THE EMERGING ROLE OF BIG DATA ANALYTICS ON SUPPLY CHAIN MANAGEMENT

Ketan Rathor

Department Information Technology, Birla Carbon

Abstract

The use of big data analytics, also known as BDA, is becoming more essential in the domain of supply chain management (SCM), which is acquiring substantial significance overall. This assertion is supported by the data that BDA demonstrates versatility, which makes it appropriate for use in a wide variety of processing operations associated with supply chain management (SCM). This category has a wide reach, including a diverse range of jobs. These vocations include trend analysis, demand forecast, and consumer behaviour assessment, among others. This comprehensive literature review has three primary objectives: to classify the different uses of predictive big data analytics (BDA) in supply chain demand forecasting, to identify specific areas that need further investigation, and to propose potential directions for future research. In the current economic climate, many firms have used several marketing techniques to sustain or enhance their profit margins and gain a competitive edge. Predictive models are essential in precision marketing, a field focused on understanding and meeting customer requests more efficiently. The analysis of consumer preferences and consumption patterns via the examination of transaction records and customer data is gaining more attention and importance due to this phenomenon. Implementing this strategy guarantees the efficient administration of goods supply networks.

Keywords: *Big data analytics, Supply chain management, Improved operational efficiency*

Introduction

Big data analytics (BDA) is widely acknowledged as an essential tool for effectively managing supply chains (SCs), specifically in areas such as procurement (supplier selection, sourcing risk management, and sourcing cost improvement), product research and development, production planning and control, quality management, maintenance and diagnosis, warehousing, order picking, inventory control, logistics/transportation (including order picking), and sourcing. The use of Big Data Analytics (BDA) in several sectors is significant.com The deployment of Big Data Analytics (BDA) has been shown to be a very important and significant application of this methodology. If this application proves its efficacy, it is reasonable to propose that the power exerted by the bullwhip might possibly be reduced. The primary goal of using this application is to provide precise forecasts of future demand (Gholizadeh 2018).

The concept of big data, characterised by its significant characteristics of volume, velocity, variety, value, and truthfulness, necessitates the development of inventive approaches in information analysis to improve the quality of insights, automate procedures, and streamline decision-making. The rise of big data necessitates the creation and application of novel technologies. The phrase "big data" has had a significant increase in its frequency of use in recent years, which may be related to the current trend of data proliferation and its consequent influence on numerous fields. In 2019, Jain argued that "big data" refers to data that has remarkable features in terms of its volume, velocity, diversity, value, and authenticity.

This chapter explains the meaning of the phrase "big data." The volume of a storage container, usually quantified in bytes, denotes the whole quantity of information contained inside it. The information may be described by using both spatial and temporal dimensions, which are sometimes referred to as the temporal and spatial dimensions, respectively. At the level of enterprise resource planning (ERP) and warehouse management system (WMS), important data related to items and orders, monitoring of goods, and invoicing of goods is carefully maintained. In other words, we now have all the essential elements of information in our hands. To put it in other words, we currently have all the necessary pieces of information in our hands. This information is accessible to people who wish to get it. Furthermore, we possess pertinent information about the conveyance of commodities. To enhance the efficiency of information generation, a diverse array of technologies is used. The technologies mentioned include barcodes, enterprise resource planning (ERP) systems, sensors, and database software (Tosarkani 2018).

The main aim of this meta-analysis and literature review is to investigate and assess the current research on "demand forecasting" in supply chains, which has become a crucial and widely researched topic in recent times. The process of predicting future demand for a particular product or service is frequently referred to as "demand forecasting" (Pang, 2018). Due to the unique characteristics of demand data in modern, expanding global supply chains, the process of predicting demand requires the use of big data analytics techniques in conjunction with machine learning methods.

