European Business & Management
2024, Vol. 10, No. 5, pp. 76-84
https://doi.org/10.11648/j.ebm.20241005.11

Review Article

Supply Chain Analytics, Definitions, Characteristics and Applications: A Systematic Literature Review

Desmond Mwangi Wairimu*

Graduate School, University of Kigali, Kigali, Rwanda

Abstract

While there is a high uptake of BDA in the realm of supply chain management, in the view of automation supply chains and improving their value proposition by providing more accurate data for demand forecasting. There are material knowledge gaps on the SC-specific analytics applied to match demand, albeit the existing knowledge could be more amorphous. From this backdrop, the study endeavored to analyze extant literature within the ambit of BDA to unpack the current trends and possible future research directions to foster the application of BDA in SC contexts. The study adopted a systematic literature review of the extant literature published between 2014-2023. The study adopted the five-stage iterative procedure used in the systematic review methodology. The review's findings depict extensive use of big data analytics in matching demand and supply and supply chain optimization. The findings of this study adduce almost non-rebuttable evidence that big data analytics can be applied in procurement, inventory control, logistics, and order processing. Under the auspices of BDA is the SCA. Arguably, extant research has demonstrated the capability of SCA in mitigating contemporary SC risks such as mismatches between demand and supply, sub-optimal SCs, and underutilization of the supply chain infrastructures at the cusps of various echelons.

Keywords

Supply Chain, Big Data Analytics, Supply Chain Analytics, Systematic Literature Review

1. Introduction

Supply chain refers to an interconnection of firms that convert raw materials to an end product and the outbound movement of manufactured goods to the end [19]. A supply chain has different physical, financial, and information flows. Supply chains have been afflicted by many challenges, ranging from poor synchronization between various facets of SC planning to the execution of plans. Another problem is poor real-time data visibility across the chain due to lip supply chain integration/linkages. Un-harmonized safety stock levels, leading to stock outs or excess inventory.

Supply chains need more robust agility, especially in their logistics network and distribution footprint [6, 18]. As such, decision-makers need help optimizing their distribution channels and meeting set customer service levels, leading to shrinking profit margins. Price volatility has compounded the planning problem, leading to inaccurate forecasts and a poor match between demand and supply forecasting, making it difficult for supply chains to become risk-averse. Other problems afflicting SCs are production line imbalance, suboptimal batch sizes, and underutilization of assets [4]. To

*Corresponding author: mwangi.desmond@gmail.com (Desmond Mwangi Wairimu), desmond.mwangi@jkuat.ac.ke (Desmond Mwangi Wairimu)

Received: 11 August 2024; **Accepted:** 2 September 2024; **Published:** 26 November 2024

this end, supply chain analytics focuses on utilizing information flow to arrive at more informed decisions in the supply chain. More succinctly, it is an analytical decision-making approach that helps match demand and supply [23].

Given the many innovations in information technology, information is a strategic resource for organizations across many industries. Big Data, also called SC analytics, business intelligence, etc., has contributed to intensified global innovation [18]. As local firms internationalize, they are confronted with massive amounts of data from their clientele and vendors. There is a need to manage and utilize such data to solve the problems inherent in a supply chain.

The emergence of SC analytics is attributed to the large amount of data captured by different firms due to the growth of mobile phones, social media such as Facebook and Twitter, and sensing technologies such as Radio Frequency Identification.

2. Materials and Methods

The study adopted a systematic literature review to review the literature published between 2014 and 2023. The study aimed to review emerging literature on this subject, so these dates were selected. A systematic literature review is the most efficient means of evaluating extensive literature and teasing out high-quality outcomes [25]. It is also the best method of characterizing extant research to support emerging trends [25].

The study adopted a five-stage procedure to review the literature systematically [25]. The method includes formulating the research questions, locating and identifying relevant studies, selecting and identifying the studies, selecting, synthesis, and report writing.

