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Big Supply Chain Analytics Enhances Decision-Making: A Literature Review Approach

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Abstract:

The way organizations function in today's dynamic market landscape has been changed by the integration of data analytics inside supply chain management. Within the supply chain domain, data analytics pertains to be methodical procedure of gathering, analyzing, and interpreting diverse data kinds produced along the chain in order to extract significant understandings and practical intelligence. It entails applying methods from the fields of descriptive, predictive, and prescriptive analytics to boost operational effectiveness, optimize decision-making, and raise overall performance in the ecosystem of the supply chain. Organizations may make well-informed decisions, spot trends, and proactively handle problems by analyzing data from a variety of sources, including suppliers, manufacturers, distributors, and retailers. This results in more efficient resource allocation and streamlined procedures. Data analytics is playing a more and more important role as businesses look to improve operational efficiency, cut costs, and successfully satisfy customer needs. This study examines the role that data analytics plays in supply chain optimization, helping firms to increase the precision of their forecasts, simplify their logistical procedures, and make well-informed decisions through literature review. Most of the literature that is currently available agrees that big data analytics goes far beyond simply reimagining the supply chain. It may help the next generation of multinational corporations function more adaptably in a setting that is becoming more demanding and unpredictable. This conceptual paper applies relevant review literature and draw conclusions.

Keywords:-Big Data, Supply Chain, Big Data Analytics, Sustainability

Introduction

The term "supply chain analytics" describes the methods used by businesses to glean knowledge and derive value from the massive volumes of data pertaining to the sourcing, manufacturing, and distribution of commodities. Analytics in supply chain management is the application of statistical methods and data analysis to optimize supply chain processes, including logistics, inventory control, and supplier performance. An integral part of supply chain management (SCM) is supply chain analytics. The management of relationship flow

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and the movement of materials, information, and resources inside and across a network, including upstream and downstream organizations, are commonly referred to as "SCM" (Rai 2019). Although supply chain analytics has been a field for more than a century, its foundational mathematical models, data structures, and software have changed considerably over that time. Better statistical methods, predictive modeling, and machine learning have all contributed to the advancement of mathematical models. The internet of things, cloud computing, and complex event processing (CEP) have all altered data infrastructure. Applications including enterprise resource planning (ERP), warehouse management, logistics, and enterprise asset management have expanded to offer information across conventional application silos. Prescriptive and predictive analytics are made possible by big data analytics, which may improve capacity utilization, help businesses develop new business models, better customer experience, lower fraud, raise supplier quality standards, and increase end-to-end supply chain visibility (Zhan and Tan 2020).

The supply chain is made up of interdependent parts that cooperate to move goods from raw resources to the final customer. Manufacturers, distributors, suppliers, and merchants are some of these parts. Suppliers supply the components and raw materials needed to make finished goods, manufacturers turn these inputs into finished goods, distributors help the goods move through different phases of production, and retailers put the goods in front of customers. Organizations may improve their supply chain operations and discover opportunities for improvement by analyzing data from several sources, including sales, production, and logistics data. Big Data has become an indispensable tool across numerous facets of supply chain management, wielding its transformative power in revolutionizing operations. It plays a pivotal role in procurement planning by scrutinizing supplier performance, predicting demand patterns, and optimizing sourcing strategies. This extensive analysis of diverse data sources aids in managing supplier risks and bolstering decision-making processes. Moreover, in logistics, Big Data orchestrates route optimization, real-time shipment tracking, and predictive maintenance for transportation fleets, harnessing information from IoT devices, GPS systems, weather forecasts, and traffic data. This intricate web of data enables precise decision-making in the movement of goods, ensuring efficiency and reliability. Using the multivariate time series analysis technique (VARX), Papanagnou and Matthews-Amune (2018) came to the conclusion that customer-generated content from a variety of online sources, including Google, YouTube, and newspapers, can enhance the accuracy of demand forecasting in the short term and improve the response to demand volatility in retail pharmacy settings.

Better traceability: It guarantees more accurate tracking of products from manufacturing to retail. Maintaining a better flow of commodities and integrating the various supply chain

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entities can be facilitated by improved traceability. Increased tracking capabilities result in improved supply chain process control.

Objectives of the study

1. To study about various types of analytics and history of supply chain analytics.
2. To study various companies case studies on supply chain analytics.
3. To identify the gap in research through review of literature on supply chain Analytics.

Descriptive Analytics in Supply Chain: focuses on analyzing historical data to understand what has happened in the supply chain. It involves summarizing and aggregating data to provide insights into past performance. For example: A company uses descriptive analytics to analyze its inventory levels over the past year to identify trends, such as seasonal fluctuations or product demand patterns.Flipkart, an Indian e-commerce company, use descriptive analytics to analyze historical sales data to understand peak buying seasons and popular product categories. It can help companies gather information about purchases and provide insights about how to save expenses without sacrificing effectiveness. To work on budgeting, for instance, companies can utilize descriptive analytics to gather historical data for reports and other visualizations on spend analysis. This might assist in providing answers to queries like:What is the company purchasing?,Where is the organization purchasing, and for whom?, Which categories are the most heavily spent in?

Predictive Analytics in Supply Chain: Models for predictive analytics can spot patterns and trends that will enable one to foresee and reduce hazards before they materialize. Companies can gain a deeper understanding of their supply chain, can spot possible hazards, and take proactive measures to lessen their exposure to those risks by analyzing both historical and current data. Predictive analytics uses historical data to forecast future events or trends in the supply chain. It involves applying statistical algorithms and machine learning techniques to make predictions. Predictive analytics is being used to forecast future demand for a particular product based on factors like historical sales data, market trends, seasonality, and promotional activities. Mahindra& Mahindra, an Indian automotive manufacturer use predictive analytics to forecast demand for specific car models based on historical sales data and economic indicators. Businesses view optimization as a good strategy in logistics and transportation because it enhances predictive analytics (Nguyen et al. 2018). To analyze logistics operations and machines objectively, Zhong et al. (2015) suggested a comprehensive Big Data approach to mine huge RFID-enabled shop floor logistics data for the frequent trajectory. The authors of Lee et al. (2018) have presented another experimental investigation to achieve a decision support optimization in logistics. To determine the ideal speed that minimizes fuel use while vessels are in service, they depended on huge data from past weather observations. They put out a novel strategy for analyzing meteorological data and

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applying data mining methods to discover how the weather affects gasoline usage. According to Govindan et al. (2018), one benefit of using big data in supply chain management (SCM) is that it can increase customer satisfaction by forecasting orders, which lowers costs and manages risks.

