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Exploring Advances in SC Forecasting Methods: A Conceptual Review

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Abstract*— The basis of Supply Chain Management (SCM) starts with accurate demand forecasting as harmonizing demand and supply is at the genesis of any operational plan. These forecasts determine every aspect of an organization from resource allocation to finished product distribution planning. Undeniably, if the demand forecasts are faulty this will have a negative impact on the Supply Chain (SC) therefore on the profits of the organization. This paper designs a conceptual review for factors involved in recent forecasting methodologies. Although the existing research has analyzed many theoretical perspectives of Supply Chain forecasting, there is a scarcity of research in overcoming the shortcomings of normal distribution because with the invention of Big Data Analytics (BDA), this traditional method is becoming weaker. The review infers that there is much to be learned about structuring a hierarchy to best forecast hybrid decision-making problems. Moreover, forecasting strategies of producers and retailer sellers play a pivotal role for consensus forecasts, meanwhile the role of forecast horizon and frequency cannot be neglected. The research focuses on reviewing the latest forecasting methods to help guide practitioners when carrying out long-term forecasting strategies.

Index Terms*— Demand forecasting, Supply Chain Management, Big Data Analytics, Collaborative forecasting

I. INTRODUCTION

In recent years, businesses adopt ever-increasing precision prediction methods to stay ahead of the competition and expand their market share. For this, forecasting models have been extensively used in Supply Chain Management (SCM) to understand and satisfy customer needs and wants [1]. The administration of the movement of goods and services is referred to as SCM, and it encompasses all procedures that transform raw materials into finished items[2]. And, analyzing data from Supply Chain (SC) partners to evaluate where more changes can be made is one technique to improve this process, also called collaborative forecasting. In most SCM problems, only capacity, demand, and cost are considered given parameters [3]. However, there are uncertainties arising from changes in client demand, supply, transportation, organizational risks, and lead times in practice. Demand forecasting, with its multiplicative effect on production plans, inventory planning, and other sources of unpredictability in an organization, does have the biggest impact on SC performance. Demand forecasting is based on a real-time analysis of previous demand for a given product or service inside the present market. For demand forecasting in SCM, a series of numerical statistical approaches have also been recommended, including regression analysis and time-series analysis [4]. The normal distribution is heavily used in most theoretical studies and forecasting software applications. This is suitable in high-count time series where actual count data can be reasonably represented by normal distributions. However, as data storage and analysis capabilities grow (BDA), a trend toward gathering and forecasting data at finer and finer levels of granularity emerges, and the argument for the normal approximation becomes less compelling. To set appropriate safety stocks for highly granular count data, we need to understand discrete predictive distributions. In this area, there has been relatively little research, and further research is urgently needed. A number of criteria have now been identified based on literature insights: relevance, reliability, comparability and consistency, understandability, and representational quality [5]. SCM is founded on the concepts of collaboration and the creation and use of connections between feedback loops in order to provide information that will increase the efficiency of all chain members. Lower prices, shorter lead times, and improved customer service are all instances of typical successes. Collaborative forecasting applies SCM principals to the forecasting function, employing preexisting data and technology to shift needs from projected to realized [6]. SCM operations focused at fulfilling customer's demand while lowering complete price of supply might benefit from more exact (data-driven) demand projections and aligning SC activities with such predictions to increase efficiency and satisfaction. In light of these possibilities, this paper proposes a conceptual review of forecasting techniques in SCM [7]. The importance of demand management in SCs is examined. This study sets the stage for a critical examination of demand forecasting applications in SCM, highlighting a number of major findings and outlining the current issues and limitations in Big Data applications for demand forecasting in SCs. The paper finishes by providing a number of prospective research options based on this foundation.

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II. RESEARCH DISCUSSIONS AND OBJECTIVES

Various types of data are found in SC. Figure 1 shows us the taxonomy of supply chain data sources. In this sense, competition, price volatility, technology advancement, and fluctuating client commitments may cause established projections to underestimate or overestimate demand [8]. As a result, SC data must be thoroughly studied to improve knowledge of market trends, customer behavior, suppliers, and technology in order to improve the precision of demand forecasting. Applying such data to uncover trends and patterns and using them to improve the accuracy of future projections, perhaps lowering SC costs [9] [10].