Fig 1: Big data analytics in Supply chain management

The growing significance of big data analytics is bolstered by many causes, including the integration of Blockchain technology to enhance supply chain monitoring. In addition, the process of converting supply chains into digital formats is also playing a role in this pattern (Merkuryeva, 2019). Concurrently, the presence of these two factors contributes to the continuous process of digitising supply chains, thereby strengthening the increasing significance of big data analytics. The supply chain, which includes several suppliers, commodities, and customers, produces a substantial volume of data quickly (Choi 2018). This claim is supported by the large number of transactions that are constantly and continuously executed across the whole supply chain networks. The manufacture of this item occurs in several settings throughout the whole supply chain to meet different objectives, such as supplier capacity, items, customers, merchants, and other pertinent criteria. Different perspectives might be acquired on the current subject (Awwad, 2018). The complexities indicated above have resulted in a departure from conventional statistical techniques in the domain of demand forecasting. The aforementioned approaches depend on identifying statistically significant patterns in historical data, defined by mean and variance properties. Nevertheless, they are now being replaced by more sophisticated predictive models that have the potential to adapt and develop in order to fulfil the ever-changing requirements of supply chains. The aforementioned conclusion is possible by using big data analytics, which refers to a range of approaches used to examine large amounts of data. This analytical methodology aims to reveal previously unreported connections among different sets of demand data obtained from distinct supply chain networks. This allows for the phrasing of the previously described conclusion in a way that increases the probability of it becoming a reality. These approaches are necessary to obtain this objective. To successfully complete these activities, a substantial amount of computer power is necessary, together with the use of sophisticated, machine-programmed techniques (Zhu 2019).

Review of Literature

The Internet of Things (IoT) and mobile devices are two notable examples of the sources that are included in this specific category. These technological breakthroughs have completely transformed the manner in which we engage with and get information in our everyday existence. The Internet of Things (IoT) is a network that connects various physical devices, automobiles, appliances, and other items. These objects are equipped with sensors, software, and network connection, allowing them to gather and share data. Smartphones and other portable electronic gadgets, on the other hand, The categorization being discussed includes a wide range of sources, such as mobile devices and social media sites, which are excellent examples. From an alternate standpoint, the term "IoT" embraces a broad array of technical entities, such as mobile devices, social media platforms, and the Internet of Things. The ongoing development of data, which includes the large amounts generated by Supply Chain Management (SCM), is mainly due to the almost infinite variety of forms and sources from which this information comes. The existence of many information forms is the fundamental reason for this phenomena. The perceived ongoing sense of uncertainty may be ascribed to the complex interaction of several other components. There is evidence indicating an increasing acceptance of this trend, as seen by the widespread usage of sensors in different public areas such as supermarkets, roadways, industries, and automated warehouses. As to Villegas (2018), the aforementioned places are now seeing an increase in automation.