Prescriptive Analytics: Going beyond descriptive and predictive analytics, leveraging prescriptive analytics to suggest optimal actions in complex supply chain scenarios, aiding in better decision-making and resource allocation. Prescriptive analytics focuses on recommending actions or strategies to optimize or improve supply chain processes based on predictive insights. It involves suggesting the best course of action to achieve desired outcomes. Based on predictive analytics indicating an upcoming surge in demand for a product, prescriptive analytics recommends adjusting production schedules or optimizing inventory levels to meet the anticipated demand. Reliance Industries Limited (RIL), a conglomerate with diverse businesses including retail, might use prescriptive analytics to optimize its inventory management and distribution network based on predicted consumer behavior and market trends. Monitoring the company's past purchases and offering real-time insights using prescriptive analytics to evaluate supplier pricing are two ways real-time analytics can save costs. If suppliers' prices are greater than those of competitors, sourcing teams can utilize this information to bargain with them on price when it is provided in real time in the form of comprehensive reports. Companies relationship with the supplier will also gain from this, as they will be able to spot sales possibilities that were lost to less expensive alternatives.

Sustainability Analytics: Integrating analytics to measure and optimize the environmental impact of supply chains, tracking carbon footprint, waste reduction, and sustainable sourcing.

Indian companies, like their global counterparts, leverage these levels of big data analytics in the supply chain to gain insights, make informed decisions, optimize operations, and enhance efficiency across various industry sectors such as e-commerce, manufacturing, and retail.

Big Data plays a crucial role, such as procurement planning, logistics, inventory management, innovation and product design, operations efficiency, product strategy development, and network design.

Procurement Planning in India: Planning in the supply chain is usually the most data-driven activity since it makes extensive use of inputs from SCM planning tools and Enterprise Resource Planning (ERP). However, with the use of new internal and external data sources, there is now a great chance to genuinely rethink the planning process and enable real-time supply and demand shaping.

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Companies can compare the management of inventory in a supply chain to that of electricity: Since storing electricity is costly and challenging, power firms either add more customers or cycle their facilities in order to maintain a balanced power system. Retailers now have the chance to employ a comparable strategy. Accessibility of inventory data, point of sale (POS) data, and Real-time analysis of production volumes can be used to spot inconsistencies in the relationship between supply and demand. These can then influence decisions, such as pricing, adjustments, the timing of sales, or the launch of new lines to realign items.

Retailers can now enhance their planning procedures by utilizing new data sources and their capacity for demand sensing. Blue Yonder, for instance, has created data-intensive forecasting techniques that are currently being used in retail where 150,000,000 is produced by 130,000 SKUs and 200 affecting factors, daily probability distributions. This has significantly increased forecast accuracy; made it possible to see the company's logistics more clearly. As retailers now have the chance to employ a comparable strategy,real-time analysis of manufacturing quantities, inventory data, and point of sale (POS) visibility can be revealed.In India, companies like Flipkart and Reliance Industries leverage Big Data to optimize procurement. Flipkart uses data analytics to forecast demand, enabling better inventory planning, while Reliance Industries utilizes Big Data to optimize sourcing strategies, negotiate better deals with suppliers, and enhance supply chain efficiency.

For smart logistics to work, the smart devices must be able to react to unanticipated situations. For example, they must be able to reroute in the event of traffic on the main route in order to save fuel and distance. Automatic guided vehicles can be utilized to collect and store items inside manufacturing warehouses. Radio frequency identification tags and rapid response codes can be used to easily identify and track items, resulting in increased visibility and inventory optimization . Smart device utilization improves supply chain efficiency and transparency, which supports SSCM sustainability. This is particularly true when considering the economic and environmental aspects of SSCM sustainability, which support resource efficiency to boost profits while protecting the environment.Logistics Optimization in the US: Companies like Walmart in the United States have adopted Big Data analytics to streamline logistics. Walmart uses real-time data from sensors and GPS systems to track shipments, optimize truck routes, and reduce delivery times, resulting in improved operational efficiency. Nike leverages Big Data analytics to optimize its logistics operations. Real-time data from GPS tracking, IoT devices, and transportation routes enable the company to monitor shipments, streamline transportation routes, and minimize delivery times. This data-driven approach enhances operational efficiency while reducing costs associated with transportation and warehousing.

The problem of identifying and preventing out-of-stock situations continues to be difficult for many companies. While RFID tags are becoming too expensive to be affixed to individual

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supermarket items, physical checks are still a costly option in developed countries. Rather than that, businesses are increasingly keeping an eye on sales activity to spot signs of stock outs. An alert is set off to have someone verify if an item that is typically sold every few minutes is out of stock at the shelf if it does not show up at the tills. Other cutting-edge technologies are also being investigated, such as using in-store cameras to keep an eye on on-shelf stock levels and mounting weight or light sensors on shelves.

Demand Forecasting and Inventory Management in China: Another critical area where Big Data shines is Demand forecasting & inventory management. Through meticulous analysis of sales data, market trends, and historical patterns, it forecasts demand accurately, optimizes inventory levels, and identifies potential shortages. This proactive approach helps in mitigating stockouts and streamlining inventory, ultimately enhancing operational efficiency. Alibaba Group in China harnesses Big Data to manage inventory effectively. By analyzing customer behavior and market trends, Alibaba optimizes its inventory levels, reduces stockouts, and ensures timely deliveries, contributing to enhanced customer satisfaction. Nike employs advanced analytics to forecast demand accurately. By analyzing historical sales data, market trends, social media interactions, and even weather patterns, the company predicts consumer preferences and adjusts its production and inventory levels accordingly. For instance, before major sports events or product launches, Nike utilizes predictive analytics to anticipate surges in demand for specific products, ensuring adequate stock availability and minimizing stockouts.