2.1. Formulation of Research Questions [15, 12]

The study sought to establish the following questions

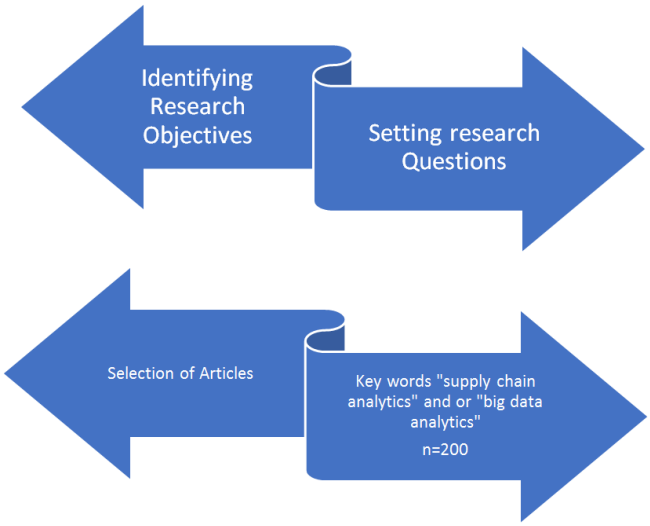
1. How has the extant research on supply chain analytics been conceptualized?
2. What research designs have been used in SCA literature?
3. What is the extant knowledge concerning the application of SCA?

Further, the study used the five-stage criteria to identify and retrieve peer-reviewed literature to answer the above research questions.

1. The title of the articles concerned Big Data analytics in companies [14].
2. The study reviewed journal articles that were published between 2014-2023 [14].
3. The reviewed journal articles were from peer-reviewed journals [14].
4. Only Academic journals were reviewed (excluding published company reports) [14].
5. Only English journals were considered for easy review and analysis [14].

2.2. Data Source

After setting the research questions, the second stage encompassed the location and identification of relevant studies. This step encompassed several sub-steps to arrive at the selected relevant articles. The initial search of the articles was conducted through electronic databases. These e-databases included Scopus, Web of Science, Science Direct, JSTOR, and Google Scholar. The common thread in all these databases is that they have a relatively expanded range [25]. Scopus is desirable because it allows the export of results in Excel [25]. Through this step, the study retrieved peer-reviewed articles relevant to the study's central theme. Based on these criteria, 25 peer-reviewed journal articles on supply chain analytics were found to apply to the research objective of this study.