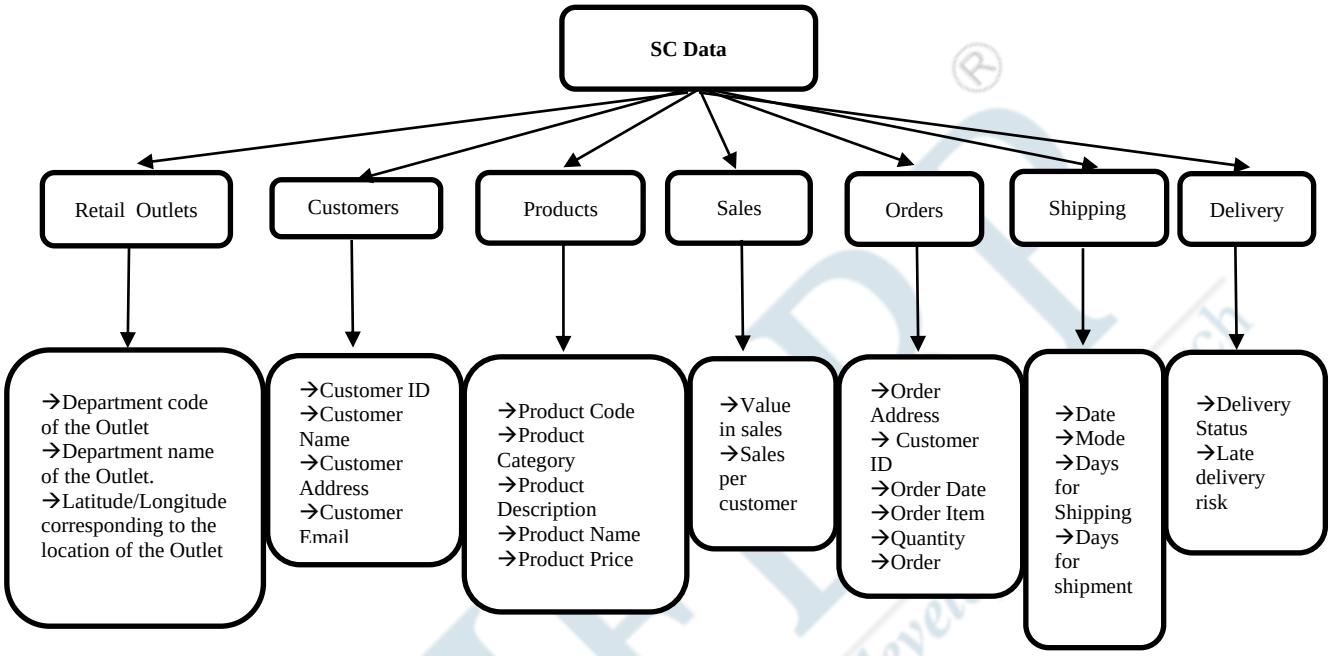

Fig. 1 Taxonomy of SC data sources

2.1. What factors affect the performance of a SC forecast?

The basic goals of a forecasting process are to improve prediction accuracy (lower forecast error) and to make the forecast less biased (not chronically too high or too low). Accurate projections assist a company in avoiding missed sales or stock-out situations, as well as preventing clients from switching to competitors [11].The use of sophisticated forecasting tools has regularly resulted in SC breakthroughs by lowering risk and uncertainty. Accurate forecasting can have a significant impact on a company's inventory levels, which is perhaps one of the most essential areas. Inventory exists to provide as a safety net in the event of erroneous forecasts. The more precise the prediction, the less inventory that must be held; understandably, low inventory levels save money. To have a good influence on inventory management, demand planning, supply planning, forecasting, and production planning must all be successful. It's harder to estimate the company's capacity to deliver than it is to determine genuine client demand [11]. An efficient and accountable sales planning and forecasting process is a critical basis for the SC operation. Companies that get input from personnel from several functional areas, each of whom contributes relevant data, may achieve effective and efficient forecasting outcomes. This demands a considerable lot of cross-organizational contact, and not all communication is created equal; some businesses are just better at it than others.

