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The Importance of Supply Chain Risk Management: Identifying, Assessing, and Mitigating Supply Chain Risks

Pentingnya Manajemen Risiko Rantai Pasokan: Mengidentifikasi, Menilai, dan Memitigasi Risiko Rantai Pasokan

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ABSTRACT
Supply Chain Risk Management (SCRM) is an important aspect in maintaining supply chain stability and resilience amidst global uncertainty. This research aims to explore the role of big data analytics in identifying, assessing and managing hidden risks in the logistics and transportation sector. The method used is a systematic literature review with the PRISMA approach, which involves identification, screening, eligibility and inclusion of articles from international databases. The research results show that big data analytics can increase visibility, improve operational efficiency, and enable the detection of hidden risks that are beyond the reach of traditional methods. The implications of this research emphasize the importance of integrating big data analytics in SCRM practices to increase supply chain resilience and minimize the impact of disruptions.
Keywords: Supply Chain Risk Management, Big Data Analytics, Risk Identification, Logistics, Transportation

ABSTRAK
Manajemen Risiko Rantai Pasok (SCRM) adalah aspek penting dalam menjaga stabilitas dan ketahanan rantai pasok di tengah ketidakpastian global. Penelitian ini bertujuan untuk mengeksplorasi peran big data analytics dalam mengidentifikasi, menilai, dan mengelola risiko tersembunyi dalam sektor logistik dan transportasi. Metode yang digunakan adalah systematic literature review dengan pendekatan PRISMA, yang melibatkan identifikasi, penyaringan, kelayakan, dan inklusi artikel dari database internasional. Hasil penelitian menunjukkan bahwa big data analytics dapat meningkatkan visibilitas, memperbaiki efisiensi operasional, dan memungkinkan deteksi risiko tersembunyi yang tidak terjangkau oleh metode tradisional. Implikasi penelitian ini menekankan pentingnya integrasi big data analytics dalam praktik SCRM untuk meningkatkan ketahanan rantai pasok dan meminimalkan dampak gangguan.
Kata Kunci: Manajemen Risiko Rantai Pasok, Big Data Analytics, Identifikasi Risiko, Logistik, Transportasi

1. Introduction

Big data analytics is increasingly recognized as effective in identifying hidden risks and improving supply chain risk management. Research shows that big data analytics can identify potential bottlenecks in supply chains, enabling proactive problem solving and optimization of various operations such as transportation routes and warehousing processes (Oriekhoe, 2024). The real-time visibility provided by big data analytics is critical in minimizing disruption and improving operational performance (Okoduwa, 2024; Sakib, 2021).

When compared with traditional methods, big data analytics offers dynamic data-based analysis that makes supply chains more competitive (Xu, 2023). By providing precise, accurate and valuable information, big data analytics improves operational efficiency, which has a positive impact on supply chain management and overall performance (Al-Khatib

& Shuhaiber, 2022). Additionally, big data analytics can increase visibility, help identify threats and disruptions, and improve supply chain resilience (Chinsomboon, 2023; Zhang et al., 2023).

Furthermore, the integration of big data analytics with supply chain practices based on dynamic capabilities theory is a developing area and requires further research to understand its impact on supply chain performance (JR., 2023). The use of big data analytics in demand forecasting has significantly improved supply chain management by enabling more precise forecasting, ultimately changing the landscape of supply chain operations. In conclusion, big data analytics plays a critical role in supply chain risk management by providing real-time insights, increasing operational efficiency, improving visibility, and enabling more precise demand forecasting. Its effectiveness in identifying hidden risks and mitigating disruptions underscores the important role of big data analytics in modern supply chain management practices.

Supply chain risk management is a crucial aspect in the logistics and transportation sector, where uncertainty and operational complexity often cause significant disruption. In the context of globalization and increasing supply chain complexity, the ability to identify, assess and manage risks is becoming increasingly important. Effective risk management not only helps in reducing financial losses but also maintains operational sustainability and company reputation. Big data analytics is emerging as an important innovation that offers potential solutions in supply chain risk management. With large and diverse volumes of data generated from various supply chain activities, this technology enables in-depth analysis to identify hidden patterns and anomalies that may not be visible with conventional methods. The application of big data analytics in supply chain risk management can provide more accurate and real-time insights, enabling more precise and proactive decision making.

The main problem in supply chain risk management is that often hidden risks are not detected until they cause significant disruption. These risks can come from various sources, including supplier failure, demand fluctuations, and natural disasters. Traditional methods are often less effective in identifying these risks due to limitations in analytical capacity and inability to process large and complex volumes of data. Therefore, there is an urgent need for more effective and sophisticated methods to identify hidden risks in supply chains.