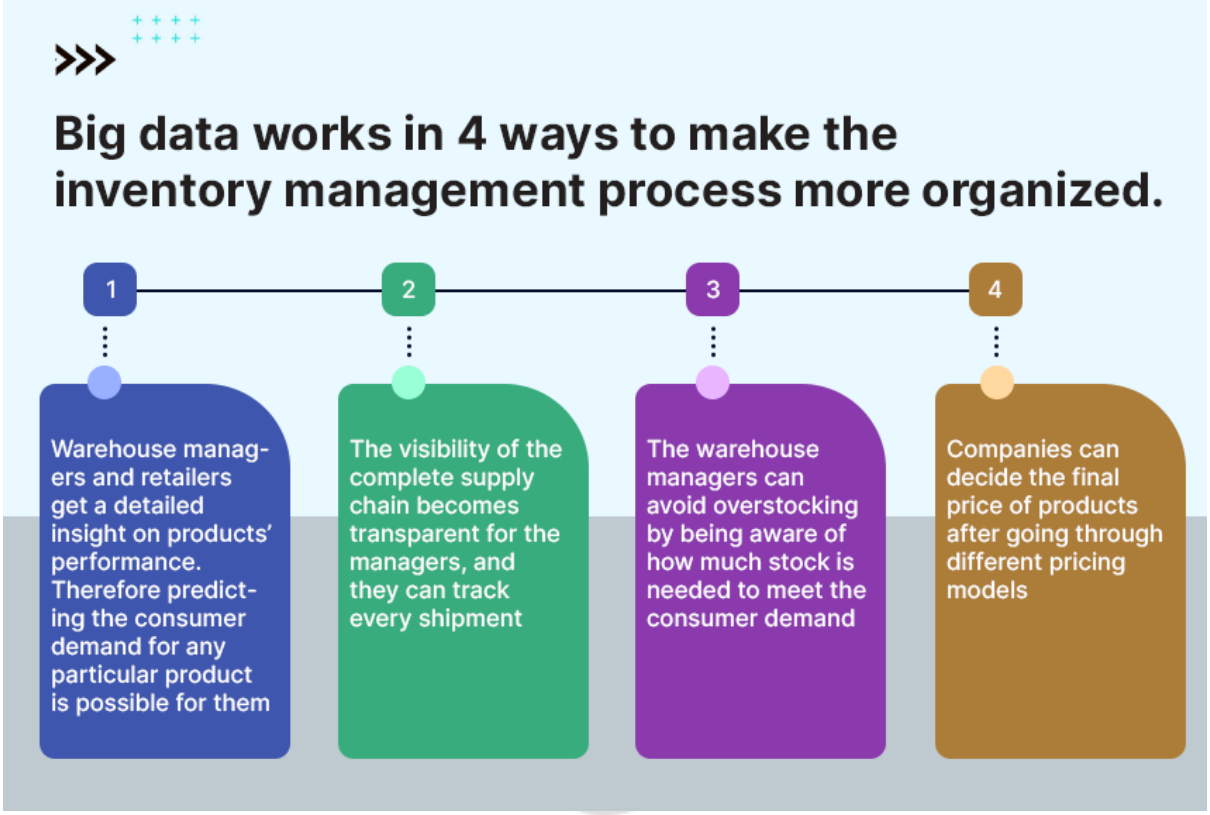

Fig 2: Big data on inventory management

These sensors are given the critical role of collecting and transmitting data to a central location for further analysis. This task is under their jurisdiction. The term "value" is linked to the essential information that guides decision-making. Acquiring the famed "Holy Grail" among the 5 Vs has proved to be an exceedingly difficult endeavour. The difficulty in acquiring it is mostly due to its status as the most arduous endeavour among all the available options. In light of the wide range of available information sources, it is crucial to verify the dependability and precision of the data under scrutiny (Ren 2019). The existence of several sources of information is the fundamental reason behind this phenomena. Based on this line of thinking, it is essential to ensure that the data accessible for real-world application is as dependable as possible. One of the many responsibilities that must be fulfilled is the consolidation of the data, followed by the following chores of data validation and filtering. Due to the wide variety of sources and formats from which the data is obtained, it is crucial that these operations are performed in the specified sequence. Munir (2019) states that using big data analytics technique enables the effective management of complex and large datasets that would otherwise be challenging to analyse and evaluate.

These disclosures have resulted in a significant body of academic research and practical knowledge, which has led to the creation of several effective methods for predicting and meeting customers' wants. Spreadsheet software is a significant tool that allows users to design diverse models and execute numerous statistical approaches, including the calculation of moving averages. Moreover, it enables the evaluation of performance against industry benchmarks, along with additional functionalities. Presently, Excel is extensively used as the predominant instrument for doing demand planning and forecasting. Hofmann (2018) said that this tendency is projected to persist in the near future.

Spreadsheet models used for demand forecasting are limited by their inability to handle very huge amounts of data. The use of spreadsheet models is linked to a notable downside, which may be regarded as the main constraint. Traditional statistical methods, such as moving averages or exponential smoothing, are not enough for successfully extracting, evaluating, and resolving the complexity and uncertainties related to Supply Chain Management (SCM). The existing application of Supply Chain Management (SCM) is impeding the viability of this job. The vulnerability of supply chain management (SCM) to change is due to the existence of several supply and demand factors within its structure (Loureiro 2018).