Innovation and Product Design in Europe: European companies like Zara employ Big Data for innovation and product design. Zara utilizes data analytics to gather customer feedback, monitor fashion trends, and swiftly design and introduce new clothing lines, maintaining their edge in the fast-fashion market. Nike integrates Big Data analytics into its product design and innovation processes. The company collects data from various sources, including customer feedback, social media sentiments, and market trends. This information guides product development, enabling Nike to design sports apparel and footwear that align with evolving consumer preferences and performance needs.

Operations Efficiency in Brazil: Brazilian companies such as Embraer use Big Data for operational efficiency. Embraer leverages predictive maintenance analytics to monitor aircraft performance, predict maintenance needs, and optimize fleet operations, ensuring safety and reducing downtime.

Product and Market Strategy Development in Japan: Simultaneously, in product and market strategy development, Big Data becomes a guiding force by deciphering consumer behavior, identifying emerging market opportunities, and tailoring marketing strategies based on comprehensive data mined from social media, surveys, and sales insights. This personalized

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approach aids in crafting products that resonate with customer needs while tapping into new markets effectively.Japan's Toyota Motor Corporation utilizes Big Data for product and market strategy development. Toyota analyzes market data, customer preferences, and feedback to design and market vehicles that meet consumer demands while maintaining a competitive edge.

Supplier Relationship Management: The brand Nike uses analytics to manage relationships with its vast network of suppliers. Nike assesses supplier performance based on various metrics, including delivery times, quality compliance, and ethical practices. Through data-driven insights, the company identifies opportunities for improvement, works closely with suppliers to address issues, and collaborates on innovative solutions for more efficient manufacturing and distribution processes.

Network Design in Australia: Australian companies like Woolworths employ Big Data for network design. Woolworths optimizes its supply chain network by analyzing data from various sources to identify the most efficient distribution channels, reducing costs and improving delivery timelines.

Cross-border Trade in Singapore: Singapore's port authority, PSA International, utilizes Big Data to manage cross-border trade. By analyzing shipping data and port operations, PSA enhances port efficiency, reduces congestion, and improves overall supply chain performance.

Retail Analytics in India: Indian retail giant, Future Group, applies Big Data analytics in retail. Future Group analyzes customer data to personalize marketing strategies, optimize store layouts, and tailor promotions, enhancing customer engagement and increasing sales.

Healthcare Supply Chain in the US: In the United States, healthcare organizations like Kaiser Permanente leverage Big Data in their supply chains. Kaiser Permanente uses data analytics to forecast demand for medical supplies, optimize inventory levels, and ensure timely availability of critical resources.

Nike, a renowned global sportswear and athletic shoe brand, relies extensively on analytics and Big Data to enhance its supply chain management. The company operates a complex global supply chain network spanning multiple countries and suppliers, making efficient management a critical aspect of its success. Nike's implementation of advanced analytics and Big Data in supply chain management led to substantial improvements. By optimizing inventory levels based on accurate demand forecasts, the company reduced excess stock and minimized the risk of stockouts. This not only improved operational efficiency but also resulted in significant cost savings by minimizing inventory holding costs and markdowns on unsold items. Moreover, Nike's data-driven approach to supplier relationship management

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enhanced collaboration and transparency within its supply chain network, fostering stronger partnerships and promoting ethical manufacturing practices.

Each example showcases the diverse applications of Big Data across different aspects of supply chain management, demonstrating its universal significance in optimizing operations and driving efficiency in various industries and regions worldwide.

Moreover, the realm of big supply chain analytics transcends conventional ERP and SCM systems. By widening the scope of data analysis to include varied sources beyond the traditional internal datasets, it empowers supply chain professionals to glean insights from a richer pool of information. This expansion allows for more accurate predictions, sharper decision-making, and a holistic understanding of the intricate network that constitutes the supply chain. Ultimately, leveraging big supply chain analytics engenders efficiency, agility, and innovation across the entire supply chain landscape.

Compiling data from raw material procurement, production, distribution, and aftermarket services is necessary to achieve end-to-end supply chain analytics. A typical company's supply chain is made up of numerous SCM and supply chain execution platforms, all of which must be effectively integrated for this to happen. Supply chain visibility, or the capacity to observe data on commodities at each stage of the supply chain, is the aim of this kind of integration.

Being more responsive to client needs and enhancing forecasting and efficiency are key objectives when selecting supply chain analytics software. For instance, a company can predict customer demand using predictive analytics on point-of-sale terminal data kept in a demand signal repository. This can help the company make cost-effective inventory adjustments and expedite delivery.

Data scientists with knowledge of certain business aspects, such as cash flow, inventory, waste, and service levels, are usually the first in the process of developing supply chain analytics. These specialists search for possible relationships between various data points in order to construct a prediction model that maximizes the supply chain's output. They experiment with different versions until they get a solid model. Data engineers put supply chain analytics models into production with an eye on scalability and performance after they reach a particular level of success. To improve how these data analytics are presented and operational zed in real-world settings, data scientists, data engineers, and business users collaborate. Over time, supply chain models are enhanced by comparing the performance. Although supply chain analytics software should ideally be used throughout the chain, in reality it is frequently concentrated on important operational subcomponents like manufacturing output, inventory management, demand planning, and transportation management. Procure-to-pay analytics help identify the best suppliers and provide early

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warning of budget overruns in specific expense categories; transportation analytics software forecast the impact of weather on shipments; and supply chain finance analytics assist in identifying increased capital costs or opportunities to boost working capital.

