THE INTERNATIONAL JOURNAL OF BUSINESS & MANAGEMENT

# Exploring Big Data Applications in Supply Chain Operations: A Review Article

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***Abstract:***
*The vast growth of Big Data has led to applying analytics in supply chain operations management. With this growth, professionals from various organizations started to understand the value of applying Big Data concepts. This paper reviews some of the advantages of Big Data applications, but mainly in supply chain operations. The researcher relied on review papers related to challenges, issues and benefits of big data analytics in supply chain configurations. More than 20 papers (including literature reviews, research papers, and review articles) were revised by the researcher to summarize the outcomes of what published and discussed by scholars in this field. Lastly, the paper concludes with some recommendations, and highlights the gaps in the current research of applying Big Data in supply chain management.*

***Keywords:*** *Big data, supply chain, big data analytics*

## 1. Introduction

Information and communication technologies continue to rapidly change to meet the 21st century corporate needs across the globe. One area that has increasingly gained attention is how both corporate firms and non-corporate organizations can leverage on big data to enhance their efficiency and performance (Wamba, S., Gunasekaran, A., Dubey, R. & Ngai, E. 2018). For business entities, they are increasingly overwhelmed by the stream of endless data that overflows from an extensive range of channels. Companies which capitalize on such data end up gaining competitive advantage, particularly streamlining their supply chain function. Big data refers to the animated, massive, and distinct volumes of information which is created by machines, tools, and people (Govindan, K., Cheng, T., Mishra, N. & Shukla, N. 2018). Besides, big data comprises information that is collected from internet-enabled electronic devices such as tablets and smartphones, especially the voice recordings, videos, and social media.

Top executives rely on big data to enhance visibility and provide more comprehensive insights on the whole supply chain operations. For instance, machine learning technology and Internet of Things (IoT) are relied on to perform predictive asset maintenance to avert operational inefficiencies such as unscheduled downtime (Coatney, K. 2018). The technologies which are equipped with high-tech RFID, sensors, and barcodes can produce real-time telemetry data to support integration and coordination of every linkage with the supply chain and production functions. Furthermore, companies are using big data solutions to analyze GPS, traffic, and weather data to enhance route planning and avoid delivery delays (Choi, T., Wallace, S. & Wang, Y. 2018; Columbus 2015). Big data has enabled companies to adopt a responsive supply chain, especially understanding market trends and customer behaviors allowing them to predict demand in the market. A study was done by Wang, Li, Zhou, Wang, and Nedjah (2016) showed that few companies (almost 17%) had adopted big data analytics in one or more of their supply chain function. The low uptake has been attributed to the firm's minimal capacity to identify suitable data as well as data security threats. This paper highlights what is covered by researchers and summarizes the key points of Big Data. Characteristics, sources, importance and barriers of Big Data analytics in supply chain management were covered in this paper to provide the reader on what is relevant.

## 2. Characteristics of Big Data

According to Hazen, Skipper, Boone, and Hill (2018), the five characteristics of big data include volume, value, veracity, variety, and velocity. In this case, velocity can be defined as the speed used to generate and deliver data; it is mostly processed in streamlines, real-time, nearly real-time, or batch. According to KPMG (2017), the volume is the size

of data, which has considerably increased exceedingly more than the capacity of the present-day storage devices. Additionally, veracity refers to the emphasis placed on the quality and integrity of data because multiple sources of data (for instance, social media networks) are somehow uncertain and unreliable (Awwad, M., Kulkarni, P., Bapna, R. & Marathe, A. 2018). Variety is used to describe the how data which has been generated from various sources, for example, online social networks, mobile devices, Internet of Things, or sensors is usually stored in unstructured, semi-structured, or structured formats (Tan et al., 2015). According to KPMG (2017), value denotes the process used and the investment made to acquire the colossal amount of datasets to facilitate decision making.