2.2. How is demand management in SCs key to corporate success?

People in other sections of the organization may not grasp what the key efficiency goals of SCM and fostering vendor relationships are, whereas SC managers should. SCM might improve operating and financial performance, generate new sources of competitive advantage, and lead to a better-managed firm if it was better understood and utilised across the organization's functional areas. The development of SC information systems, particularly performance measurement systems, is significantly reliant on IT in SCM. Successful businesses have long recognized the value of considerable inventory reductions combined with high and lucrative consumer availability in gaining a competitive advantage. They also recognize that forecasting with data from Point of Sale and Stock Keeping Units gives a more immediate and accurate view of demand for their SC, and is a key contributor to enhancing forecast accuracy and making suitable and profitable inventory selections [12]. Sales forecasting is used by marketing to design new goods, reward salespeople, and make other important choices. If projections are accurate, acquiring raw materials and component components may be far more cost-effective. If you buy in the spot market on a frequent basis, inaccurate projections might lead to greater costs. By precisely estimating manufacturing

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demands, unnecessary costs may be avoided.

2.3. How is BDA revolutionizing SC demand forecasting?

BDA is using advanced analytics techniques to large volumes of data with purpose of extracting useful information and facilitate data-driven decision-making. There are three tiers of analytics in BDA. Each level of analytics has a distinct function and goal. Prescriptive Analytics, Predictive Analytics, and Descriptive Analytics are the three levels of BDA that we investigate for this literature analysis. Prescriptive Analytics currently has the highest degree of consideration, then comes Predictive Analytics, while Descriptive Analytics has the lowest level of attention[13]. Procurement, risk assessment, risk management, and forecasting are all areas where predictive analytics may be useful. In terms of the amount of processes in a system, descriptive analytics provides the most flexibility. Descriptive analytics is used to provide effective and summary reports on raw data that are easy to understand for humans.

Data created is rapidly expanding as a result of technology developments throughout SC organizations. Until the adoption of Information Technology in SC, the information flow was documented using physical papers. The bulk of information flow associated with material flow is now captured as digital structured data. Because the breadth of SC is now global, the volume of data collected from its many activities, as well as the speed with which it is created, may be classified as Big Data. Furthermore, organizations such as marketing and sales are now depending on the analysis of unstructured data in addition to structured data to acquire a better understanding of client demands and reduce the cost of SC procedures. Big Data can be utilized with product creation, market demand forecasts, supply decisions, network optimization, and consumer feedback. Figure 2 presents a summary of Big Data capabilities in each business domain.[14].

III. REVIEW PROCESS METHODOLOGY

The review process is driven by the research questions outlined in the preceding section; these are based on systematic reviews that necessitate a thorough article search, increasing transparency in the field and reducing prejudice through a scientific approach. This concept simplifies reviews as a management tool for making evidence-based and theoretically-based choices [11]. On the basis of review, there are three principal steps of approach adaptation: 1. planning, 2. conducting, and 3. presenting the review.

3.1. Review protocol

Regular meetings were held to establish the review procedure, which aimed to improve understanding of: I collaborative forecasting difficulties faced by partners in the FSC, (ii) research topics as outlined in Section 2, and (iii) the literature search approach used to find relevant publications.

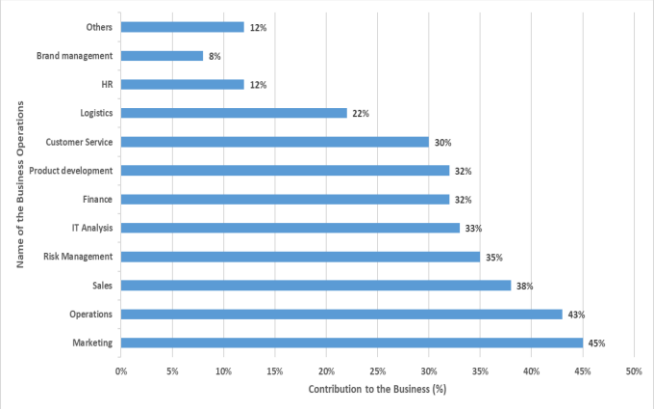

Fig. 2 Bar chart of BDA contribution in business features [32].

More than 250 papers from peer-reviewed journals and conference proceedings were discovered using principal keywords in the search. Non-peer reviewed documents were excluded because this is standard practise. The data for the study was extracted from three classes, with the dimensions of the classification for analysis shown in Table 1.