Supply chain analytics enhances decision-making throughout the strategic, tactical, and operational processes that comprise supply chain management by combining data from various applications, infrastructure, outside sources, and developing technologies like IoT. Supply chain analytics enhances real-time visibility into these operations and their effects on customers and the bottom line, which helps synchronize supply chain planning and execution. Improved decision-making about the trade-offs between cost and customer service can be facilitated by enhanced visibility, which can also lead to increased flexibility within the supply chain network.

The majority of the following capabilities are often included in supply chain analytics software:

• Visualization of data. The capacity to analyze and interpret data by slicing it into distinct categories.

• Processing streams. gaining knowledge from various data streams produced by many sources, including as applications, third-party data, weather reports, and the Internet of Things.

• Using social media together. Sentiment analysis of social media posts to enhance demand forecasting.

• Organic language acquisition. retrieving and classifying unstructured data from news sources, papers, and data feeds.

The wisdom of location. using knowledge from location data to better comprehend and manage distribution.

• The supply chain's digital duplicate. Arranging information into an extensive supply chain model that can be accessed by many user categories in order to enhance prescriptive and predictive analytics.

The way organizations function in today's dynamic market landscape has been changed by the integration of data analytics inside supply chain management. Data analytics is playing a more and more important role as businesses look to improve operational efficiency, cut costs, and successfully satisfy customer needs. This study examines the role that data analytics plays in supply chain optimization, helping firms to increase the precision of their forecasts, simplify their logistical procedures, and make well-informed decisions.

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History of supply chain Analytics

Frederick Taylor's 1911 book The Principles of Scientific Management, which established the foundation for contemporary supply chain management and industrial engineering, is credited with inspiring the development of supply chain analytics. Henry Ford developed the modern assembly line and a supply network that facilitated more productive methods of production by utilizing Taylor's methods.

With the introduction of mainframe computers, IBM researcher Hans Peter Luhn began processing data, and it is partly due to him that the word "business intelligence" was first used in his 1958 paper "A Business Intelligence System." The foundation for the many forms of data analytics utilized in supply chain analytics was laid by his work.

Professor Bud Lalonde of Ohio State University argued in 1963 that procurement, production, materials management, and physical distribution management should all be integrated into a new field he named business logistics. Around this time, new concepts were being investigated by management consultant Stafford Beer and others. One such notion was the viable systems model, which aimed to improve business planning and execution by arranging business information into a hierarchical hierarchy. The rapidly developing field was called supply chain management by the early 1980s. When the internet gained popularity in the 1990s, many began to consider its potential applications in supply chain management. Kevin Ashton, a British technologist, was a pioneer in this field. Radio frequency identification sensors were Ashton's discovery as a young product manager entrusted with finding a solution to the challenge of maintaining a popular lipstick on store shelves.

They allowed Ashton to automatically gather data about the flow of items across the supply chain. The term "internet of things" was invented by Ashton, who went on to co-found the Auto-ID Center at Massachusetts Institute of Technology, which advanced RFID technology and sensors, to describe this ground-breaking new aspect of supply chain management. CEP was also developed in the 1990s by academics including David Luckham's team at Stanford University and others. Supply chain managers were able to link low-level data about plant operations, product movements, and weather conditions into events that could be further examined by supply chain analytics tools because to CEP's capacity to record incoming data from real-time events. Production process data, for instance, might be abstracted to factory performance, and factory performance could be abstracted to business events pertaining to things like inventory levels.

An other significant development in the field of supply chain analytics was the introduction of cloud computing, which provided a new means of distributing platforms, software, and IT infrastructure as services. Improvements in supply chain analytics have been facilitated by the cloud, which offers a framework for coordinating data from various sources. The advent

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of data lakes such as Hadoop made it possible for businesses to gather information from many sources on a single platform, which improved supply chain analytics by allowing businesses to correlate a wider range of data types. Advanced analytics that worked with a range of structured and unstructured data from various applications, event streams, and the Internet of Things were also made simpler to execute by data lakes.

Robotic process automation, or RPA software, has grown in popularity as a potent tool for enhancing corporate automation and data integration into analytics. RPA software automates repetitive computer operations that were previously completed by humans.

In addition, supply chain analytics are getting better thanks to the application of deep learning, an artificial intelligence approach. Enhancements in machine vision (to facilitate better inventory tracking), natural language processing (to automate contract management), and routing model optimization are being propelled by deep learning approaches.

Utilizing supply chain analytics

Sales and operations planning create strategies that coordinate day-to-day activities with corporate strategy, using supply chain analytics to match a manufacturer's supply with demand. Moreover, supply chain analytics is employed in the following tasks:

Enhance risk management by recognizing existing risks and forecasting potential hazards by examining patterns and trends across the supply chain; boost planning precision by examining customer data to pinpoint variables that influence demand; enhance order management by combining data sources to determine fulfillment problems, forecast demand, and evaluate inventory levels;

Organize and analyze departmental spending to better negotiate contracts and find chances for discounts or alternate sources. Streamline procurement. Boost working capital. Improve models for calculating the necessary inventory levels.

Upcoming Developments in Supply Chain Analytics

The development of analytics models, infrastructure, data architectures, and the capacity to connect data across application silos will all continue to influence supply chain analytics. Over time, more intelligent supply networks will be able to handle and adapt to changes, much way self-driving cars are beginning to do now, thanks to improved analytics. Furthermore, as IoT, CEP, and streaming architectures advance, businesses will be able to extract insights from a wider range of data sources faster. People's capacity to produce increasingly precise and practical predicted insights that can be integrated into processes will continue to advance thanks to AI technology.

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The following other technologies are anticipated to be crucial to supply chain analytics and management:

Blockchain technology to enhance transparency and traceability: More layers of the supply chain will have better visibility and traceability thanks to blockchain infrastructure and technologies. These same building blocks may encourage businesses to automate, manage, and carry out transactions through the use of smart contracts, analytical graphs. Within ten years, graph analytics is expected to power over 50% of all enterprise applications, which will enable supply chain managers to more effectively examine the connections between different supply chain entities. Implementing blockchain to enhance transparency and traceability across the supply chain, ensuring trust and security in transactions, particularly in industries like food and pharmaceuticals.

