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Navigating the Quality Quandaries: Big Data Applications' Challenges in Supply Chain Management

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Abstract:-Consumers anticipate that businesses involved in a supply chain will provide the required goods at the proper moment, which requires adaptable manufacturing and modification, high service standards to address facility location challenges, fewer forecasting errors, less expensive procurement, and quicker supply chain interactions.However, with the availability of a variety of information sources and the ability to manage a massive and varied amount of real-time data on the life cycles of goods, outbound/ inbound logistics, customer-product interactions, and market needs, this issue may now be reduced to a minimum. Hence, this paper provides informative discussions on quality Assurance Challenges for Supply Chain Management Big Data Applications.The publications taken into consideration for this study were published between 2011 and 2021. A thorough literature study was used as the research methodology. A minimum of 50 peer-reviewed academic publications, conference proceedings, and business white papers were examined. The articles were compiled using the Thomson Reuters Web of Science, a descriptive analysis was conducted, categories were created, and the content of the articles was evaluated.

A discussion of quality assurance issues for supply chain management applications using big data is presented in this paper. Moreover, it introduces and discusses supply chain analytics based on big data, its importance, challenges, and applications. Furthermore, quality assurance issues for big data applications were presented.

Big Data Analytics requires expensive infrastructure. Therefore, by focusing research efforts on lowering the costs of storing Big Data, Big Data Analytics could become more widely available.

Keywords:-*Big Data Analytics, logistics systems, Quality assurance, Supply chain management, Manufacturing system.*

I. INTRODUCTION

According to Li et al.in [1], the term "Big Data" has attracted a lot of attention from the academic community as well as from corporations, governments, and the publicsince 2011. Although some academics believe that big data began in the middle of the 1990s, there have not been any reports of literature work published for more than ten years [2]. Controlling customer and supplier value is supply chain operations management's most important task[3]. To do this, supply chain operations management must combine reliable multi-market models with demand data [4]and supply-focused procedures [5]. Customers expect companies in a supply chain to provide the needed items at the appropriate time, which necessitates flexible production and customization, high service levels to handle facility location issues, fewer forecasting mistakes, cheaper procurement, and speedier supply chain interactions [6,7]. This operational efficiency was extremely challenging to accomplish until recent years.

Nevertheless, this problem may be minimized now because of the accessibility of numerous knowledge sources and the capacity to handle in real-time [8] a vast and varied quantity of data on goods' life cycles, inbound/outbound logistics, product-customer interactions, and market demands [9,10]. Consequently, those involved in supply chain operations management may create an industrial digital ecosystem that enables them to collect and depend on information in support of the fusion of supply- and demand-focused activities [11]. Big data is a component of a growing market that will change how supply chains are handled and created in this setting[12]. Several new literature evaluations in the field of supply chain management provide more evidence of the crucial function that big data plays[13], also paying close attention to how operations management is practiced [14]. The most important factor to consider is making sure that the data are used in a way that is valuable and helps to address actual challenges and problems using network representation learning and neural network methodologies[15].

Considering this, the following research questions will get explicit contributions from this study.

- What are the roles of Big Data inthe Supply Chain?
- What are the obstacles to the supply chain adoption of big data analytics?
- How are the applications of Big Data Analytics in the Supply Chain?
- What are the issues with Quality Assurance in Big Data Applications?

A. Aim

This paper aims to provide informative discussions on Quality Assurance challenges for Supply Chain Management Big Data Applications

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II. LITERATURE REVIEW

According to Mikalef*et al*in[16], a systematic assessment of the literature on the subject of "Big Data Analytics" revealed varying opinions on both its definition and the benefits that businesses might obtain from it to achieve their organizational objectives. Big Dataare datasets that are too large to be managed, captured, stored, and analyzed by standard database software tools[17]. The dimensions of the data that are used to describe them as "big," which vary based on the sectors, industries, and technology involved, are the main emphasis of this approach.However, Chen and Zhang in [18]studied Big Data Analytics, which refers to extremely large (varying between terabytes and exabytes) and sophisticated datasets and analytical software tools (connecting the sensor to the data on social media), which demand cutting-edge and distinctive data management, storage, processing, and visualization technologies. This clarified big data's impact on analytical processes. Several academics have also claimed that the distinctive qualities of a wide range of unstructured, structured, and semi-structured data sources contribute to big data analytics' high success rate,which mostly originates from the usage of mobile devices, social media, healthcare,and product assessment [15].

