Solutions	Authors
1	**To provide adequate supply chain risk management**	The effectiveness of risk alert tools depends on building adequate supply chain IT infrastructure and Big data analysis capabilities.	Park & Singh (2022)
		Multi-tiered and Multi-directional Big data analysis must be implemented to support supply chain risk management.	Santos & Marques (2022)
		Qualitative and quantitative Big data analysis must be combined to assess supply chain risks.	Dai & Liu (2020)
		Rule mining techniques can categorize internal and external risks in the supply chain.	Salamai et al. (2018)
		A risk warning system based on Big data can improve food safety in the chain	Liu et al. (2018)
		Implementing Big data analysis can mitigate systematic risks related to supply chain complexity.	Muhammed & Kulakli (2018)
1	**To provide adequate supply chain risk management**	Implementation of Big data analysis can predict and mitigate social risks in the supply chain.	Mani et al. (2017)
		Big data analysis can be implemented to identify reliable characteristics of uncertainties and risks in the supply chain.	Wu et al. (2017)
		Using Big data analysis can contribute to reducing default risk in supplier-retailer channels.	Y.Tsao (2017)
		Big data can extract useful information to support decision-making and can be leveraged to redefine supply chain management	Biswas & Sen (2016)

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		Big data analysis improves supply chain risk management by analyzing internal and environmental data.	Fan et al. (2015)
		Big data improve manage supply chain risk providing insights into demand and supply uncertainties	G. Schlegel (2014)
		Big data technologies are crucial in addressing increasing complexity issues and optimizing supply chain visibility.	Leveling et al. (2014)
		Big data-based machine learning algorithms can reveal deceptive activities and recognize possible supply chain issues.	Zage et al. (2016)
2	**To reduce supply chain costs**	Big data analysis of credit reports and e-wire transactions can improve the financial efficiency of the supply chain.	Hung et al. (2020)
		Big data technologies allow large-scale analysis and can improve supply chain finance efficiency.	Sun & Shen (2020)
		Big data can increase profit for original manufacturers and third-party remanufacturers sharing information between supply chain participants.	Niu & Zou (2017)
		Big data can reduce supply chain costs and increase customer satisfaction	Benabdellah et al. (2016)
3	**To enhance supply chain networks**	Big data and the IoT can be used to strengthen supply chain networks.	K. Gupta (2019)
		Data-driven decisions based on Big data analysis are critical in supporting supply chain networks.	Li & Liu (2019)
4	**To create a competitive advantage**	Companies can use Big data to optimize inventories, risk assessment, and target location-based marketing, consequently creating a competitive advantage.	N. Sanders (2016)
		Big data analysis can extract value from data to enhance business competitiveness	H. Ittmann (2015)
	Total papers	**22**	

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DISCUSSION.

Based on the provided search results, many studies have employed quantitative analyses using historical data to examine organizational challenges related to supply chain management and possible solutions using Big data. Managers can implement big data analytics to optimize inventory levels, increase forecasting accuracy, shorten lead times, boost supplier performance, and increase delivery efficiency. Because it is affordable and can reduce the time and effort required for data collection, secondary data is a crucial resource for academics. Supply chain managers can use big data analytics to optimize inventory levels, increase forecasting accuracy, shorten lead times, boost supplier performance, and increase delivery efficiency. Because it is affordable and can reduce the time and effort required for data collection, secondary data is a crucial resource for academics.

From a methodological standpoint, it is obvious that secondary data is more significant in these investigations. Researchers can focus on analysis and reporting since secondary data analysis is time- and cost-effective (Alchemer, 2021). Additionally, secondary data analysis can provide a broader perspective on a research question, allowing researchers to analyze data from multiple sources across different periods.