Extreme automation: Increasing the digitalization and automation of supply chain processes, utilizing technologies like robotic process automation (RPA) and autonomous vehicles to streamline operations and reduce manual efforts. Supply chain automation will be accelerated by the hyperautomation-enabling technologies, which use process mining analytics to find automation candidates, create the automations, and oversee these automated processes.

Google acquired Skybox Imaging, a satellite imaging company, back in 2014. The primary aim was to utilize Skybox's technology to enhance Google Maps and Earth services. While Google leverages satellite imagery for mapping purposes and to provide up-to-date information about locations, it's important to note that using this technology specifically to track cars in a car park for anticipating in-store demand might involve privacy and ethical considerations.

IoT (Internet of Things) and Sensor Integration: Utilizing IoT devices and sensors to collect real-time data on shipments, inventory levels, and equipment conditions, allowing for better decision-making and predictive maintenance.

AI-Driven Supply Chain Risk Management: Using AI algorithms to identify, assess, and mitigate risks within the supply chain, considering factors like geopolitical issues, natural disasters, or supplier disruptions.

Contextual intelligence is supported by a wealth of data sets, which are being produced at an increasingly rapid pace via data supply chains in terms of volume, scope, and depth. An overview of 52 distinct sources of big data generated in supply networks is given in the accompanying figure. When the data sources are plotted according to their variety, volume, and velocity as well as the proportion of structured and unstructured data, it becomes evident

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that most supply chain data is produced outside of businesses. Big data is being viewed by progressive manufacturers as a stimulus for increased teamwork.

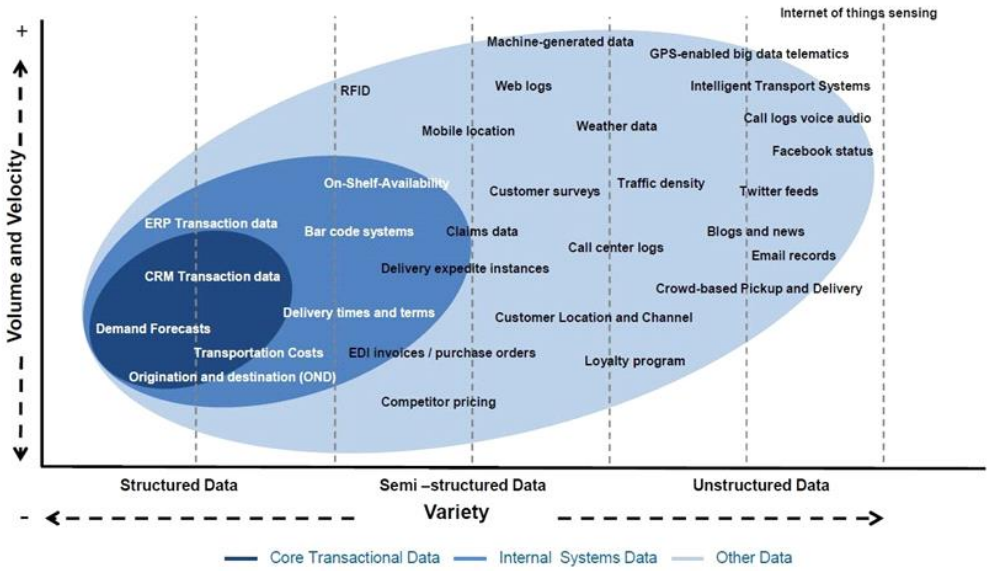

Figure 1. SCM Data Volume and Velocity vs. Variety

Figure 1 : Details Different Motivations for Employing Supply Chain Analytics:

Volume: This represents the sheer amount of data generated within a supply chain. With the advent of technology and interconnected systems, supply chains produce vast amounts of data daily. This data can come from various sources such as sales transactions, inventory records, production logs, transportation information, and more. Managing this large volume of data is crucial for making informed decisions in supply chain management.

Velocity: Velocity refers to the speed at which data is generated, processed, and analyzed. In supply chains, data is continuously flowing in from different points, such as sensors, RFID tags, ERP systems, and more. The faster this data can be collected, transmitted, and analyzed, the more agile and responsive the supply chain can be. Real-time data analysis enables quicker decision-making, allowing companies to adapt to changes or disruptions swiftly.

Veracity: Veracity focuses on the quality and reliability of the data. In a supply chain, data can come from various sources, and ensuring its accuracy and consistency is crucial. Poor data quality can lead to incorrect insights and decisions, potentially causing disruptions in the supply chain. Verifying the authenticity, reliability, and consistency of data helps in building trust and confidence in the information being used for decision-making.

"High-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision

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making, and process automation" is how Gartner (2012) defines big data. Furthermore, Laney (2001) defined big data using the "3V's" concept: Volume: Up until 2010, an estimated 13,000 Exabytes of data were generated, with 1 Exabyte being equivalent to 1 billion.The "3V's" idea, introduced by Laney (2001), defines big data as follows: Volume: Up to 2010, 13,000 Exabytes of data were generated, with 1 Exabyte being equivalent to 1 billion gigabytes (Firican, 2017).

Managing these three aspects—volume, velocity, and veracity—is essential for leveraging data effectively within a supply chain. It involves implementing robust data management systems, employing analytics tools for real-time insights, ensuring data accuracy, and establishing processes for maintaining data quality throughout the supply chain network. This holistic approach enables businesses to derive meaningful insights, optimize operations, and respond swiftly to changes in the market or within the supply chain itself.