Dubey*et al.*in[19]stated that examining this trend will show how crucial connectivity is to supply chain networks and businesses.Big data analytics provide additional details on the development of supply chains and how companies may utilize their resources to improve both external and internal organizational operations[17]**.**This demonstrates how the physical supply chain is impacted by big data because supply chain management necessitates coordinated efforts to develop and transport a finished commodity from supplier providers to the customer's clients. The justification given above demonstrates that the goal of supply chain management is to seamlessly integrate information and material flow across the supply chain as a powerful instrument for competition [1]**.**Some scholars have also underlined that maintaining an advantage in the marketplace requires more than just refining internal processes and efficiency [20], as managing the supply chain sustainably is crucial to reducing costs, increasing agility, and utilizing the available resources. Big data and predictive analytics have been shown to improve visibility, resilience, and robustness in the supply chain, according to Gunasekaran*et al.*[21]**.**In addition, they mentioned further opportunities that may be realized if senior management is committed to incorporating the technology into the organization's procedures.

Harris *et al.*in[22]give a convincing debate on how technological improvements may affect supply chain integration and highlight the potential uses of ICTs, such as Big Data Analytics, to optimize the freight transportation supply chain. According to Chelbi-Gamoura*et al.* [23], the combination of supply chain management with big data analytics opensseveral possibilities. Zhang and Xiao[24]**,** on the other hand, examined how a data-rich environment presents previously unheard-of opportunities for product innovation as well as useful insights into comprehending customer demands. Different industries, as well as society and the government, have adopted this innovation because of its advantages in providing pertinent business insights to organizations like Microsoft, Google, EMC, Facebook Oracle, Amazon, and IBM [15]. This supports the finding that e-commerce businesses with big data analytics integrated into their value chains outperform their competitors in terms of productivity by 5% to 6%[17]. Additionally, the supply chain shocks and alterations experienced throughout the COVID-19 pandemic and post-pandemic recovery periods amply illustrated the need for digital technologies for supply chain network mapping and preserving visibility[25].

III. REVIEW OF RELATED WORKS

Manufacturing companies employ big data analytics to improve the intelligence and effectiveness of their designs and applications throughout the whole manufacturing value chain, which include Research and development, supply chain, and service and manufacturing processes [1]. Using big data solutions may shorten the product development cycle, improve assembly efficiency, boost yields, and satisfy customer demands. Big data has increased organizational efficiency by enhancing operations, fostering innovation and flexibility, and optimizing resource allocation, according to Kshetri[26]. Big data's definition now includes a variety of characteristics because of how widely used it is. Dubey*et al.*[19] claim that big data is a challenging process that requires storing, retrieving, and processing semi-structured, structured, and unstructured data to extract important information to improve decision-making skills.Big data analytics, according to Mikalef*et al.*[16], refers to a collection of technologies and architectures that provide speedy data capture and analysis to profitably extract value from very large amounts of data. Lamba and Singh[2] also affirm that a business cannot effectively use big data to generate value if there are no technologies in place to gather, store, and retrieve copious quantitiesof data, as big data's potential for use in a range of sectors depends heavily on developments in storage and processing technology. Better data exploitation and the promotion of connections inside businesses and within supply chain networks were also made possible by big data [19]**.**More precisely, the application of big data analytics may improve supply chain resource management and communications for demand forecastingbecause supply chain management presently has many processes and auxiliary systems that help with the implementation of business strategies and operations to increase organizational competitiveness[27].