The research question asked is: "How is big data analytics used to identify hidden and undetected supply chain risks in the logistics and transportation sector?" This question seeks to explore the potential of applying big data analytics in detecting risks that are undetectable by traditional methods, as well as how this technology can change the approach to risk management in this vital sector. The gap in the literature regarding the effectiveness of big data analytics in identifying hidden risks in the logistics and transportation sector is still quite significant. Although there are various studies discussing the application of big data in supply chain management in general, research specifically examining how this technology can be used to identify undetected risks is still very limited. Most research tends to focus on the general benefits of big data without delving deeper into how this data can be processed and used to detect specific risks that are not visible with conventional approaches.

The importance of this research lies in its potential to improve supply chain efficiency and resilience. By identifying hidden risks early, companies can take proactive steps to mitigate their negative impact, so that operations continue to run smoothly and without major disruption. This not only helps in reducing financial losses but also increases the company's competitiveness in the face of market uncertainty and changes in the operational environment. The novelty of this research lies in the new approach in using big data analytics to overcome hidden risks. This approach has not been widely explored in the current literature, especially in the context of the logistics and transportation sector. This research seeks to fill this gap by offering new insights and innovative methods that companies can adopt to improve their risk management.

The contribution of this research to supply chain management practitioners and academic literature is invaluable. For practitioners, the results of this research can be a practical guide in implementing big data analytics for risk detection, which ultimately increases operational efficiency and supply chain resilience. From an academic perspective, this research enriches the literature with empirical findings and theoretical models that can form the basis for future research. This also opens up opportunities for further development in the fields of big data analytics and supply chain risk management.

2. Methods

2.1. Collecting Articles from Reputable International Databases using the PRISMA Method

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method was used in this research to ensure that the process of collecting, filtering and analyzing literature was carried out systematically and transparently. PRISMA is a widely accepted guide for conducting systematic literature reviews, and consists of four main stages: identification, screening, eligibility, and inclusion.

1. Identification: At this stage, a literature search was carried out in several reputable international databases such as Scopus, Web of Science, and IEEE Xplore. This search uses predetermined keywords to identify relevant articles.
2. Filtering: Articles obtained from the identification stage are then filtered based on the title and abstract to determine their relevance to the research topic. Articles that do not match the inclusion criteria will be eliminated at this stage.
3. Qualifications: Articles that pass the screening stage are then further evaluated by reading the entire text to ensure that they meet all the established inclusion criteria.
4. Inclusion: Articles that meet all inclusion criteria will be included in the final analysis. This stage ensures that only relevant and high-quality articles are used in the review.

2.2. Keywords Used to Search for Articles

Article searches were conducted using several main keywords and keyword combinations to ensure broad and comprehensive coverage:

1. Main Keywords: "big data analytics", "supply chain risk management", "hidden risks", "logistics", "transportation".
2. Keyword Combinations: "identification", "assessment", "mitigation", "supply chain".
3. These keywords were chosen to capture various aspects of the use of big data analytics in supply chain risk management, as well as to identify hidden risks in the logistics and transportation sector.

2.3. Number of Articles Retrieved

An initial search process in international databases yielded a large number of relevant articles:

1. Number of Articles in the Identification Stage: A total of 120 articles were found through keyword searches in various databases.
2. Number of Articles After Filtering: After a filtering process based on title and abstract, the number of relevant articles was reduced to 75.
3. Number of Articles After Eligibility Evaluation: After reading the entire text and ensuring compliance with the inclusion criteria, 53 articles were selected for further analysis.

2.4. Article Inclusion and Exclusion Techniques

To ensure that only relevant and high-quality articles were included in the review, the following inclusion and exclusion criteria were used:

1. Inclusion Criteria:
    - Articles that explicitly discuss the use of big data analytics in the context of supply chain risk management.
    - Articles published in reputable and internationally recognized journals.
    - Articles written in English.
    - Articles published within a certain time frame (for example, within the last 10 years) to ensure relevance and up-to-date data.
2. Exclusion Criteria:
    - Articles that are not relevant to the research topic.
    - Specific case studies that cannot be generalized or have significant limitations in methodology.
    - Articles with low methodological quality or lack of transparency in data reporting and analysis.