Review of Literature

Big data applications in supply chain management seem to be covered and debated in the literature frequently; yet, there are a variety of poorly defined perspectives on this subject. The literature has some gaps and fragmentation for the following reasons: The supply chain's scope has changed significantly over the past 20 years from being synonymous with logistics (Cooper et al. 1997) to a mash-up of primary and supporting activities, ranging from purchasing to operations management, logistics and transportation, distribution and retail, relationship management, and information technology (Giunipero et al. 2008); multiple disciplines have handled SCM frequently, using different nomenclature, impeding the development of a cohesive body of knowledge (Maestrini et al. 2017).Supply chain optimization is becoming critical to modern industry. Businesses need to be able to optimize their supply chain in order to stay ahead of the competition. The possibilities, advantages, difficulties, and potential developments of big data applications in supply chain management are all covered in this study. Big Data is essential to supply chain management in many areas, including inventory management, logistics, product design and innovation, operational efficiency and upkeep, network architecture, and the creation of product and market strategies. The use of Big Data in supply chain management is justified by the growing volume of data exchanged by supply networks in the industrial and service industries. Big data in supply chain management may lead to improved decision-making, more productivity, lower costs, and improved risk management. IT capabilities and infrastructure, talent management and HR, information and cyber security, integration and collaboration, information management, governance and compliance, financial implications, and ethical and managerial implications are some of the challenges that come with introducing and implementing big data in supply chain management. Bigdata models in supply chain management, the use of big data on closed loop supply chain management, the application of

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big data at the supply chain management function level, and new big data techniques are among the areas for future directions in the development of big data research in supply chain management that were identified by the study(Mohsen,2022).

Due to climate change, sustainable supply chain management has been a major area of research for the past 20 years. From a global perspective, the United Nations has introduced sustainable development goals, which emphasize sustainability. Manufacturing supply chains are among those that release harmful effluents into the environment in addition to social issues that affect the societies and economies in which they operate. New developments in information and communication technologies, particularly big data analytics (BDA), can help create new insights that can identify and correct members of a supply chain whose activities are unsustainable. This conceptual paper reviewed pertinent material and made conclusions using Toulmin's argumentation paradigm. According to this study, data processing, analytics, reporting, integration, security, and economics are the components of big data analytics. Transparency, a sustainability culture, company objectives, and risk management are components of sustainable supply chain management. It is proven that BDA improves manufacturing supply chains' SSCM. Among the obstacles preventing BDA deployment are cyberattacks and a skills gap in information technology. By utilizing Toulmin's argumentation model, which is rarely employed in management studies, to connect big data analytics and supply chain supply chain management (SSCM) in manufacturing supply chains, the research contributed conceptually and methodologically to the literature on supply chain management.(Mageto, 2021). Dubey et al. (2018) tested the effects of big data and predictive analytics on visibility and coordination in humanitarian supply chains using ordinary least square regression. Shafique et al. (2019) examined the association between supply chain success and big data predictive analytics uptake in the Chinese pharmaceutical logistics business using partial least square structural equation modeling (PLS-SEM).

Smart devices have the capacity to continuously gather smart data, process the data using advanced analytics, and produce insights that can expand knowledge and direct corporate decisions, particularly with regard to achieving sustainability. Data is gathered from all aspects of the manufacturing supply chain, including the procurement of raw materials, manufacturing, use, services, and end of life. Consequently, he contended that intelligent or smart technologies and devices are used in big data analytics, enabling continuous data gathering and analysis as well as the extraction of insights for improved decision-making. For smart logistics to work, the smart devices must be able to react to unanticipated situations. For example, they must be able to reroute traffic on the main route in order to save fuel and distance (Seliger,2016).

According to Gunasekaran et.al.(2016) statements of truth, figures, or professional judgments that offer proof and data that sustainable supply chain management and big data analytics go

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hand in hand. There is enough proof to suggest that supply chain big data analytics can be implemented successfully. Supply chain management tasks, including risk management, sourcing, cost reduction manufacturing and production planning , supplier selection, and management ,Demand management , inventory management and logistics planning , and warehousing BDA has been used in supply chain management in general, as well as demonstrated in order to cut the cost.

Prescriptive analytics was given the most weight, followed by predictive analytics, while descriptive analytics was given the least weight. Prescriptive analytics gathers application data from newly introduced processes like Cyber Physical Systems in the Industry 4.0 trend, as well as from established processes like Manufacturing, Logistics, Transportation, and Warehousing. Procurement, risk assessment, risk management, and forecasting are among the areas where predictive analytics finds considerable use. The application of descriptive analytics is shown in the creation of easily interpreted reports on unprocessed data that are both efficient and summarized. Historical data is the primary type of data utilized in descriptive analytics (Nguyen, Zhou, Spiegler, Ieromonachou, & Lin, 2017). In their 2019 study, Irfan and Wang examined the effects of data-driven skills on company competitiveness and supply chain integration in Pakistan's food and beverage sector. They used the structural equation modeling method to gather survey data and evaluate their theories. Using a structural equation modeling technique

In their study of 2022, an extensive review of big data supply chain analytics (BDSCA) was carried out. The use of big data in supply chain management and its advantages for businesses and society were examined in the research paper. The study also looked at the operational, security, privacy, and ethical issues with big data approaches, as well as the possible harm to a company's reputation. Four main aspects were covered in the review: big data analytics, applications, ethics and privacy concerns, and how businesses used this new technology to plan ahead and even foresee the future. Seven themes and fourteen sub-themes represent the various levels and distinctive conceptual stances on which these key features are constructed. Based mostly on 120 publications (2005–2020) from prestigious academic journals, this research paper was developed by the authors (Ogbuke, et.al 2022).

Businesses can obtain a number of immediate benefits in their operations by utilizing big data in SCM (Chen et al. 2015). The optimisation of quality-product trade-off can assist in producing high-quality products at lower costs (Mubarik et al. 2019). For example, analysing point of sale data can assist with pricing and special services for each customer group. Analyzing inventory and shipping data can reduce lead times and increase product availability, and consequently increase sales amount (Chen et al. 2015). Additionally, tiny markets can benefit from the usage of Radio Frequency Identification (RFID) by enhancing the logistics function's decision-making process (Navickas and Gruzauskas 2016). The

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additional uses of big data in SCM are fraud detection tools and behavioral analytics (Patil 2017).Businesses who have used Big Data analytics in a systematic manner have seen higher returns on their individual investments in the technology. This is according to a research conducted by Accenture in 2014. Big Data and Big Data Analytics can be used in Supply Chain areas like Marketing, Procurement, Transportation, and Warehousing, as it is clear that these strategies can yield a good Return on Investment (Benabdellah et al. 2016).