A. The Roles of Big Data in the Supply Chain

Data generation is rapidly expanding because of technological advancements in the Supply Chain's enterprises. The information flow was documented on paper before the supply chain adopted information technology. The vast majority of material flow information nowadays is captured as digitally structured data. Nowadays, the Supply Chain is worldwide, and big data may be characterized as the quantity of data acquired from its numerous operations and the rate at which it is created. Moreover, companies like marketing and sales today depend on the analysis of both structured and unstructured data to better understand

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customer needs and lower the cost of supply chain operations. Big Data utilization may be very beneficial for things like product creation, forecasting market demand, sourcing choices, distribution planning, and consumer feedback. Figure 1 summarizes the contributions of big data to each commercial field[28].

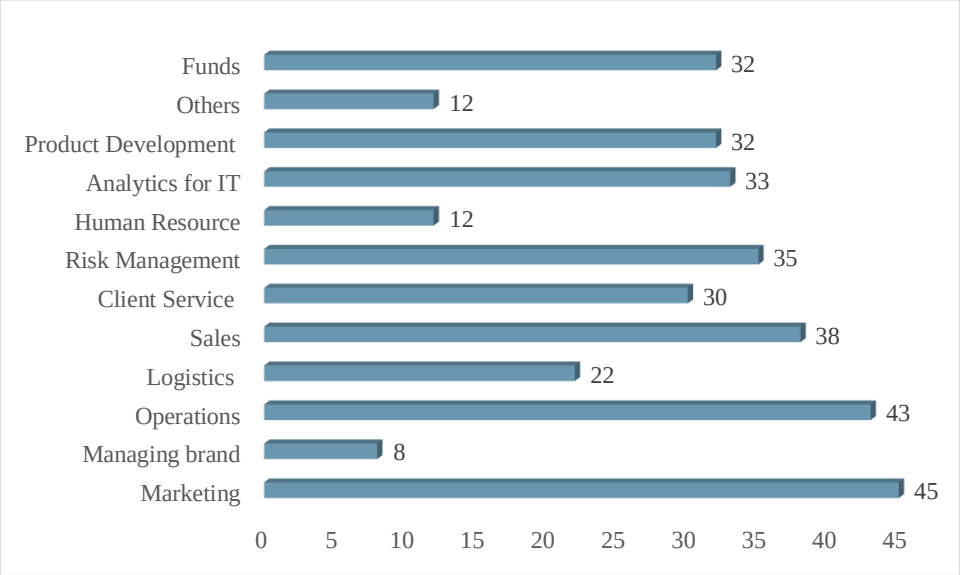

Fig. 1: Contribution of big data in commercial fields (%) [28].

B. Supply Chain Big Data Analytics Applications

According to a computer industry article, giving priority to the creation of a Big Data analytics plan can help your business get through these Supply Chain problems.A supply chain should use big data and big data analytics to improve in areas like the evaluation of the supply chain, including its overall performance, risk assessment, and reaction time, as well as the forecasting of consumer demands [29].

- **Enhancing Consumer Need Predictions**: If businesses do not meet client needs, they risk losing customers. Moreover, incomplete, or non-fulfillment of orders might harm a company's image. In the era of the consumer, achieving (or maintaining) customer happiness and loyalty depends on providing the right product to the right person at the appropriate time and location. Smart businesses will use big data to obtain a complete 360-degree perspective of their customers so that they can better understand their preferences, foresee future demands, and offer a distinctive brand experience.
- **Accelerating Response Time:** 90% of businesses claim that speed and agility are crucial or extremely crucial to their operations. The second most significant factor in determining competitive advantage across all businesses is the capacity to act fast and flexibly to accomplish customer satisfaction objectives.According to Accenture, integrating big data analytics into operations may enhance order-to-cycle delivery times by 4.25 times and affect how quickly firms respond to supply chain problems (41%).
- **Enhancing Supply Chain Efficiency**: Supply chain management will continue to place a high priority on the use of Big Data analytics for suitable cost efficiency, cost reduction, and spend analytics.
- **Increasing Supply Chain Traceability:** Better traceability provides more accurate tracking of products from manufacture to retail. An improved supply chain may be maintained by improving traceability and integrating the various supply chain participants. Improved tracking capabilities improve the management of supply chain operations.
- **Enhancing Supply Chain Risk Assessment:** A significant component of Big Data Analytics is predictive analytics. Predictive analytics may be used to evaluate the likelihood that an issue will arise and its possible effects. By examining vast amounts of historical data and using risk-mapping techniques, predictive analytics in big data can aid in the detection of supply chain vulnerabilities.It is possible to create tools and procedures to reduce the impact of prospective hazards by making accurate predictions of the risks.