According to the literature, we have identified supply chain challenges and clustered them into four groups based on their characteristics. The first group is providing adequate supply chain risk management. Authors of analyzed papers believe that following the implementation of Big data can improve managing the

abovementioned challenge. Multi-tiered and Multi-directional, qualitative, and quantitative Big data analysis must be combined to assess supply chain risks (Santos & Marques, 2022; Dai & Liu, 2020). Based on the findings of Salamai et al. (2018), to categorize internal and external risks, Rule mining techniques can be helpful. As we know, risk warning systems are crucial in the supply chain, especially regarding food safety. A risk warning system supported by Big data can improve food safety in the supply chain (Liu et al., 2018). Simultaneously, Big data analysis implementation can predict and mitigate social and systematic risks related to supply chain complexity (Muhammed & Kulakli, 2018; Mani et al., 2017).

Moreover, other authors found that Big data analysis can identify reliable attributes of supply chain risks and uncertainties and reduce default risk in supplier-retailer channels (Wu et al., 2017; Y. Tsao, 2017). Big data can extract useful information to support decision-making and can be leveraged to redefine supply chain management and improve risk management by examining internal and environmental data (Biswas & Sen, 2016; Fan et al., 2015). Although, Big data analysis is essential to manage supply chain risk providing insights into supply chain dynamics, demand, and supply uncertainties, and can optimize supply chain visibility (G. Schlegel, 2014; Leveling et al., 2014). Finally, Big data-based machine learning algorithms can reveal deceptive activities and recognize possible supply chain risks (Zage et al., 2016).

However, there are two challenges to using Big data effectively in supply chain management. First, establishing good IT infrastructure to collect, explore and evaluate the Big data. The second challenge is a lack of data analysis capabilities (Park &

Singh, 2022). Technical skills are not enough to extract valuable information from the collected data.

The second group is papers outlining that reducing costs is essential in the supply chain. Other four studies suggested that Big data analysis can improve the financial efficiency of the supply chain, increase profit for original manufacturers and third-party remanufacturers, reduce costs, and increase customer satisfaction. For example, Hung et al. (2020) believe that Big data analysis of credit reports and e-wire transactions can improve the financial efficiency of the supply chain. Sun & Shen (2020) also supported this statement outlining the importance of large-scale analysis. On the other hand, Niu & Zou (2017) found that Big data can increase profit for original manufacturers and third-party remanufacturers sharing information between supply chain participants. Moreover, Benabdellah et al. (2016) outlined the importance of customer satisfaction and found that Big data can reduce supply chain costs and increase customer satisfaction. All these studies suggest that Big data can positively impact supply chain management and solve the challenges from financial efficiency to customer satisfaction.

The next group of authors believes Big data can enhance supply chain networks. Gupta (2019) and Li & Liu (2019) agree that Big data and the Internet of Things can strengthen supply chain networks. The adoption of wireless sensor networks with the Internet of Things has enabled the collection of large amounts of data, which can be analyzed lately to improve supply chain management (Pal, 2023).

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Finally, the last group believes Big data enables the creation of a competitive advantage. Sanders (2016) and Ittmann (2015) believe that companies can use Big data analysis to extract value from data to optimize inventories, risk assessment, and target location-based marketing, creating a competitive advantage. The effective use of Big data analysis can give companies a competitive advantage, notably helping data-based decisions (Cabrera-Sánchez & Villarejo-Ramos, 2020).

In summary, Big data analysis can effectively improve supply chain challenges, providing adequate supply chain risk management, reducing costs, enhancing supply chain networks, and creating competitive advantage.

CONCLUSION.

The analysis of the reviewed literature revealed that Big data could help companies improve inventory levels, increase predicting accurateness, shorten lead times, and increase delivery efficiency. In addition, big data analytics can improve managing internal and external risks and reduce default risk in supplier-retailer channels. At the same time, machine learning algorithms can reveal deceptive activities and recognize possible supply chain risks.

Moreover, Big data analysis can improve the financial efficiency of the supply chain, increase profit, reduce costs, and increase customer satisfaction. However, the full impact of Big data on supply chain management is restrained by two significant challenges: a lack of capabilities and IT infrastructure.

In summary, business leaders now view big data analytics as a must-have skill, and the uses of analytics that can give businesses a competitive edge can be found at every stage of the supply chain decision-making process.

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