3. Results and Discussions

3.1. Supply Chain Risk Management

Supply chain risk management (SCRM) is a critical process that involves collaborative efforts between organizations to identify, evaluate, reduce and monitor potential risks that can affect every part of the supply chain (Lufika et al., 2022). This process includes activities such as risk identification, analysis, evaluation and mitigation which are essential to reduce disruptions along the supply chain (Handayani et al., 2019). SCRM involves a coordinated approach among supply chain members to manage risk effectively, including supply management, demand management, production management, information management, and safety management (Pramudhita & Santoso, 2022).

Risk identification and mitigation components are very important in SCRM. Effective risk management involves both reactive and proactive strategies. Reactively, monitoring changes in the supply chain, customer needs, technology and competitor strategies enables rapid response to events as they occur. Proactively identifying risks and implementing preventive measures helps minimize their impact (Dias et al., 2020). In addition, collaboration with suppliers, supply chain transparency, open exchange of information, and business continuity plans are indicators of effective SCRM practices (OWUOR, 2019).

SCRM is not only concerned with risk management, but also increasing supply chain resilience. Supply chain resilience, along with appropriate risk mitigation strategies, is critical in dealing with uncertainty in the global supply chain environment (Um & Han, 2020). Strategies such as supplier diversification, improving product quality, utilizing technology for risk monitoring, and developing cost-effective supply chain strategies contribute to effective risk mitigation (Achmad, 2023). In addition, the use of modern technology such as big data helps in identifying and analyzing risks in the supply chain ("Improvement of Supply Chain Risk Management Algorithm using Modern Technologies", 2019). In conclusion, SCRM plays an important role in ensuring the stability of production and delivery processes while increasing competitiveness. By implementing strong risk identification, analysis, evaluation and mitigation strategies, organizations can overcome uncertainty and build a resilient supply chain that is able to withstand a variety of risks and disruptions.

3.2. Big Data Analytics in Supply Chains

Big data analytics in supply chains involves the use of technology, processes and techniques to collect, organize, visualize and analyze data to improve the efficiency and effectiveness of supply chain operations (Yamin, 2021). The application of big data analytics

allows organizations to make informed decisions, improve supply chain performance, and overcome various challenges that may arise in the supply chain (Al-Khatib & Shuhaiber, 2022). By leveraging big data analytics, organizations can achieve manufacturing supply chain resilience, improve operational efficiency, and gain valuable insights that have a positive impact on supply chain management and performance (Xu, 2023).

The benefits of applying big data analytics in supply chains are vast. Big data analytics can improve decision-making processes, proactive problem solving, optimize transportation routes, simplify warehouse operations, and real-time visibility to minimize disruption (Oriekhoe, 2024). Additionally, big data analytics plays an important role in various aspects of supply chain management such as demand forecasting, product development, shipping decisions, and customer feedback, thereby improving the overall performance of the supply chain ("Big Data Applications in Supply Chain Management: SCOPUS Based Review" , 2023). Furthermore, the use of big data analytics can revolutionize traditional supply chain management practices, offering opportunities to increase efficiency, reduce costs, and improve operational performance (Okoduwa, 2024).

However, apart from the benefits, implementing big data analytics in the supply chain also presents challenges. The risks associated with implementing big data analytics include ethical, privacy, and security issues that can affect business, industry, and society at large (Ogbuke et al., 2020). In addition, the complexity of managing high-dimensional data generated at various points in the supply chain poses challenges in effectively utilizing big data analytics for demand forecasting and decision-making processes (Seyedan & Mafakheri, 2020). Despite these challenges, the integration of big data analytics in supply chain management offers significant potential to increase supply chain resilience, improve performance, and encourage sustainable business practices (Nisar et al., 2022). In conclusion, big data analytics is a powerful tool that can transform supply chain operations by providing valuable insights, improving decision-making processes, and improving the overall performance of the supply chain. While there are challenges in implementing big data analytics in supply chains, the benefits it offers in terms of efficiency, cost reduction and operational performance make it a valuable asset for organizations looking to optimize their supply chain processes.

3.3. Hidden Risks in the Supply Chain

Hidden risks in supply chains include various types of risks that can have a significant impact on an organization's operations and performance. These risks can be classified into internal risks originating from the supply side, process side, and demand side, as well as logistics side risks, financial side risks, and collaboration side risks (Shahbaz et al., 2019). In addition, quality risks in the supply chain can spread and accumulate, posing hidden dangers to product quality along the chain (Li et al., 2020). Furthermore, risks arising from information asymmetry and misinformation can lead to inefficiencies in supply chain operations and overall business performance (Nguyen et al., 2022).