**3. Sources of Data in Supply Chain**

The high-variety, high-velocity, and high-volume information assets require economic and advanced forms of information processing to support management and automation of operations (Nguyen, T., Li, Z., Spiegler, V., Ieromonachou, P. & Lin, Y., 2018). Each year, thousands of data Exabytes (1 Exabyte equals 1 Billion Gigabyte) are being produced from various sources. Reservation, sales, and financial systems are known to produce structured data while telephone calls, emails, and social networking sites generate unstructured data (Computer World 2018). The prominent sources of big data are depicted in Figure 1 below. They are set according to their velocity and value set against the variety. The supply chain datasets are usually obtained from both internal and external sources as well as transactional data. The diagram has three ovals which represent the sources of supply chain data.

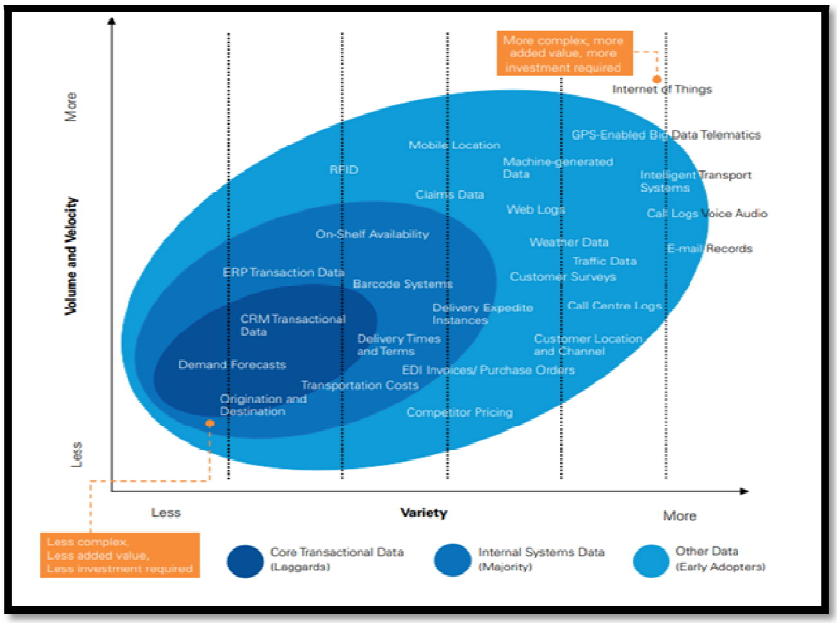


*Figure 1: Sources of Big Data (KPMG 2017)*

External sources (outer oval) contribute to the vast amount of data as compared to the internal and external ones. Furthermore, the velocity and volume of change in external data are averagely greater as compared to the internal system and core transactional data (McKinsey Global Institute 2011). Companies mostly rely on GPS and RFID big data to perform real-time monitoring of the warehousing and inventory positioning functions. Additionally, a common enabler of customer behavior analysis and demand forecasting is the Point of Sale (POS) data. Firms capitalize on the big data and telemetry to manage production or operational capacity and risks as well as track suppliers' performance (Yaqoob, I. et al. 2016). Furthermore, the post-analytic information is critical with regards to determining imminent machine failures and operational gridlocks, which helps to avert machine breakdowns that can be disruptive and costly. All the sources of big data need to be proactively managed and analyzed since they provide vital information which can be used to enhance market responsiveness, supply chain efficiency, as well as optimal balance demand and supply (Grover, P. & Kar, A. 2017). Statistical observations done by Awwad, Kulkarni, Bapna, and Marathe, A. (2018) identified five different sources that contributed considerably towards data generation and analytics. They include the POS, RFID, and sensors, social media, and all transactions recorded.

**4. Importance of Big Data in Supply Chain**

There is an increase in the amount being generated owing to the technological advancement across the supply chain entities. The information flow is recorded in structured and unstructured digital formats as opposed to being manual (Barbosa, M., Vicente, A., Ladeira, M., & Oliveira, M. 2018). Given the globalized nature of the supply chain function, the volume and velocity have led to the generation of big data which is explored to provide details about customer needs and to reduce operational costs (Govindan, K. Cheng, T., Mishra, N. & Shukla, N. 2018). Furthermore, big data has supported value addition in several areas related to supply chain such as customer feedback, distribution optimization, making supplying decisions, market demand predictions, and product development (Katal, A., Wazid, M. & Goudar, R. 2013; Chen, D., Preston, D., & Swink, M. 2015). Table 1 below illustrates how several business functions rely on big data to enhance organizational competitiveness and efficiency (Ghosh, 2015).