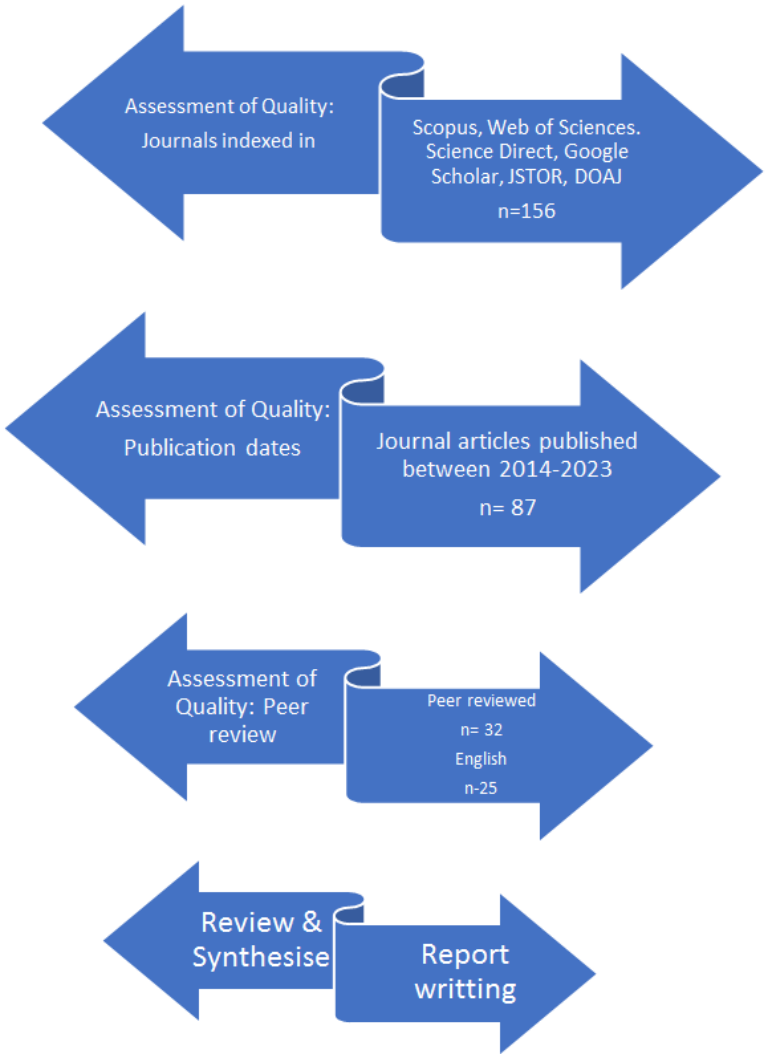


Figure 1. *Schematic diagram of literature search and article selection process.*

3. Results

3.1. Definitions of Supply Chain Analytics

Table 1. *Definitions of Supply Chain Analytics*

S/No.	Author	Definition
1.	[2].	Refers to the application of advanced analytics techniques to mine valuable information from information repositories to enable data-driven decision-making
2.	[17].	It defined supply chain analytics as applying mathematical and statistical tools to enormous amounts of data to make supply chain-related decisions. It is an analytical tool that leverages information flow in a supply chain to make decisions that help in matching demand and supply.
3.	[19].	It defined supply chain analytics as applying mathematical and statistical tools to enormous amounts of data to make supply chain-related decisions. It is an analytical tool that leverages information flow in a supply chain to make decisions that help in matching demand and supply.
4.	[24]	Defined supply chain analytics as the data science in supply chain management that applies qualitative and quantitative methodologies borrowed from different disciplines combined with supply chain management theory to diagnose supply chain management problems and undertake supply chain forecasts, considering the data quality and availability

S/No.	Author	Definition
		issues.
5.	[12].	They defined supply chain analytics as an operational shift from the traditional management models built to respond to data with the capability of helping supply chain practitioners analyze large data sets using acceptable analytical and mathematical techniques.
6.	[15].	Supply chain analytics is the application of analytical methods to deduce more accurate forecasts and better understand a supply chain's upstream and downstream activities.
7.	[10].	Supply chain analytics involves mining and presenting supply chain information to provide key performance indicators for measuring, monitoring, evaluating, forecasting, and managing the supply chain.

From the above definitions, supply chain analytics encapsulates the application of both qualitative and quantitative mathematical and statistical analytical models and techniques on a spectrum of supply chain-related information to derive supply chain insights that are used for supply chain decision-making in contemporary areas such as procurement, operations management, logistics customer relationship management, and SC optimization. Supply chain analytics is "high volume, high velocity, and high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insights, decision making, and process automation [2]."

3.2. Categories of Supply Chain Analytics

Supply Chain Operation Reference (SCOR) Model was used to classify analytics in supply chain management. The SCOR model enumerates five supply chain activities: Plan, Source, Make, Deliver, and Return. The planning element of the SCOR model is concerned with demand forecasts that help in Sourcing, Delivering, and Returning. Supply chain analytics supports various decisions in the different aspects of the SCOR model that are either strategic, tactical, or operational [25].