Table 1. Classification of Analysis

Classes	Dimensions
1) Characteristic	Year, Journal, Methodology, Country
2) Feature	Aim, Research questions/hypothesis, findings
3) Problem Relevance	Collaborative Informational sharing SC integration Forecasting process

The first session focused on article "characteristics," which includes information such as publishing years, journals, methodology, and nation. The second class (feature) summarizes the aim, research questions/hypotheses, and relevant findings of the articles [13]. In order to carry out the review process, we based it on the questions raised in the outset. Then we profited from the perspectives of experts in the fields of supply chain management, forecasting, and operations management. These viewpoints were taken into account during the data collecting, article elimination, and result interpretation stages of the evaluation.

IV. REVIEW RESULTS

4.1. Characteristics and features

We utilised Scopus, Google Scholar, and Elsevier to conduct a comprehensive search of the available literature, with publication dates ranging from 2005 to 2021. SC, demand forecasting, BDA, and forecasting frequency and horizon were the keywords employed in the search. Figure 3 illustrates the examination of SC demand forecasts papers

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from 2005 to 2021. There is a steady increase in the number of publications from 2005 to 2021. It is expected that such growth continues in 2022.

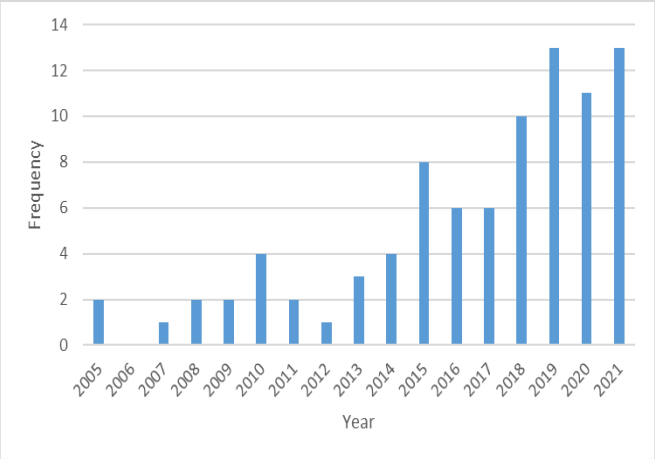

Fig. 3 Distribution of literature in SC demand forecasting from 2005 to 2019

Steps	Processes
1) Research questions formulation	→Interpreting collaborative forecasting problems in the SC. →Designing research questions for the on problems that appear in the process of information sharing and forecasting.
2) Settling articles	→Focusing on primary-keywords over the research themes integration in SC, information sharing and forecasting process. →Specifying secondary-keywords by taking into account the rationale of research questions.
3) Literature Search	→ Reviewing articles related to primary-keywords & content.
4) Exclusion Criteria	→ Exclude all non-peer reviewed & unpublished articles
5) Inclusion Criteria	→Based on three categories , this process is carried out: 1) The article's goal should be relevant to the issues mentioned. 2) The article's research questions/hypotheses should argue relevant elements for the research inquiries. 3) The findings of the article should provide either supportive or contradictory information on the relevance of the research problem and/or research questions.
6) Critical Comparison	→Synthesis of results during meetings is compared.
7) Cross disciplinary approach	→ Cross-referencing approach is applied.
8) Final decision	→ Completing the article consideration process.

Table. 2 Our review protocol

4.2. Problem relevance followed by propositions

Many aspects influence demand in supply chains, but for the sake of simplicity, many of them were not captured in research using traditional approaches. Forecasts could only give a limited knowledge of demand changes in SCs in this regard. Furthermore, unexplained demand shifts might be brushed aside as statistical noise. [14]. Finally, data-driven systems may learn to include non-linear behaviours, resulting in improved demand forecasting approximations than traditional methods, most of which are based on linear models. The bullwhip effect, competition among suppliers, and mismatch between supply and demand all contribute to substantial non-linearity in demand behaviour in SC. The features of our insights show us that issues with demand forecasting in most companies have to do with missing data. Here are some of the things that can get in the way of forecasts. Lack of historical sales data is a problem for companies without much of a track record. Even more established enterprises, though, may face difficulties. Sales data from previous years should be collated and structured in an easy-to-use way [14].

Another issue is a lack of inventory control. The cornerstone of excellent demand planning is good inventory management. If warehouse capacity is not accurately determined, production is over- or under-estimated.