There are certain potential and uses for big data analytics that are process-specific in addition to those that are attribute-specific, as illustrated in Figure 2 and Table 1.

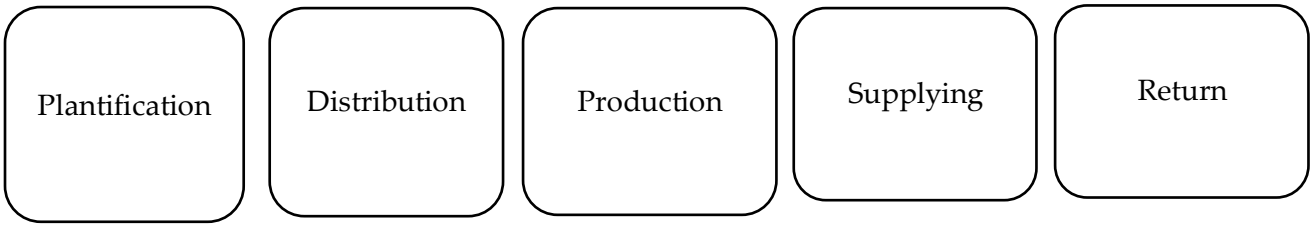

Fig. 2: Possible applications for big data analytics **[30]**.

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Table 1:Big Data Analytics Applications

Procedure	Uses
Planification	i. Risk assessment and preparing for resilience. ii. Enabling performance tracking, as well as enhancing planning and management processes. iii. Minimize the risk associated with contractual external capacity and infrastructure expenditures.
Supplying	i. Decrease distribution and storage space. ii. Obtain aggregated purchase patterns at granular levels. iii. Creating additional supplier networks with an emphasis on knowledge sharing and cooperation rather than simply transactional value.
Production	i. Market research for small- and medium-sized businesses ii. Obtaining real-time capacity availability, responding more quickly, and managing vendor inventories iii. The greatest data clusters relate to applications for material handling and packaging systems that include automated sensing, networking, and intelligence.
Distribution	i. Shorten lead times, cut expenses and delays, as well as process halts. ii. Route optimization in real-time, address confirmation, crowdsourced picking up and delivering, and environmental intelligence. iii. Increase the traceability of the supply chain. iv. Calculated lead times depending on weather and traffic factors, as well as the real-time marginal cost for various channels. v. Delivery route optimization in real time vi. Improve supply chain effectiveness, lower costs, and customer satisfaction to optimize logistics activities. vii. Improve the administration of the shop floor, the production logistics, and the manufacturing processes
Return	i. Lowering driver turnover, assigning drivers using sentiment analysis of data ii. ii. Get insight into how customers view the goods and services being supplied and identify any unobservable qualities. iii. Management of customer loyalty, ongoing service enhancements, and product innovation iv. With the advent of big data and the ability to sense social activity, technology has made it easier than ever to obtain and comprehend customer data. v. Advantages for businesses and the government (such as in urban planning) (e.g., localized advertising, optimized routing) vi. Integrating customer contacts and operational performance to ensure that the sender and recipient are both satisfied. vii. Obtain and comprehend client data because big data makes it possible to detect social activity.

C. Challenges in the Adoption of big data analytics for the supply chain

Organizational and technical hurdles are two main categories that may be used to classify the problems and obstacles associated with implementing big data analytics for the supply chain[31].