Table 2. *Categories of Supply Chain Analytics.*

S/No.	Author	Categories of Supply Chain Analytics
1.	[1, 19].	Supply chain analytics is categorized into descriptive, predictive, and prescriptive. Descriptive analytics describes a past business situation in a way that makes the business trends and patterns more apparent. First-level analytics explores past business events to gain insights about the future. Simply put, it answers the question of "what happened?" The techniques employed in descriptive analytics include standard reporting and dashboards, ad-hoc reporting, query drill-down, alerts, and visualization. Predictive analytics involves real-time and historical data analysis to forecast future occurrences. It encompasses algorithm-based techniques; it is all about technology being able to learn from data based on machine learning techniques and other computational data mining algorithms. Some methods used in predictive analytics include time series analysis, linear and logistic regression, decision tree, and clustering and dimensionality regression. Prescriptive analytics uses mined data to suggest and propose beneficial actions or prevent the occurrence of an unwanted outcome, such as risk. It also assesses variability between the desired and the actual outcome through what-if analysis and game theory approaches.

3.3. Characteristics of Supply Chain Analytics

Table 3. *Characteristics of Supply Chain Analytics.*

S/No.	Author	Characteristics	Description
1.	[1, 2, 9].	Volume:	-
2.		Velocity	Refers to the rate at which data is being gathered. Big data analytics leverages the internet and global integration for centralized data collection techniques.

S/No.	Author	Characteristics	Description
3.		Variety	It is the collection of different types of data, both structured and unstructured. Structured data is systematic data collected from various sources, such as sales information, financial transactions, and reservation systems. On the other hand, unstructured data is generated from sources such as social media, emails, and communication.
4.	[2, 26]	Veracity	It is the quality and trustworthiness of the collected data. As a rule of thumb, quality is always prioritized over quantity.
5.		Value	Obtaining data for analytics requires a colossal investment. The value of a data set is determined by estimating the insights that can be generated from post-analytics of data sets.

SC analytics has 15 characteristics [1, 8, 26]. These characteristics can be summarized as follows;

3.4. Characteristics of SC Analytics

Table 4. *Characteristics of SCA.*

S/No.	Characteristics	Elucidation	Description
1.	Volume	Data Size	Amount of the collected and stored data.
2.	Velocity	Rapidity of data	The rapidity of data transfer between source and destination.
3.	Value	Relative importance of data	The enterprise derives its value from SC analytics.
4.	Variety	Data type	Different data types, such as pictures, videos, multimedia, audio, etc
5.	Veracity	Quality of data	Precise analysis of captured data. It makes the data worthwhile for the application.
6.	Validity	Authenticity of data	It is the accuracy of the data used to derive information for decision-making.
7.	Volatility	The practical timespan of the data	For how long is the captured data useful
8.	Visualization	Data process/act	The process of representing abstract
9.	Virality	The speed of data spread	The rapidity with which data is spread by a given disseminator and how different users receive it.
10.	Viscosity	Lag of event	The total time lapse between the occurrence of an event and its description.
11.	Variability	Differentiation of data	The constant arrival of data from multiple sources and its stratification to sieve out essential data.
12.	Venue	Various platforms	Data types arrive from different platforms, such as personnel systems and private and public clouds.
13.	Vocabulary	Terminologies relating to data	Terminologies such as data models and data structure.
14.	Vagueness	Non-distinct data	Non-coherent information with no logical flow that coveys little or no information.
15.	Complexity	Data correlation	Since data emanates from multiple sources, it can vary from previously arrived data.
16.	Verbosity	Redundancy	The extent to which the available information from diverse sources needs to be revised.
17.	Voluntariness	Wilful availability of data	The wilful availability of contextualized big data
18.	Versatility	Agility	The ability of the supply chain analytics to be flexible enough to be applied in diverse contexts

3.5. Types of Supply Chain Analytics

Table 5. Types of Supply Chain Analytics.