Objectives

To understand the importance of big data analytics on supply chain management

To explore the existing research on Enhancing Forecasting Accuracy on Demand management through big data analytics in supply chain management

To understand the role of big data analytics in providing Improved operational efficiency to the management

Research Methodology

The study makes use of a descriptive research approach, and its primary attention is directed towards the interpretation and analysis of secondary data that already exists. Information that has been obtained and recorded by earlier researchers, organisations, or other trustworthy sources is often referred to as "secondary data," and the word "secondary data" typically describes this kind of information. The logic that led to the selection of this particular approach is based on the fact that it is suitable for exploring the interconnections, developments, and regularities that are present within the area of supply chain management, particularly in regard to the implementation and utilisation of big data analytics.

An exhaustive evaluation of the existing body of literature is carried out as a component of the research process. Collecting pertinent secondary data from credible web sources, academic publications, industry studies, and white papers is a necessary step in this process. For the purpose of this literature review, the primary objective is to give a full overview of the present situation of big data analytics in supply chain management and to build a theoretical framework in the process of doing so. After the researcher has finished the examination of the relevant literature, they will next go on to the next step, which is the collecting of statistical data. This study's main purpose is to gather secondary data relating to the use of big data analytics in many parts of supply chain management. There are many different components of supply chain management. Risk management, inventory optimisation, demand forecasting, and inventory optimisation are some of the factors that fall under this category. However, this list is not exhaustive. This study may include the collection of secondary data from a variety of sources, including but not limited to case studies, empirical research, statistical reports, and the views of experts who are practitioners in the relevant subject.

Critical Discussion

The current component of the study gives a detailed assessment of the use of big data analytics in the context of supply chain management. The researchers have identified three significant impacts that the use of big data analytics has had on the area of supply chain management. These effects were discovered via an exhaustive review of relevant academic publications. Increased visibility and cooperation, improved operational efficiency, and improved accuracy in demand management forecasts are some of the impacts that stem from this.

Enhancing Forecasting Accuracy on Demand management

For the purpose of improving the precision of demand management predictions in the realm of supply chain management, the use of big data analytics is an extremely important factor to include. Businesses may increase the accuracy of their demand predictions by applying advanced analytics methods to utilise massive volumes of data from a variety of sources. This is one way that businesses can enhance the precision of their demand forecasts. Some examples of these sources include past sales data, trends in the market, consumer behaviour, and external variables such as weather patterns and economic indicators. Professionals working in supply chains are able to successfully foresee changes in demand and coordinate operations related to production, stock management, and distribution because to the higher degree of precision that is supplied by this skill.

When it comes to demand forecasting, one of the most significant advantages is that big data analytics has the capacity to record and examine enormous amounts of data in parallel with real-time processing. When it comes to forecasting, conventional approaches often depend on data that has become outdated and statistical models that are too simple. These methods may not fully take into account the intricacies and swings of the current economy, which is linked and always changing. Despite the widespread notion to the contrary, the use of big data analytics gives businesses the capacity to effectively manage and investigate a wide variety of information. Because of this, they are able to receive insightful information that is both more accurate and more timely on the different patterns and trends of demand.

In addition, the use of big data analytics makes it possible for businesses to combine a broad variety of features and variables into their predictive models. Merging is a technique that is often used by businesses in order to merge data sources from outside the company with their typical data sources from inside the company. Examples of such sources include sales history and inventory levels. Among the external data sources that are included into this investigation are the sentiments expressed on social media platforms, trends in internet search, and macroeconomic statistics. Organisations are able to obtain a full understanding of the dynamics of the market and the behaviour of consumers when they include these additional elements into their analysis. In turn, this allows them to develop demand predictions that are both more exact and robust than they would have been otherwise.

Furthermore, the usage of big data analytics permits the adoption of sophisticated statistical methods and machine learning algorithms with the purpose of discovering anomalies, correlations, and patterns existing in the dataset. Through the use of predictive models, organisations have the opportunity to enhance the precision and dependability of their demand projections. The performance of these models is improved by using sophisticated analytics capabilities, which are meant to enable them to continually learn and adapt from new data. Using machine learning algorithms, such as those used in this work, it is feasible to automatically find significant characteristics and correlations within the dataset. This is made possible via the use of these techniques. As a consequence of this, researchers are presented with the opportunity to make more precise forecasts about future demand trends.