| Business Function | Contribution to Business (%) |
|---|---|
| Marketing | 45 |
| Operations | 43 |
| Sales | 38 |
| Risk Management | 35 |
| IT Analytics | 33 |
| Finance | 32 |
| Product Development | 32 |
| Customer Service | 30 |
| Logistics | 22 |
| HR | 12 |
| Brand Management | 8 |
| Others | 12 |

*Table 1*

KPMG (2017) highlighted how companies benefit from investing in big data analytics, as shown in Figure 2 below. It is evident that adopting an efficient and proactive strategy towards big data analytics ensures an organization secures a competitive advantage. Big data analytics helps to streamline supply chain operations such as warehousing, logistics, inventory management, procurement, and marketing (Benabdellah, A., Benghabrit, A. & Bouhaddou, I. 2016).

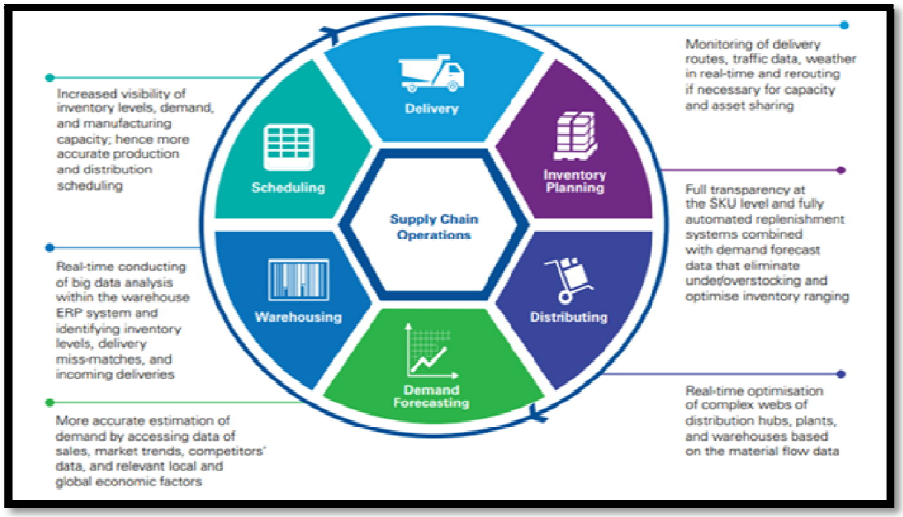


*Figure 2: Application of Big Data Analytics in Supply Chain (KPMG 2017)*

Other advantages of harnessing the power of big data analytics include the capacity to improve the company's response to unpredictable demand, achieving cost reduction, and improving customer satisfaction, as indicated in Figure 3 below:

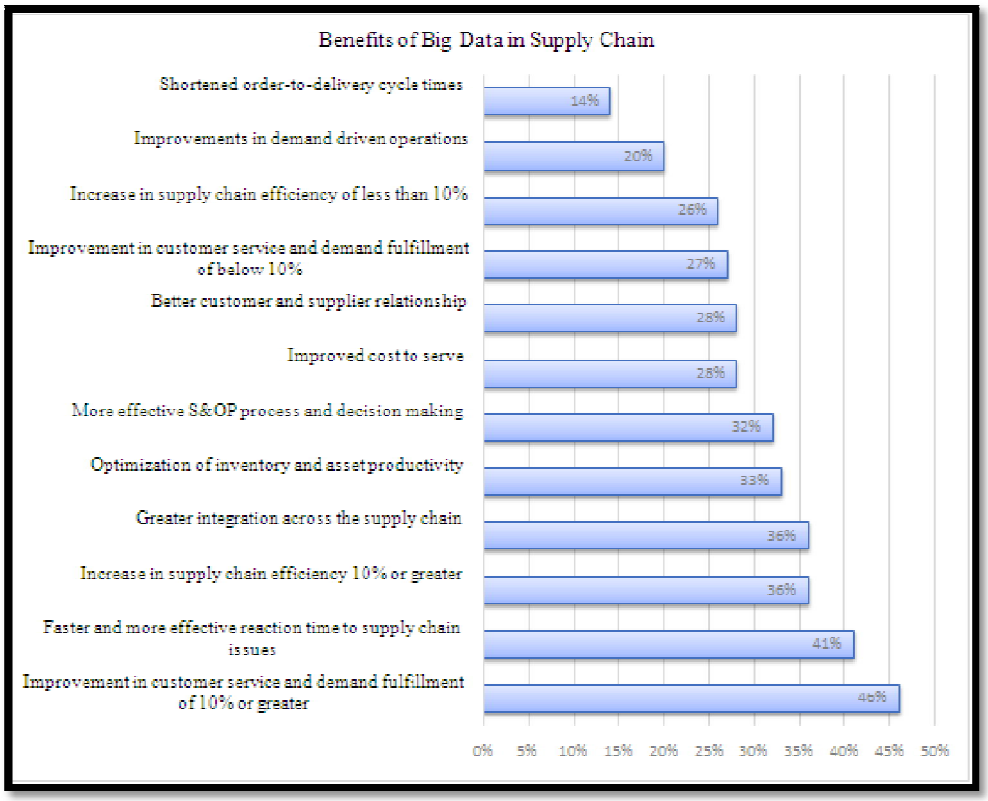


*Figure 3: Benefits of Big Data in Supply Chain Management (Awwad, M., Kulkarni, P., Bapna, R. & Marathe, A. 2018)*

**5. Challenges in Adopting Big Data Analytics for Supply Chain**

Big data continues to be relied on to improve the supply chain function nonetheless, the volume of unstructured data being produced and the complexity of the analytic process has made many companies be cautious with regards to its adoption. According to Arunachalam, Kumar, and Kawalek (2017), the major limiting factors that impact the integration of big data include the technical and organizational challenges such as privacy and security concerns since data must be shared across wide supply chain networks. Additionally, the analytic process is time-consuming given the volume and complexity of big data that needs to be interpreted (Fan, J., Han, F. & Liu, H. 2014). Top managers are also worried about the return on investment since it is challenging to estimate the value of big data collected given its variety and volume. Furthermore, there is a need for the company to make a significant investment in building the infrastructure used for data analytics (Fan, J., Han, F. & Liu, H. 2014). Firms also lack personnel with experience and specialized analytics skills and capable of making a correct interpretation of the usability of data. Similarly, Arunachalam, Kumar, and Kawalek (2017) noted several technical challenges that impact the adoption of big data analytics in the supply chain. Some of the issues include data scalability whereby companies fail to shift form cloud storage or distributed databases in favor of the traditional limited databases which ultimately compromises the amount of relative data and ability to make insights (Fan, J., Han, F. & Liu, H. 2014). Other issues include the quality of data collected and the use of obsolete methods to make analysis, forecasting, and visualization of data.

**6. Conclusion**

The literature review sought to discuss the concept of big data and its application in supply chain management. It is evident that big data analytics has proved to be an essential, indispensable, and disruptive innovation that can help a company excellently perform in today's competitive business landscape. Despite the overwhelming task of collecting and assessing the voluminous data, top management must prioritize the use of big data analytics to enhance supply chain management. Companies can outsource the services to a competent contractor data collection and analytic aspects while it remains focused on its core operations. Additionally, the scope of big data in terms of the 5V's (Value, Veracity, Velocity, Variety, and Volume) as well as the analysis of multifaceted data which has mined from supply chain activities and technologies can help resolve persistent challenges that affect supply chain management. Besides, top managers must

monitor all the technical and organizational issues that might hinder the adoption of the big data analytics considering the numerous benefits it provides. There is also a need to conduct detailed studies on the cost-effective ways of ensuring big data is easily integrated within the supply chain processes. Furthermore, future research must focus on investigating how to improve the correctness and scope of data collected from diverse sources, for instance, logistics, and manufacturing.