➢ *Organizational issues*

- *A lack of resources*: better results can be achieved using real-time data. The supply chain is a platform for generating complex cross-functional data that can be stored and accessed by a variety of organizations connected via the supply chain.
- *Concerns about security and privacy*: Data sharing across a supply chain network is one of the essential elements in acquiring data from many sources, processing it, and delivering insights.Regional or worldwide supply chain networks may not be able to communicate data due to different privacy and security regulations. In these circumstances, the accuracy of any insights that big data analytics may offer may be compromised by a lack of shared data.
- *Problems with Return on Investment*: It is challenging to determine the value of the acquired data due to the amount and variety of Big Data. Building the infrastructure for Big Data analytics needs a large financial commitment. There is a higher risk of the returns that an investment in infrastructure may provide since the value of the data is unpredictable.
- *Time-consuming*: Big Data quantity, supply chain complexity, and information interpretation objectives, as well as external constraints like limited access to data, all contribute to how time-consuming the analytics process is.
- *Behavioral problems*: If those in charge react to minor modifications in the physical world, it might increase supply chain risk and inventory cost, which would exacerbate the "bullwhip effect". Decision-makers are more likely to uncover irrelevant correlations but statistically significant relationships with weak causal links due to the variety and volume of Big Data.
- *A lack of expertise*: Given the complexity of Big Data created from Supply Chain sources, it is necessary to combine solid subject knowledge, analytical proficiency, and the capacity to assess the data's applicability. According to studies, it might be challenging to locate such a mix of expertise.

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➢ *Technical issues*

- *Data Accuracy*: The caliber of the data that is saved and used may have an impact on how effectively the analytics methodologies produce their results. Based on its origins and uses, data is intangible and multifaceted. There are two types of dimensions in the multidimensional dataset: intrinsic and contextual. For reliable and consistent results that may be used to make decisions, consistent data quality is required. The supply chain's utilization of various data sources and data diversity could affect how well the data is obtained.
- *Data scalability*: Its issue Applying big data analytics to any system presents a few technological challenges, with data scalability being one of the most significant. The insights from Big Data Analytics are hampered by enterprises' incapacity to transition from old, constrained databases to distributed databases or cloud storage databases.
- *Inadequate techniques*: The incapacity of a corporation to use the data affects the validity of the findings reached after reviewing the datasets. The approaches used for analysis, computing, forecasting, and visualization need to be improved or adjusted in response to the complexity or volume of data [31].

➢ *Issues with Quality Assurance in Big Data Applications*

Large-scale data quality control and validation face many significant problems and difficulties, as mentioned by Tao *et al.*[32]. These are some common examples,

- *Appropriate test models and test coverage standards for applications utilizing big data as a service.*

Applications and service systems based on big data are being developed for use in several parts of our daily lives, such as smart cars, smart cities, business intelligence, environmental control, and other fields, as big data technology and analytics methodologies progress quickly. Concerns about quality assurance are raised by the growing deployment of big data applications and services. To satisfy the validation requirements of software applications in functions, behaviors, and structures, several current white-box and black-box software test models as well as suitable validation criteria have been established in the past. Nevertheless, all currently available appropriate test models only pay attention to program structures, state-based behaviors, and functionalities. The absence of research on sufficient test modeling and coverage analysis for large data application systems considering their characteristics and requirements in rich Oracle functionality, the evolution of knowledge-based systems using machine learning, as well as multidimensional large-scale data sets are the challenges for the community of software testing and quality assurance. Thus, real-world practitioners report that there is a definite need for creating unambiguous test coverage standards for large data application systems. Otherwise, it will be challenging for engineers and big data analysts to determine when to halt quality testing for big data applications. This brings about the first requirement listed below. To meet the unique features and requirements of big data applications and services, it is necessary to build well-defined suitable validation models and criteria.

- *Programs and standards for big data system quality assurance that are well specified, including procedures, evaluation metrics, rules, and policies*

For large data quality assurance, ISO is striving to update current data quality assurance standards and initiatives. The issue of quality assurance and control for big databased systems must be addressed given the popularity of big data applications and services [33]. To assure system quality, it is necessary to build quality assurance procedures and standards that consider the unique QoS criteria and features of big data applications and services.