In addition, the use of big data analytics makes it possible for businesses to improve their capacity to forecast demand by easing the process of collaborative planning and encouraging the sharing of information across the ecosystem of the supply chain. Organisations are able to increase their understanding of demand signals and the complexities of supply chain dynamics by integrating data that they have gathered from suppliers, distributors, and other relevant partners. The introduction of a collaborative approach provides stakeholders with the chance to maximise the alignment of their planning processes, which may be beneficial to the organisation. The use of this strategy enables the sharing of vital insights and projections, which in turn enables stakeholders to swiftly adjust their strategies in response to changing market circumstances or preferences among consumers.

Improved operational efficiency

In the field of supply chain management, the use of big data analytics is an essential component that contributes significantly to the enhancement of operational efficiency. It does this by providing businesses with vital insights and tools, which in turn helps them to improve a variety of operational issues. The utilisation of big data analytics provides businesses with the opportunity to get instantaneous and up-to-date insights into the operations that comprise their supply chain. This gives companies the ability to successfully monitor and assess performance indicators, identify areas of inefficiency, and improve overall operations by making choices based on data analysis that are informed and informed by the data. By using advanced analytics approaches such as predictive modelling and prescriptive analytics, companies are able to proactively detect inefficiencies and take remedial steps in order to improve their operational performance.

In addition, the utilisation of big data analytics makes it possible for businesses to optimise the allocation of resources and improve the overall efficiency of supply chain operations. An business may acquire insights into

possible possibilities to improve asset utilisation and avoid waste by conducting an analysis of data pertaining to the availability of manpower, inventory levels, production capacity, and transportation routes. When it comes to enhancing the accuracy of demand forecasting, the use of predictive analytics has the potential to be of significant service to businesses. In turn, this makes it possible to optimise production schedules and inventory levels, which eventually results in the satisfaction of customer demand while simultaneously reducing the likelihood of stockouts and surplus inventory by a significant margin.

Additionally, the usage of big data analytics allows businesses to improve their supply chain agility and responsiveness by providing them with real-time insights into market trends, customer preferences, and competitive dynamics. This enables businesses to better respond to changing market conditions. businesses have the capacity to fast alter their supply chain strategies and procedures in order to meet changing demand patterns or reduce possible hazards if they regularly monitor external variables such as geopolitical events, economic indicators, and changes in consumer behaviour. This allows the businesses to respond to these threats and mitigate potential risks. The potential for agility imparts upon businesses the skill to adeptly manage market upheavals, capitalise upon opportune situations, and sustain a competitive edge within the marketplace.

In addition, the use of big data analytics makes it possible to enhance the logistics and transportation operations of supply chains via the exploitation of optimisation. Organisations have the ability to find viable ideas for improving logistics operations and decreasing transportation costs by conducting an analysis of data pertaining to transportation networks, fuel expenditures, shipping routes, and other carrier performance metrics. As a perfect example, the employment of route optimisation algorithms may give companies with extremely helpful support in their attempts to reduce their consumption of petroleum and to reduce the amount of time it takes for deliveries to be completed. These algorithms are able to do this by carefully evaluating a variety of aspects, including the forms of cargo transportation that are the most efficient and the routes that are the most ideal to travel.

Additionally, the utilisation of big data analytics gives organisations the capacity to improve visibility and drive cooperation across the whole of the supply chain ecosystem they are operating in. It is possible for an organisation to combine data from a variety of stakeholders, such as customers, distributors, manufacturers, and suppliers, in order to get a thorough picture of the supply chain. This technique makes it possible to build a single viewpoint, which in turn enables the organisation to get useful insights into the ecology of the whole supply chain. In the statement that was just given, the facilitation of information exchange, the promotion of cooperation among stakeholders, and the enabling of more efficient activity coordination are all highlighted. This expanded cooperation helps to develop increased levels of openness, trust, and alignment among stakeholders throughout the supply chain. As a result, it enables organisations to optimise their operational processes and provide enhanced value to customers in a way that is both more effective and more efficient.