4.2.1 SC integration

Given the partners' internal-external conflicts occurring through information exchange and forecasting, their close integration in the SC is a good platform towards collaborative forecasting. SC integration is defined as "the degree to which a manufacturer strategically collaborates with SC partners and collaboratively manages intra- and inter-organizational processes in order to achieve effective and efficient flows of products and services, information, money, and decisions in order to provide maximum value to customers."

4.2.2. Collaborative Information sharing

Sharing various sorts of data, such as pricing adjustments, assortments, and promotional plants, improves forecast accuracy and saves time for partners. Transparency is improved and forecasting errors are reduced when production and delivery plans are shared [10]. In the literature on information sharing, the information quality metric was used to analyse how well information flows between parties matched their expectations. This metric was calculated based on a number of characteristics, including availability, currency, credibility, frequency, completeness, and recency, and it represented partners' happiness with information sharing.

4.2.3. Forecasting process

In SCs, combining and/or adjusting forecasts seem to be a remedy to departments' multiple forecasts, causing overlapping of internal expectations and tacitly influencing collaborations. Model construction, breakdown, forecast combinations, and judgement modifications are the four main processes used in forecasting [12]. Equally, weighting constituent forecasts are suitable and work well based on the number of forecasts combined when taking into account historical information. In addition, collaborative forecasting should take into account the partners' shared and long-term goals, as well as other concerns including commitment, trust, and dependency.

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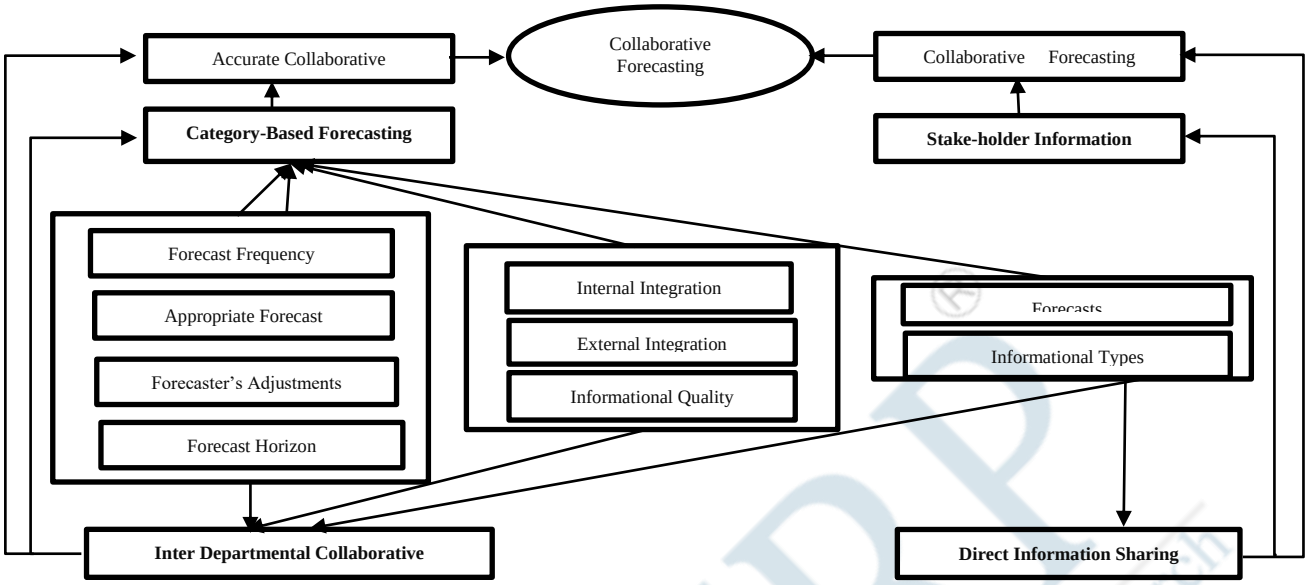

Fig. 4 The Conceptual Review

V. DISCUSSIONS WITH CONCEPTUAL FRAMEWORK

This paper this paper reviewed the literature on demand forecasting in the SCM in three interrelated areas: SC integration, collaborative information sharing and forecasting process [6].These sub processes represent the three research questions addressed in this paper. They were identified by considering partners' challenges in information sharing and forecasting which prevent accurate and long term collaborating and consensual forecasting. Subsequently, we can depict the propositions in a conceptual framework as shown in the figure 4.