Scholars are increasingly interested in studying real-time optimisation models in manufacturing and production to improve the efficiency of the production processes. The use of modeling and simulation in the development of real-time production control systems is growing, with tracking devices such as RFID and sensors offering a steady and adequate flow of real-time data (Zhong et. al. 2015). Ji et. al. (2017) forecasted direct food production and market demand accurately by using a Bayesian network to establish a cause-and-effect relationship between the variables. IoT is another big data application that is related to supply chain management (SCM) since it improves operational efficiencies and opens up chances to reduce costs in the production, distribution, sourcing, and procurement processes (Aryal et al. 2018; Kim 2017).

Four separate but connected departments, including marketing, procurement, warehouse management, and transportation, can be combined to form the supply chain. Supply chain management is in charge of establishing and preserving the connections between various company entities that are in charge of everything from raw material acquisition to the final delivery of the product to the end customer (Halo, 2018). This paper focused on the sources of data generated in supply chains, the opportunities that arise from analyzing collected data, and the difficulties associated with using that data. Author talked about the significance, possible uses, and difficulties of big data applications in supply chain and logistics in this review paper. Asrini et al. (2020) examined the effects of supply chain integration, learning, big data analytics skills, and supply chain agility on the performance of the company in Indonesian pharmaceutical enterprises. The impact of big data supply chain analytics and supply chain integration on supply chain efficiency was investigated by (Mubarik et al. 2019). This included an examination of the effects on forecasting and supplier management, sourcing, production, inventory management, and transportation. They employed covariance-based structural equation modeling to quantify the correlations.

The United Nations has established sustainable development goals that are oriented towards sustainability on a global scale. Due to of climate change, sustainable supply chain management has been a significant area of research over the past 20 years. Supply chains in the manufacturing industry are among those that not only cause social problems that affect the communities and economies in which they operate, but also release hazardous waste water into the environment. The emergence of novel insights that enable the identification of

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unsustainable supply chain components and members and the implementation of remedial measures can be facilitated by the latest advancements in information and communication technologies, particularly big data analytics (BDA). Studies on the impact of BDA on sustainable supply chain management (SSCM) in the context of manufacturing supply chains are scarce, despite the fact that SSCM has been the subject of numerous studies.(Joash Mageto,2021). This conceptual paper reviews pertinent material and makes conclusions using Toulmin's argumentation paradigm. According to the study, data processing, analytics, reporting, integration, security, and economics are the components of big data analytics. Transparency, a sustainability culture, company objectives, and risk management are components of sustainable supply chain management. It is proven that BDA improves manufacturing supply chains' SSCM. Among the obstacles preventing BDA deployment are cyberattacks and a skills gap in information technology. By utilizing Toulmin's argumentation model, which is rarely employed in management studies, to connect big data analytics and supply chain supply chain management (SSCM) in manufacturing supply chains, the research contributes conceptually and methodologically to the literature on supply chain management.

The development of software and technological solutions, according to Hofmann et al. (2017), is one of the key elements in the success of supply chain finance programs because it enables businesses to collaborate and accelerate cash flows throughout the supply chain. This suggests that the use of big data must also have an impact on organizational administrative processes, with time optimization being the primary benefit. This is consistent with the statements made by Sodero et al. (2019) and Boone et al. (2019) regarding the predictive use of data in the logistics of supply chain operations and the potential for generating a sales forecast and consumer analysis based on sufficient data processing. A challenge in the supply chain pertains to the strategic placement of distribution centers. By utilizing data mining in conjunction with a clustering algorithm that relies on large data clusters, this link in the chain can be better managed to enable effective responses to the company's sales indicators based on what the market will bear (Li, 2019). Because the data indicates consumer behavior, sales forecasting is therefore one of the supply chain's most practical benefits (Boone et. al., 2019). Given the potential impact on the firm's performance, this is not a little detail, which is why one of the biggest company budgets is now allocated to its implementation.

Few researches have attempted to address big data-driven optimization methodologies for warehouse difficulties like order-picking and routing. Mathematical modeling, simulation, and heuristic and metaheuristic solution methods have all been used to tackle such issues (Ardjmand et al. 2020; Cano et al. 2020; Schubert et al. 2020; Shavaki and Jolai 2021a, b). According to Nguyen et al. (2018), the review revealed that not much is known about real-time optimization models to improve the efficiency of the manufacturing and logistics

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process. Research on the subject of big data management in supply chains is scarce. Conceptual models of data infrastructure, big data management tools, and suggested strategies for dealing with the massive volume of big data are available.

Alsobi et.al.(2023)in contrast to other literature reviews that mostly concentrated on big data analytics, the scope of their systematic literature review included both big data management and optimization research in supply chain management from recent years. They provided their work a unique multidimensional structure. By (i) providing a definition of big data optimization, explaining how big data is optimized, and outlining strategies for optimizing big data in supply chains, they thought that their study will be able to overcome the prior constraints. (ii)They also compared popular big data management tools and their industrial applications. To improve the validity of their study and facilitate its adoption, they changed an established review approach by adding a reporting flowchart and a content analysis method.

Conclusion

Leading companies are already utilizing big data to improve the efficiency of their supply chains, as demonstrated by the examples provided above.The supply chain industry may be able to overcome obstacles with the help of big data analytics. But there are challenges, like the requirement for infrastructure and a lack of qualified workers. Big Data is characterized by its quantity, diversity, speed, accuracy, and worth. It provides insightful information that is applicable to product development, demand forecasting, and client feedback, among other areas. Big Data analytics is divided into three levels: descriptive, predictive, and prescriptive. Every level has a distinct purpose and intended result. New models and methods are needed because supply networks are becoming more complicated and because data generation is increasing. More precise and extensive data generation depends on advances in data integration technologies and sensor accuracy.