**7. References**


i. Arunachalam, D., Kumar, N. & Kawalek, J.P., 2018. Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice. Transportation Research Part E: Logistics and Transportation Review, 114, pp.416-436.

ii. Awwad, M., Kulkarni, P., Bapna, R. & Marathe, A., 2018. Big data analytics in supply chain: A literature review. In Proceedings of the International Conference on Industrial Engineering and Operations Management (ICIEOPM) (pp. 1-6). IEEE

iii. Barbosa, M.W., Vicente, A.D.L.C., Ladeira, M.B. & Oliveira, M.P.V.D., 2018. Managing supply chain resources with big data analytics: A systematic review. International Journal of Logistics Research and Applications, 21(3), pp.177-200.

iv. Benabdellah, A.C., Benghabrit, A. & Bouhaddou, I., 2016. Big data for supply chain management: Opportunities and challenges. In 2016 IEEE/ACS 13th International Conference of Computer Systems and Applications (AICCSA) (pp. 1-6). IEEE.

v. Chen, D.Q., Preston, D.S. & Swink, M., 2015. How the use of big data analytics affects value creation in supply chain management. Journal of Management Information Systems, 32(4), pp.4-39.

vi. Choi, T.M., Wallace, S.W. & Wang, Y., 2018. Big data analytics in operations management. Production and Operations Management, 27(10), pp.1868-1883.

vii. Coatney, K., 2018. Big data analytics capabilities, the business value of information technology, and healthcare organizations: the need for consensus in evidence-based medical practices. American Journal of Medical Research, 5(2), pp.28-33.

viii. Columbus, L., 2015. Ten ways big data is revolutionizing supply chain management. Forbes (13. July 2015).

ix. ComputerWorld (2018). Overcoming 5 major supply chain challenges with big data analytics. [Online] Available at <https://bit.ly/2KIqZyF> [Accessed 20 Aug. 2018].

x. Fan, J., Han, F. & Liu, H., 2014. Challenges of big data analysis. National Science Review, 1(2), pp.293-314.

xi. Ghosh, D., 2015, September. Big data in logistics and supply chain management: A rethinking step. In 2015 International Symposium on Advanced Computing and Communication (ISACC) (pp. 168-173). IEEE.

xii. Govindan, K., Cheng, T.C.E., Mishra, N. & Shukla, N., 2018. Big data analytics and application for logistics and supply chain management. Transportation Research Part E, 114, pp.343–349.

xiii. Grover, P. & Kar, A.K., 2017. Big data analytics: A review on theoretical contributions and tools used in literature. Global Journal of Flexible Systems Management, 18(3), pp.203-229.

xiv. Hazen, B.T., Skipper, J.B., Boone, C.A. & Hill, R.R., 2018. Back in business: operations research in support of big data analytics for operations and supply chain management. Annals of Operations Research, 270(1-2), pp.201-211.

xv. Katal, A., Wazid, M. & Goudar, R.H., 2013. Big data: Issues, challenges, tools and good practices. In 2013 Sixth International Conference on Contemporary Computing (IC3) (pp. 404-409). IEEE.

xvi. KPMG (2017). Supply chain big data series part 1: How big data is shaping the supply chains of tomorrow. [Online] (Updated March 2018) Available at <https://bit.ly/2Hv90dh> [Accessed 20 Aug. 2018].

xvii. McKinsey Global Institute (2011). Why data is the next frontier of innovation. [Online] (Updated 31 May 2011) Available at <https://mck.co/2wLmJJZ> [Accessed 20 Aug. 2018]

xviii. Nguyen, T., Li, Z.H.O.U., Spiegler, V., Ieromonachou, P. & Lin, Y., 2018. Big data analytics in supply chain management: A state-of-the-art literature review. Computers & Operations Research, 98, pp.254-264.

xix. Wamba, S.F., Gunasekaran, A., Dubey, R. & Ngai, E.W., 2018. Big Data Analytics in Operations and Supply Chain Management. Annals of Operations Research, 270(1-2), pp.1-4.

xx. Wang, C., Li, X., Zhou, X., Wang, A. & Nedjah, N., 2016. Soft Computing in Big Data Intelligent Transportation Systems. Applied Soft Computing, 38, pp.1099-1108.

xxi. Yaqoob, I., Hashem, I.A.T., Gani, A., Mokhtar, S., Ahmed, E., Anuar, N.B. & Vasilakos, A.V., 2016. Big Data: From Beginning to Future. International Journal of Information Management, 36(6), pp.1231-1247.