5.1. Forecast combinations and judgement adjustments

Combining forecasts appears to provide a solution to the inaccuracies in typical SC forecasting approaches. By reducing the impact of conflicting forecasts made by different departments based on different goals and information [7]. While an organization actually agrees on a single unified forecast before convening with its counterparts, it streamlines the process of reaching consensus during the operation. Nonetheless It's critical to use the right forecasting methods for combination to improve the forecast's accuracy, predictability, and precision. However, because of the influence of contextual data and information, the impact of judgments and human variables cannot be overlooked [8]. As a result, it goes without saying that modifying statistical results with descendent data is a must. This might be performed at the divisional level or at the company level.

5.2. Importance of forecast Frequency and horizon

Beyond a doubt, the forecaster's prejudice has a detrimental effect on the findings. However, the forecasters' expertise and technical know-how, as well as their understanding of new information and statistical results, reinforce its accuracy and reliability. As a result, we can deduce that the development of forecasters' trust and commitment is likely to benefit partners during long-term collaborative forecasting [9]. Despite the fact that we examined at a variety of forecasting methodologies, the best strategy depends on the amount of collaboration and consensus, product qualities, and the current market scenario. More importantly, the product categories are time sensitive and should be supplied to customers as soon as possible, requiring the most accurate consensus forecast in the smallest period of time.

VI. CONCLUSION AND FUTURE SCOPE

Globalization and rising market competitiveness, as well as a spike in SC digitization methods, are driving up the demand for customer behaviour analysis and demand forecasting. We conducted a detailed assessment of forecasting methodologies in SC demand forecasting in this paper. The poll looked at how BDA may be used to estimate SC demand. We gathered and examined these studies in terms of demand prediction methods and strategies. Seven common strategies were discovered and evaluated, along with their benefits and drawbacks. The most commonly used approaches, among others, are neural networks and regression analysis. The paper also mentioned that optimization models or simulation can be utilised to increase predicting accuracy.

REFERENCES

[1] You Z, Si Y-W, Zhang D, Zeng X, Leung SCH, Li T. A decision-making framework for precision marketing. Expert Syst Appl. 2015;42(7):3357–67. https://doi.org/10.1016/J.ESWA.2014.12.022.

[2] Guo ZX, Wong WK, Li M. A multivariate intelligent decision-making model for retail sales forecasting. Decision Support Syst. 2013;55(1):247–55.
[3] Wei J-T, Lee M-C, Chen H-K, Wu H-H. Customer relationship management in the hairdressing industry: an application of data mining techniques. Expert Syst Appl. 2013;40(18):7513–8. https://doi.org/10.1016/J.ESWA.2013.07.053.
[4] Lu LX, Swaminathan JM. SCM. Int Encycl Soc Behav Sci. 2015. https://doi.org/10.1016/B978-0-08-097086-8.73032-7.
[5] Gholizadeh H, Tajdin A, Javadian N. A closed-loop SC robust optimization for disposable appliances. Neural Comput Appl. 2018
[6] Tosarkani BM, Amin SH. A possibilistic solution to configure a battery closed-loop SC: multi-objective approach. Expert Syst Appl. 2018;92:12–26.
[7] Blackburn R, Lurz K, Priese B, Göb R, Darkow IL. A predictive analytics approach for demand forecasting in the process industry. Int Trans Oper Res.2015;22(3):407–28
[8] Boulaksil Y. Safety stock placement in SCs with demand forecast updates. Oper Res Perspect. 2016;3:27.
[9] Tang CS. Perspectives in SC risk management. Int J Prod Econ. 2006;103(2):451–88.
[10] Wang G, Gunasekaran A, Ngai EWT, Papadopoulos T. BDA in logistics and SCM: certain investigations for research and applications. Int J Prod Econ. 2016;176:98–110.
[11] Awwad M, Kulkarni P, Bapna R, Marathe A. BDA in SC: a literature review. In: Proceedings of the international conference on industrial engineering and operations management, 2018(SEP); 2018, p. 418–25.
[12] Convergence and Hybrid Information Technologies - Google Books.
[13] Kshetri N. 1 Blockchain's roles in meeting key SCM objectives. Int J Inf Manage. 2018;39:80–9.
[14] Michna Z, Disney SM, Nielsen P. The impact of stochastic lead times on the bullwhip efect under correlated demand and moving average forecasts. Omega 2019