Many businesses are being held back by limited capabilities and an unstructured approach to supply chain analytics. For sophisticated analytical and large-scale data instruments to provide more advantages for a larger number of businesses, those entities require a more methodical strategy. Supply chain analytics, which presents creative answers to difficult problems, will continue to influence supply chain management in the future. Scholars and practitioners have the opportunity to significantly improve the sustainability, resilience, and efficiency of global supply chains by adopting emerging technology and filling up current gaps.

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References:

[1].Ansari, Z. N., & Qureshi, M. N. (2015). Sustainability in supply chain management: An overview. IUP Journal of Supply Chain Management, 12(2).Proceedings of the International Conference on Industrial Engineering and Operations Management ,Washington DC, USA, September 27-29, 2018.

[2].Asrini M, Setyawati Y, Kumalawati L, Fajariyah NA (2020) Predictors of firm performance and supply chain: evidence from indonesian Pharmaceuticals Industry. Int J Supply Chain Manage 9(1):1080

[3].Alsolbiet.al.(2023)Big data optimisation and management in supply chain management: a systematic literature review Artificial Intelligence Review, 56:S253–S284 https://doi.org/10.1007/s10462-023-10505-4

[4].Awwad et.al. (2018).. "Big Data Analytics in Supply Chain: A Literature Review, Proceedings of the International Conference on Industrial Engineering and Operations Management Washington DC, USA, September 27-29, 2018

[5].Boone, Tonya &Ganeshan, Ram & Jain, Aditya & Sanders, Nada. (2018). Forecasting sales in the supply chain: Consumer analytics in the big data era. International Journal of Forecasting. 35. 10.1016/j.ijforecast.2018.09.003.

[6].Chen DQ, Preston DS, Swink M (2015) How the use of big data analytics affects value creation in supply chain management. J Manage Inform Syst 32(4):4–39

[7].Dubey R, Luo Z, Gunasekaran A, Akter S, Hazen BT, Douglas MA (2018) Big data and predictive analytics in humanitarian supply chains. Int J Logistics Manage 29(2):485–5122

[8].Exploring The Role Of Data Analytics In Enhancing Supply Chain Efficiency downloaded from https://iabac.org/blog/exploring-the-role-of-data-analytics-in-enhancing-supply-chain-efficiency dated 4 December at 11.12 a.m.

[9].Irfan M, Wang M (2019) Data-driven capabilities, supply chain integration and competitive performance: evidence from the food and beverages industry in Pakistan. Br Food J 121(11):2708–272911

[10].Govindan K, Cheng T, Mishra N, Shukla N (2018) Big data analytics and application for logistics and supply chain management. Transportation Research Part E-Logistics and Transportation Review. vol 114, pp. 343-9

[11].Gunasekaran, A.; Manoj, T.K.; Dubey, R.;Wamba, F.S. Big data and predictive analytics applications in supply chain management.Comput. Ind. Eng. 2016, 101, 525–527.

[12].Ji G, Hu L, Tan KH (2017) A study on decision-making of food supply chain based on big data. J Syst Sci Syst Eng 26(2):183–1982

[13].Huang, T.; Lan, L.; Fang, X.; An, P.; Min, J.; Wang, F. Promises and challenges of big data computing in health sciences. Big Data Res. 2015, 2, 2–11.

[14].Karbach, J. Using Toulmin's model of argumentation. J. Teach. Writ. 1987, 6, 81–91.

Power System Technology
ISSN:1000-3673
Received: 16-09-2024 Revised: 05-10-2024 Accepted: 22-11-2024

[15].Krumeich, J.;Werth, D.; Loos, P. Prescriptive control of business processes. Bus. Inf. Syst. Eng. 2016, 58, 261–280.
[16].Chase, C. Next Generation Demand Management: People, Process, Analytics, and Technology; John Wiley & Sons: Hoboken, NJ, USA,2016.
[17].Mageto J.(2021) " Big Data Analytics in Sustainable Supply Chain Management: A Focus on Manufacturing Supply Chains", downloaded from https://www.semanticscholar.org/paper/Big-Data-Analytics-in-Sustainable-Supply-Chain-A-on-Mageto/60bcbf8a4ce55fbc23a9eadb38d7c64ab4ec65b6
[18].Mani, V.; Delgado, C.; Hazen, B.T.; Patel, P. Mitigating supply chain risk via sustainability using big data analytics: Evidence from the manufacturing supply chain. Sustainability 2017, 9, 608.
[19].Mohsen B.(2022). " Role of Big Data in Supply Chain Management" International journal of Management,13(5):24-40,downloaded fromhttps://www.researchgate.net/publication/370183948_Role_of_Big_Data_in_Supply_Chain_Management
[20].Mubarik M, Zuraidah R, Rasi B (2019) Triad of big data supply chain analytics, supply chain integration and supply chain performance: evidences from oil and gas sector. 7(4):209–224Humanities and Social Sciences Letters
[21].Navickas V, Gruzauskas V (2016) Big Data Concept in the food supply chain: small market case. Sci Annals Econ Bus 63(1):15–281
[22].Ogbuke et.al. (2022). Big data supply chain analytics: ethical, privacy and security challenges posed to business, industries and society, Production Planning & Control, 33:2-3, 123-137.
[23].Shafique M, Khurshid M, Rahman, Khanna A, Gupta D (2019) The role of big data predictive analytics and radio frequency identification in the pharmaceutical industry. IEEE Access 7:9013–9021
[24].Stock, T.; Seliger, G. Opportunities of sustainable manufacturing in industry 4.0. Procedia CIRP 2016, 40, 536–541.
[25].Zhong R, Huang G, Lan S, Dai QY, Chen X, Zhang T (2015) A big data approach for logistics trajectory discovery from RFID-enabled production data. Int J Prod Econ 165:260–272