- *Tools and solutions for test automation that enable thorough and efficient testing of big data services and applications.*

For engineers, several test automation tools and solutions have been developed over the past three decades to support test automation operations. However, most of these tools are only useful for checking the QoS parameters and other software system behaviors, functions, and program structures. Regarding validation methodologies, a few publications have been published. Nevertheless, the unique characteristics and requirements of big data application systems are not addressed by the design and development of these validation methodologies. There have been a few published research studies addressing specific validation needs in big data-based systems, as highlighted by [32]. Yet, research on automatic validation techniques and approaches for large data application services is lacking. To handle the unique requirements and features of big data application systems and services, it is necessary to develop more creative and effective testing methodologies and test automation tools. These anticipated test automation solutions, in contrast to traditional software test automation tools, must consider the unique characteristics of big data applications, as depicted in Figure 2.

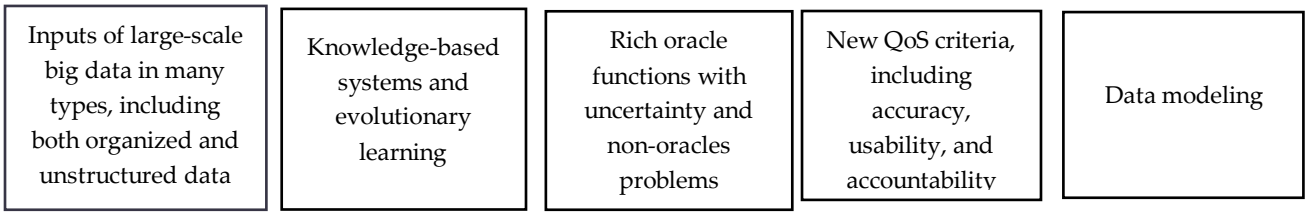

Fig. 2: Big data applications' special features

D. Gaps identified in reviewed studies

According to the literature and a survey of companies' experiences with big data analytics in manufacturing, more applied case studies have been published than theoretical ones. There is a high expectation that academia will provide more cutting-edge big data applications for industrial systems, such as methods that will minimize the time and money required to acquire high-quality solutions. Furthermore, the quality of the model used to analyze the data has a significant impact on the accuracy of big data analysis beyond only the quality of the data that is analyzed. It is still necessary to develop metrics that can assess the precision of a large data analysis technique. There are few studies of analytical models in the existing literature on the application of big data to supply chain management, which is predominantly theoretical and conceptual. In addition, many of the analytical models in use now focus primarily on the use of big data for modeling sustainability. Thus, big data is not yet widely applied to the optimization of supply chain operations (such as logistics and procurement).

IV. METHODOLOGY

The publications taken into consideration for this study were published between 2011 and 2021. A thorough literature study was used as the research methodology. A minimum of 50 peer-reviewed academic publications, conference proceedings, and business white papers were examined. Applications of big data in supply chain management are briefly discussed in this article. Thomson Reuters Web of Science was used to compile the articles, perform the descriptive analysis, create the categories, and assess the content.

V. CONCLUSION

It has become increasingly important to provide high-quality big data application services as big data management technologies and analytics solutions have developed rapidly. Yet, businesses and organizations are seeing a spike in quality problems that are costing them money because of erroneous data. This paper presents insightful talks on quality assurance concerns for supply chain management applications of big data. The article also defines and examines the idea of big data supply chain analytics, as well as its significance, difficulties, and applications. In addition, problems with quality control for large data applications were discussed. Big Data Analytics requires expensive infrastructure, therefore, research efforts should be directed at reducing the cost of storing Big Data so that Big Data Analytics will become more accessible. To boost the quantity and quality of the data produced by numerous activities, including manufacturing and logistics, it is important to increase the sensor precision in physical systems, and there is room for improvement in the data integration technology across different business processes.

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