Author	Description
[5]	It contends that supply chain analytics has two data types: structured and unstructured. They equate structured data to a data warehouse, whereby data is tagged and sorted, while unstructured data is random and difficult to analyze. Both structured and unstructured data are computer and human-generated. Computer-generated structured data includes sensor data, web log data, Point of Sale (POS), and financial data. Human-generated structured data encompasses click stream, input, and gaming-related data. On the other side of the divide, machine-generated unstructured data includes satellite images, scientific data, photographs and videos, and radar or sonar data. Human-generated structured data includes internal text for the company, social media data, mobile data, and website content.
[21]	In addition to structured and unstructured data, there are other forms of data, such as geographic data, real-time data, natural language data, time series data, event data, network data, and linked data. Geographical Information Systems (GIS) generate geographic data. They generate descriptive information about transport infrastructure, routes, oceans, and lakes. Real-time data generates large volumes that are challenging to process and store. Sources include video conferencing and social media such as YouTube, Flicker, Facebook, etc. Natural language data is human-generated. Sources of natural data include speech recognition devices, phones, and the Internet of Things (IoT). Time series data is collected longitudinally through successive measurements to generate trends and anomalies. Event data is generated by matching external events with time series data. A prerequisite for this is stratifying important events from unimportant ones. Event data contains three types of information: action, timestamp, and state. Network data is obtained from relatively large networks, such as social networks, information networks, and technological networks. Linked data is built upon standard Web technologies, such as HTTP, RDF, SPARQL, and URL, to share semantically queried information by computers.

3.6. Application of Supply Chain Analytics

Based on the literature reviewed, the following are the benefits of SC analytics. An article entitled "Big Data and its Applications in Supply Chain Management: Findings from a Delphi Study" identified a cluster of analytics applications in the supply chain [3, 7].

Table 6. Application of Supply Chain Analytics.

S/No.	Author	Application	Description
1.	[3].	Sourcing	Used as decision support for procurement Provides information necessary for procurement negotiations Includes information and KPIs for evaluating supplier performance Used to support collaboration through chain-wide information asymmetry. Used to provide information to develop alternative sources of supply and supplier development Analytics are applied in the automation of the procurement function It is also used in procurement process benchmarking.
2.		Manufacturing	Applied in identifying optimal production methods Applied in diagnosing manufacturing problems through the Ishikawa cause and effect diagrams. It helps in teasing out new insights about production processes Evaluating the performance of manufacturing activities Automating manufacturing processes

S/No.	Author	Application	Description
			Designing flexible manufacturing set-ups
3.		Customer Service	Customer segmentation Gaining insights about customer needs Synchronizing products /services to actual customer needs Customization/product differentiation and diversification New Product Development Customer management
4.	[1]	Logistics	Logistics optimization Assessing the performance of logistics Dissemination of logistics information across the chain Routing and scheduling Track and tracing Logistics network design
5.		Forecasting	Forecasts of independent demand, i.e., for finished goods Forecasting of dependent demand Determination of appropriate demand and supply strategy Obtaining feedback about new product releases. Contingency planning and what-if analysis and risk management.
6.		Returns Management	Learning from customer complaints Generating problem trees to identify surface and root problems related to the defects. Predicting returns rate Evaluating return process performance
7.	[2, 17, 21, 27]	Planning	Risk and resilience planning Reducing risks associated with investments in infrastructure and contracted third parties Facilitating monitoring and evaluation of performance as well as better planning.
8.		Procurement	Warehouse and distribution optimization Enabling value-added SCs that focus on collaboration Achievement of granular levels on aggregated procurement patterns
9.		Production	Gaining market intelligence Vendor-managed inventories. Materials handling and packaging
10.	[1]	Distribution	Real-time route Optimization Track and tracing in the SC More accurate estimation of lead times among different distribution channels. Optimization of critical logistics activities Optimization of manufacturing activities and better shop floor management.
11.		Returns Management	Reduced driver turnover and assignment through the application of sentiment data analysis Management of customer loyalty Continuous service improvement Product innovation SC Visibility
12.	[22]	Demand Management Risk mitigation Sustainable SC	Creating a responsive demand-driven supply chain through SC analytics of internal and external sources of demand data and comparing store cluster profiles to predict demand. Application of SC analytics for supplier information management minimizes SC risks and provides supplier information in real-time.