Better collaboration and visibility

Increasing visibility and promoting cooperation are two of the most important goals that can be accomplished via the use of big data analytics in supply chain management. Consequently, this makes it possible for businesses to maximise the sharing of information, coordination, and communication across the full ecosystem of the supply chain. The capacity of big data analytics to combine and analyse data from a wide variety of sources, such as customers, manufacturers, distributors, and suppliers, is the enormous contribution that this field has made. Through the process of collecting and evaluating this varied dataset, businesses have the potential to develop a single perspective of the supply chain. This enables them to provide stakeholders with up-to-date information about inventory levels, manufacturing schedules, order statuses, and logistical operations on a consistent basis.

In addition, the utilisation of big data analytics makes it possible for organisations to improve the visibility of their supply chains by providing stakeholders with increased access to vital information and by providing a higher level of transparency. Data visualisation and dashboards are two examples of complex analytics tools that may be used by businesses in order to effectively convey supply chain data to stakeholders. The presentation of complicated material in a style that is straightforward and simple to comprehend is made possible by these approaches. As a result, stakeholders are able to acquire new perspectives and make judgements that are well-informed on the information that is offered. The capacity of stakeholders to monitor performance measures, recognise trends, and make decisions based on accurate information is improved as a result of this implementation. By providing stakeholders with the ability to detect potential impediments, risks, and rewards within the supply chain, the increased degree of visibility makes it possible for them to engage in proactive troubleshooting and decision-making.

By building a centralised platform for stakeholders to exchange data and coordinate their actions, the introduction of big data analytics also makes it easier for stakeholders to work together more effectively within the supply chain. This centralised location acts as a hub for the exchange of information and the coordination of activities,

which ultimately leads to increased cooperation among the numerous organisations that are engaged in the supply chain. Enhancing communication channels, automating workflow processes, and fostering real-time collaboration on critical supply chain operations such as demand planning, production scheduling, and inventory management are all made possible for organisations through the integration of data that originates from suppliers, manufacturers, and distributors. The stakeholders in the supply chain have the chance to cultivate an atmosphere that is characterised by enhanced trust, alignment, and synergy if they choose a collaborative strategy and proceed with its implementation. Consequently, this results in enhancements to their total performance as they work towards the accomplishment of goals and objectives that are shared by all of them.

Furthermore, thanks to the usage of big data analytics, businesses are able to get vital information about the performance, reliability, and quality of their suppliers. Because of this, they are able to enhance their management of the connections they have with their suppliers. Organisations are able to efficiently identify suppliers that display great performance if they do a comprehensive study of the delivery times, lead times, and product quality data of their suppliers. This makes it possible for them to form strategic relationships that encourage innovation and increase the value of the business as a whole. Despite the widespread perception to the contrary, it is essential to take into account the fact that businesses possess the capacity to recognise providers who do not live up to their expectations. It is possible for them to take the proper activities in response to these difficulties in order to resolve them, reduce risks, and enhance performance. After everything is said and done, these actions will eventually increase the overall resilience and efficacy of the supply chain.

Conclusion

In the vast majority of data-driven models that have been recorded in academic literature, the use of previously acquired information is a widespread practice that has been noticed. This assertion is supported by a substantial majority of these models, which is something that should be taken into consideration. As an alternative to doing an analysis of the present economic environment, which entails studying the swings in value that the industry is now experiencing, this strategy makes use of previous data in order to develop forecasts. As a replacement for carrying out an exhaustive investigation of the present status of the economy, the strategy that was just described is put into action.

In addition, it is essential to consider the fact that the demand from customers may be significantly influenced by a variety of internal circumstances. These aspects include the distinctive qualities of the company, such as its reputation and the marketing methods it employs. Furthermore, the availability of resources for supply chain management may also play a key impact in determining the demand from customers. Therefore, when compared to other techniques of assessment, the estimations of demand that are obtained from Big Data Analytics (BDA) and historical data are substantially less dependable than other approaches. Inflation, buying power, and economic instability are some of the prevalent driving variables that may be taken into consideration when revising future demand predictions. These estimates are not based on previous data, therefore they are open to adjustment. It is possible to trace the possibility of this phenomena to the enormous influence that each of these components has on the environmental circumstances that are now in place.