The impact of these hidden risks on the supply chain is profound. Supply chain risks can compromise the safe operation of the chain, resulting in reduced efficiency, increased costs, and even network failure and disintegration due to uncertainty and unexpected events (Guo, 2021). Furthermore, the presence of hidden risks can cause disruptions along the supply chain, affecting various members and processes, and ultimately impacting the overall performance of the organization (Handayani et al., 2019). Risks associated with supply chain finance can exacerbate challenges, potentially leading to difficulties in operations and increased credit risk (Chen et al., 2021; ELBICHRI, 2022).

To effectively address these hidden risks, organizations need to proactively manage supply chain risks. This involves identifying, analyzing and mitigating risks using modern technologies such as big data to improve risk management algorithms ("Improvement of Supply Chain Risk Management Algorithm using Modern Technologies", 2019). By adopting a

data-driven approach and framework for supply chain risk management, organizations can increase their resilience to disruption and uncertainty in the supply chain (Er et al., 2019; AKKARTAL, 2022). In addition, improving supply chain risk prevention capabilities and coordination between supply chain nodes can help improve the overall chain's resilience to risk (Wang & Zhang, 2022). In conclusion, hidden risks in supply chains can have far-reaching implications for organizational performance and the stability of the chain. By understanding the types of risks involved, their impact, and implementing a robust risk management strategy, organizations can face these challenges effectively and ensure the resilience and efficiency of their supply chains.

3.4. Big Data Analytics in Identifying Supply Chain Risks

3.4.1. Application of Big Data Analytics in the Logistics and Transportation Sector

Big data analytics has received significant attention in the logistics and transportation sector due to its potential in improving operations and decision-making processes. By leveraging technologies and tools such as real-time data processing, sensor data analysis, and advanced analytics architectures, organizations can optimize routes, improve supply chain performance, and increase overall efficiency (Dang et al., 2019; Lin, 2023; Silva et al. , 2021). Big data analytics offers the ability to process large data volumes both at rest and in motion, contributing to the data value chain in the logistics industry (Reshadat, 2021).

Despite the great promise of big data analytics, many companies have not yet fully exploited its potential in logistics and supply chain management (Aubakirova, 2024). Research has shown that the application of big data analytics can lead to innovation in inventory management, supply chain optimization, and transportation system maintenance (Yang, 2024; Kour et al., 2019; Tannady et al., 2023). In addition, real-time information exchange and analysis of location data from vehicles, products and facilities are important aspects of Logistics 4.0, highlighting the importance of real-time big data analytics in this industry (Silva et al., 2021).

Research also emphasizes the role of big data analytics in decision-making processes, not only in logistics but also in various other sectors, enabling organizations to make better and more efficient decisions (Noby et al., 2021; Ayuningtyas, 2023). Furthermore, the transformational potential of big data analytics has been recognized in driving customer engagement, satisfaction and revenue growth in industries such as hospitality (Nkatekho, 2024). In conclusion, the application of big data analytics in the logistics and transportation sector offers great opportunities to improve operational efficiency, supply chain performance and decision-making processes. By leveraging advanced technology and tools, organizations can optimize the power of data to drive innovation and competitiveness in an increasingly complex and dynamic industrial landscape.

3.4.2. Risk Identification Method with Big Data Analytics

Supply chain risk management is critical for businesses to identify, assess and mitigate risks effectively. Big data analytics plays a significant role in improving this process by providing dynamic data-based analysis (Sakib, 2021). By leveraging big data analytics, organizations can increase operational efficiency, make informed decisions, and improve supply chain management and performance (Xu, 2023). This technology enables the identification of potential bottlenecks in the supply chain, enabling proactive problem solving and minimizing disruption (Oriekhoe, 2024).

Big data analytics in supply chain management involves a combination of technology, processes, and techniques that enable organizations to collect, organize, visualize, and analyze data quickly (Yamin, 2021). By utilizing big data analytics, organizations can collect and process large amounts of data from various sources to assess risks and their potential impact (Yang,

2024). Additionally, this technology provides insight into how supply chains are structured and how organizations can improve internal and external processes (Ogbuke et al., 2020).

In the context of supply chain risk management, big data analytics can increase resilience, provide greater control over supply chains, and reduce risks and disruptions from external factors (Al-Khatib & Shuhaiber, 2022). By adopting big data drivers, companies can strengthen supply chain resilience and reduce risks in a sustainable manner effectively (Hsu et al., 2022). In addition, big data analytics capabilities contribute significantly to the development of innovative green products, improving overall performance and learning in supply chain management (Nisar et al., 2022).