S/No.	Author	Application	Description
		practices	SC analytics also enables financiers to map risk inherent processes and SC bottlenecks. Analytics provide a more accurate assessment of sustainability-related SC considerations and environmental impacts, such as track and trace, waste production, and Environmental and Social Governance performance measurement.

4. Discussion

This study has systematically reviewed existing literature on SC analytics using content analysis. The research has identified about 25 different analytics applications in the supply chain. Extant research has sparse empirical contributions to SC analytics. To this end, the findings of this research have been empirically based on a systematic literature review. More so, this research has confirmed previously identified analytics applications in supply chain management. This research defines how practitioners can apply supply chain analytics to manage various facets of SC better. Past researchers have undoubtedly contributed to demystifying the application of big data in supply chain management. Analytics has seen the unprecedented entry of SC into the digital ecosystem.

5. Conclusions

The study adopted a systematic literature review of 25 peer-reviewed articles. There could be a minimal possibility of replication because the researcher did not register the review in a database to provide the latitude for updates about the review status.

Abbreviations

BDA	Big Data Analytics
SC	Supply Chain
SCA	Supply Chain Analytics

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] Arya, V., Sharma, P., Singh, A., & De Silva, P. T. M. (2017). An exploratory study on supply chain analytics applied to spare parts supply chain. Benchmarking: An International Journal, 24(6), 1571–1580. https://doi.org/10.1108/BIJ-04-2016-0053

[2] Awwad, M., Kulkarni, P., Bapna, R., & Marathe, (2018). A. Big Data Analytics in Supply Chain: A Literature Review. Proceedings of the International Conference on Industrial Engineering and Operations Management Washington DC, USA, September 27-29, 2018. https://ieomsociety.org/dc2018/papers/149.pdf

[3] Brinch, M., Stentoft, J., & Jensen, J. K. (2017, January). Big data and its applications in Supply Chain Management: findings from a Delphi Study. In Proceedings of the 50th Hawaii International Conference on System Sciences. https://scholarspace.manoa.hawaii.edu/server/api/core/bitstreams/156afa78-506c-43e7-a982-04b54ac1f778/content

[4] Chae, B., Olson, D., & Sheu, C. (2014). The impact of supply chain analytics on operational performance: a resource-based view. International Journal of Production Research, 52(16), 4695–4710. https://doi.org/10.1080/00207543.2013.861616

[5] Hadi, H. J., Shnain, A. H., Hadishaheed, S., & Ahmad, A. H. (2014). Big data and five's characteristics. In IRF International Conference. https://www.researchgate.net/publication/332230305_BIG_DATA_AND_FIVE_V'S_CHARACTERISTICS

[6] Fosso Wamba, S., & Akter, S. (2019). I understand supply chain analytics capabilities and agility for data-rich environments. International Journal of Operations & Production Management, 39(6/7/8), 887-912. http://dx.doi.org/10.1108/IJOPM-01-2019-0025

[7] Ittmann, H. W. (2015). The impact of big data and business analytics on supply chain management. Journal of Transport and Supply Chain Management, 9(1), 1-9. https://doi.org/10.4102/jtscm.v9i1.165

[8] Kapil, G., Agrawal, A., & Khan, R. A. (2016, October). A study of big data characteristics. In 2016 International Conference on Communication and Electronics Systems (ICCES) (pp. 1-4). IEEE. https://doi.org/10.1109/CESYS.2016.7889917

[9] Laney, D. B. (2017). Infonomics: how to monetize, manage, and measure information as an asset for competitive advantage. Routledge.

[10] Marabotti, D. (2003). Build supplier metrics and build better products. Quality, 42(2), 40. https://www.qualitymag.com/articles/84432-build-supplier-metrics-build-better-product

[11] Martin, F., Sánchez-Hernández, S., Gutiérrez-Guerrero, A., Pinedo-Gomez, J., & Benabdellah, K. (2016). An overview of biased and unbiased methods for detecting off-target cleavage by CRISPR/Cas9. International journal of molecular sciences, 17(9), 1507.