The incorporation of these components into the unfamiliar setting has the potential to make the process of acclimatisation easier to accomplish. Increasing the possibility of producing accurate predictions is something that might be accomplished via the use of this specific strategy. The employment of predictive algorithms makes it easier to generate prescriptive answers to future occurrences. This is accomplished by the incorporation of optimisation, simulation, or a mix of the two approaches. In a broad variety of settings, the advantages of these kinds of reactions have been found to be beneficial. As a consequence of this, models have the ability to generate reactions that are related to events that have not yet taken place in the real world.

References

Awwad M, Kulkarni P, Bapna R, Marathe A. Big data analytics in supply chain: a literature review. In: Proceedings of the international conference on industrial engineering and operations management, 2018(SEP); 2018, p. 418–25.

Choi Y, Lee H, Irani Z. Big data-driven fuzzy cognitive map for prioritising IT service procurement in the public sector. Ann Oper Res. 2018;270(1–2):75–104.

Gholizadeh H, Tajdin A, Javadian N. A closed-loop supply chain robust optimization for disposable appliances. Neural Comput Appl. 2018. https://doi.org/10.1007/s00521-018-3847-9.

Hofmann E, Rutschmann E. Big data analytics and demand forecasting in supply chains: a conceptual analysis. Int J Logist Manage. 2018;29(2):739–66. https://doi.org/10.1108/IJLM-04-2017-0088.

Huber J, Gossmann A, Stuckenschmidt H. Cluster-based hierarchical demand forecasting for perishable goods. Expert Syst Appl. 2017;76:140–51. https://doi.org/10.1016/J.ESWA.2017.01.022.

Jain A, Sanders NR. Forecasting sales in the supply chain: consumer analytics in the big data era. Int J Forecast. 2019;35(1):170–80. https://doi.org/10.1016/J.IJFORECAST.2018.09.003.

Loureiro ALD, Miguéis VL, da Silva LFM. Exploring the use of deep neural networks for sales forecasting in fashion retail. Decis Support Syst. 2018;114:81–93.

Merkuryeva G, Valberga A, Smirnov A. Demand forecasting in pharmaceutical supply chains: a case study. Procedia Comput Sci. 2019;149:3–10.

Munir K. Cloud computing and big data: technologies, applications and security, vol. 49. Berlin: Springer; 2019.

Pang Y, Yao B, Zhou X, Zhang Y, Xu Y, Tan Z. Hierarchical electricity time series forecasting for integrating consumption patterns analysis and aggregation consistency; 2018. In: IJCAI international joint conference on artificial intelligence; 2018, p. 3506–12.

Ren S, Zhang Y, Liu Y, Sakao T, Huisingh D, Almeida CMVB. A comprehensive review of big data analytics throughout product lifecycle to support sustainable smart manufacturing: a framework, challenges and future research directions. J Clean Prod. 2019;210:1343–65. https://doi.org/10.1016/J.JCLEPRO.2018.11.025.

Rostami-Tabar B, Babai MZ, Ali M, Boylan JE. The impact of temporal aggregation on supply chains with ARMA(1,1) demand processes. Eur J Oper Res. 2019;273(3):920–32. https://doi.org/10.1016/J.EJOR.2018.09.010.

Tosarkani BM, Amin SH. A possibilistic solution to configure a battery closed-loop supply chain: multi-objective approach. Expert Syst Appl. 2018;92:12–26.

Villegas MA, Pedregal DJ. Supply chain decision support systems based on a novel hierarchical forecasting approach. Decis Support Syst. 2018;114:29–36. https://doi.org/10.1016/J.DSS.2018.08.003.

Zhu Y, Zhao Y, Zhang J, Geng N, Huang D. Spring onion seed demand forecasting using a hybrid Holt-Winters and support vector machine model. PLoS ONE. 2019;14(7):e0219889.