Although big data analytics offers many benefits, there are risks associated with its application in sustainable supply chains (Kusi-Sarpong et al., 2021). However, by effectively identifying and assessing risk factors in real-time through a data mining approach, organizations can reduce these risks and increase supply chain resilience (Ganesh & Kalpana, 2022). The use of big data analytics in supply chain management, known as supply chain analytics, has a direct impact on various dimensions of the supply chain, such as planning, supplier management, procurement, manufacturing, and inventory management (Mubarik & Rasi, 2019). In conclusion, big data analytics plays a crucial role in supply chain risk management by enabling organizations to make data-driven decisions, increase operational efficiency, and improve overall supply chain performance. By harnessing the power of big data analytics, businesses can proactively identify, assess and mitigate risks, ultimately strengthening their supply chains and ensuring operational resilience.

3.4.3. The Effectiveness of Big Data Analytics in Identifying Hidden Risks

Big data analytics is increasingly recognized as effective in identifying hidden risks and improving supply chain risk management. Research shows that big data analytics can identify potential bottlenecks in supply chains, enabling proactive problem solving and optimization of various operations such as transportation routes and warehousing processes (Oriekhoe, 2024). The real-time visibility provided by big data analytics is critical in minimizing disruption and improving operational performance (Okoduwa, 2024; Sakib, 2021).

When compared with traditional methods, big data analytics offers dynamic data-based analysis that makes supply chains more competitive (Xu, 2023). By providing precise, accurate and valuable information, big data analytics improves operational efficiency, which has a positive impact on supply chain management and overall performance (Al-Khatib & Shuhaiber, 2022). Additionally, big data analytics can increase visibility, help identify threats and disruptions, and improve supply chain resilience (Chinsomboon, 2023; Zhang et al., 2023). Furthermore, the integration of big data analytics with supply chain practices based on dynamic capabilities theory is a developing area and requires further research to understand its impact on supply chain performance (JR., 2023). The use of big data analytics in demand forecasting has significantly improved supply chain management by enabling more precise forecasting, ultimately changing the landscape of supply chain operations. In conclusion, big data analytics plays a critical role in supply chain risk management by providing real-time insights, increasing operational efficiency, improving visibility, and enabling more precise demand forecasting. Its effectiveness in identifying hidden risks and mitigating disruptions underscores the important role of big data analytics in modern supply chain management practices.

4. Conclusions

Supply Chain Risk Management (SCRM) is an important element in maintaining supply chain stability and resilience amidst global uncertainty. Through the process of identifying, analyzing, evaluating and mitigating risks, SCRM enables organizations to deal with various risks that may arise. Implementing appropriate strategies, both reactive and proactive, as well as

strong collaboration between supply chain members, contributes to more effective risk management. Big Data Analytics, on the other hand, plays a crucial role in increasing operational efficiency and improving decision making by providing deep data-driven insights. Successful application of big data in the supply chain can identify hidden risks, increase visibility, and improve the overall performance of the supply chain.

4.1. Implications

1. Managerial: Organizations need to integrate comprehensive SCRM practices with the use of modern technology, including big data analytics, to increase supply chain resilience. This involves closer collaboration with suppliers and the use of technology for real-time risk monitoring.
2. Technology: The application of big data analytics must be prioritized to improve supply chain visibility and efficiency. Organizations need to invest in advanced analytical tools and leverage big data to support strategic and operational decisions.
3. Business strategy: Leveraging big data analytics for demand forecasting and supply chain process optimization can bring competitive advantage. Organizations must adopt a data-driven approach to respond to market changes and improve operational performance.

4.2. Limitations

1. Data Complexity: Managing and analyzing complex big data can be challenging, especially when it comes to integrating and interpreting data from multiple sources. This requires deep technical expertise and adequate resources.
2. Ethics and Privacy Issues: The use of big data in supply chains can face challenges related to data privacy and security. Organizations must ensure that their practices comply with relevant privacy and ethics regulations.
3. Dependence on Technology: High reliance on technology can be a risk in the event of a system failure or cyber attack. Organizations need to have a solid contingency plan to address potential technical issues.

4.3. Future Research

1. Big Data Technology Development: Further research is needed to develop more efficient and integrated big data analytical techniques, as well as to overcome challenges in big data management.
2. SCRM Effectiveness Against Hidden Risks: A deeper study of how SCRM and big data analytics can be more effective in identifying and managing hidden risks in supply chains.
3. The Influence of Big Data on Strategic Decisions: Research to explore how big data analytics can better support strategic decisions in various industry sectors and their impact on overall supply chain performance.
4. Implementation and Evaluation of Best Practices: Investigation of best practices in applying big data analytics and SCRM in various industries to improve supply chain resilience and efficiency.

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