[12] O'Dwyer, J., & Renner, R. (2011). The promise of advanced supply chain analytics. Supply Chain Management Review, 15(1).

[13] Ogbuke, N. J., Yusuf, Y. Y., Dharma, K., & Mercangoz, B. A. (2022). Big data supply chain analytics: ethical, privacy and security challenges posed to business, industries, and society. Production Planning & Control, 33(2-3), 123-137. https://doi.org/10.1080/09537287.2020.1810764

[14] Osobajo, O. A., Oke, A., Omotayo, T. and Obi, L. I. (2022), "A systematic review of circular economy research in the construction industry," Smart and Sustainable Built Environment, 11(1), pp. 39-64. https://doi.org/10.1108/SASBE-04-2020-0034

[15] Pearson, P. D., Valencia, S. W., & Wixson, K. (2014). Complicating the world of reading assessment: Toward better assessments for better teaching. Theory into practice, 53(3), 236-246. https://doi.org/10.1080/00405841.2014.916958

[16] Pelz, M. (2019). Can management accounting be helpful for young and small companies? A systematic review of a paradox. International Journal of Management Reviews, 21(2), 256-274. https://doi.org/10.1111/ijmr.12197

[17] Saunders, C. S., Liu, G., Yu, Y., & Zhu, W. (2016). Data-driven distributed analytics and control platform for smart grid situational awareness. CSEE Journal of Power and Energy Systems, 2(3), 51-58. https://doi.org/10.17775/CSEEJPES.2016.00035

[18] Shamout, M. D. (2019). Does supply chain analytics enhance supply chain innovation and robustness capability? Organizacija, 52(2), 95-106. https://doi.org/10.2478/orga-2019-0007

[19] Souza, G. C. (2014). Supply chain analytics. Business Horizons, 57(5), 595-605. https://doi.org/10.1016/j.bushor.2014.06.004

[20] Srinivasan, R., & Swink, M. (2018). An investigation of visibility and flexibility as complements to supply chain analytics: An organizational information processing theory perspective. Production and Operations Management, 27(10), 1849-1867. https://doi.org/10.1111/poms.12746

[21] Thanintorn, N., Wang, J., Ersoy, I., Al-Taie, Z., Jiang, Y., Wang, D., & Shin, D. (2016). RDF sketch maps-knowledge complexity reduction for precision medicine analytics. In Biocomputing 2016: Proceedings of the Pacific Symposium (pp. 417-428).

[22] Ülkü, M. A., & Engau, A. (2021). Sustainable supply chain analytics. Industry, innovation and infrastructure, 1123-1134. https://doi.org/10.1007/978-3-319-95873-6_117

[23] Waller, M. A., & Fawcett, S. E. (2013). Big data, predictive analytics, and theory development in the maker movement supply chain era. Journal of Business Logistics, 34(4), 249–252. https://doi.org/10.1111/jbl.12024

[24] Waller, M. A., & Fawcett, S. E. (2013). Data science, predictive analytics, and big data: a revolution that will transform supply chain design and management. Journal of Business Logistics, 34(2), 77–84. https://doi.org/10.1111/jbl.12010

[25] Xiao, Y., & Watson, M. (2019). Guidance on Conducting a Systematic Literature Review. Journal of Planning Education and Research, 39(1), 93-112. https://doi.org/10.1177/0739456X17723971

[26] XSNET. (2017). Updated for 2017: The V's of Big Data: Velocity, Volume, Value, Variety, and Veracity.

[27] Zhu, S., Song, J., Hazen, B. T., Lee, K., & Cegielski, C. (2018). How supply chain analytics enables operational supply chain transparency: An organizational information processing theory perspective. International Journal of Physical Distribution & Logistics Management, 48(1), 47-68. https://doi.org/10.1108/IJPDLM-11-2017-0341