Article

Use of Big Data Analytics in Operations Management: A Review Using Text Analytics

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Abstract

Objective: The companies integrate their operations with their supply chain partners and align their technological resources with that of their workforce resources on a global scale. In the wake of which Big data analytics (BDA) presents new capabilities and opportunities for Operations Management (OM). All such integrations in the companies result in the creation of a large amount of real-time data, including the different formats of storage, which could be used to optimize operational decisions. This work aims to figure out current industry trends and future implementation of BDA in OM and summarize the research gaps in the domain using Text analytics.

Keywords: Logistics, Supply chain management, Big data Analytics, Text Analytics, Literature review

Methodology: Text analytics was applied to 68 research articles identified from various journals, published from 2010 to 2020. These were used to build a word cloud to evaluate the key textual data points and to study the academic studies conducted in OM using BDA.

Findings: The analysis revealed most of the articles were published in supply chain management, specifically in the logistics area. The study further revealed the application of BDA in the field, such as cold-chain logistics, identifying factors related to cargo-loss in shipping firms, and advances made in urban transport using Big Data. The analysis also identified Big Data in demand forecasting, inventory management, supply chain management, and transportation management. The key factors for value creation for achieving competitive advantage were also identified.

Introduction

With digitalization, by incorporating technology such as cloud computing, AI, deep learning, and big data, companies are redeveloping their industries and creating new business prospects. Due to these technologies, organizations transform their decision-making processes and strategies, their day-to-day operations to achieve competitive advantage (Haddud & Khare, 2020). Digitization impacts the entire supply chain by allowing real-time accountability from manufacturers to consumers, interconnected systems, decentralized, autonomous management (Kayikci, 2018). In current times, organizational data have been digitized exponentially for effective decision-making. As a consequence, a variety of innovations, such as data processing, deep learning, and big data analytics, help to obtain useful insights into a market by understanding its relationships and dependencies (Ruchi & Srinath, 2018).

Big Data is an environment that deals with ways to analyze, constantly retrieve, or generally handle data repositories that have humungous volumes and are beyond the capacity of traditional data processing applications (Emmanuel & Stanier, 2016). Big Data Analytics is the approach by which these large data sets (Big Data) are obtained, analyzed, and examined to establish associations and other useful information. State-of-art algorithms can help companies fully understand the specifics obtained from the data and classify the most important facts for future management and strategic decisions. The advances in computer and information technology have contributed to an influx of data in all fields of Operations Management.

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For organizations, working with Big Data to extract useful information is one of the drivers for achieving a competitive advantage in the industry (Biswas & Sen, 2016). Business analytics and Big Data are emerging fields to increase organizational performance management and gain a competitive advantage through better decision-making (Schläfke et al., 2013).

As Big Data Analytics is a key technology in modern operations management, it can be extended to a range of operations, such as forecasting, inventory management, logistics management, supply chain management, sales management, and risk analysis through a variety of big data approaches such as techniques, strategies, and architecture (Choi et al., 2018). One of the complex activities that might benefit from the incorporation of Big Data Analytics is demand forecasting. It could only be done if the organization has a technological foundation and has made technological investments (Hofmann & Rutschmann, 2018). Implementation of Big data Analytics can have four perspectives within an organization- operational, technical, economic, and supply chain network. (Lai et al., 2018).

The implementation of big data analytics by the organizations affects the value creation, and the critical antecedents of the bigdata analytics usage within an organization are influenced by the rate at which the environmental and technological factors of an organization changes and these factors indirectly are influenced by the support of top management (Chen et al., 2015). Supply chain analytics can be explained as the extension of big data analytics into the supply chain to enhance the operational effectiveness of the company. This could be achieved by enabling data-driven decisions at strategic, operational, and tactical levels. From a resource-based organizational perspective, the supply chain analytics architecture is characterized through the intersection of three resource sets, IT-enabled planning resources, and performance management resources, data management resources (Chae et al., 2014).

The field of Logistics and Supply Chain Management (LSCM) has been a pioneer in the implementation of Business Analytics. By mapping domain characteristics, around thirty-four characteristics were identified in the analytics initiative that differentiated the domains of Logistics and Supply Chain by implementing these initiatives (Herden, 2020). Supply Chain Analytics Agility (SCAG) is identified as a mediator between Supply Chain Analytics Capabilities (SCAC) and firm performance. Furthermore, another study (Fosso Wamba & Akter, 2019) found significant antecedents of dynamic Supply Chain Analytics Capabilities (SCAC) model as supply chain management (planning, investing, coordinating and controlling), supply chain technology (connectivity, compatibility, and modularity), and supply chain talent (technical knowledge, business knowledge, relational knowledge and technology management knowledge). The intention to incorporate Big Data Analytics within an organization is motivated by market operations and improved decision-making. The value factor associated with a supply chain organization's big data provides a multi-faceted perspective across value dimensions such as data discovery, data

generation, and data capture (Chen et al., 2015).

Although many researchers have conducted literature reviews (Mišić & Perakis, (2020), Nguyen et al., (2018), etc.), very few used content-based text-analysis to do the same. This paper seeks to review current literature to assess developments in the market and the potential implementation of state-of-art data analytics applications in Operations Management by using text analytics techniques such as word-cloud to draw inferences from existing literature.

Content research based on the literature review

The criteria for performing the content review, as suggested by Seuring & Gold (2012), were implemented in this report, consisting of the following steps:

Data Collection

We opted not to limit the review to a selection of publications and included various case studies and papers written in a series of journals. Emerald Insight, a research archive comprising influential journals, magazines, and case studies in management and industry, was used to search for this analysis's appropriate data. Apart from Emerald Insight, Wiley Online Library, Google Scholar, and the research gate database were also used to search for relevant data.

Unique keywords have been used to search for documents from the database, such as:

("Operations Management" OR "Logistics and Supply Chain Management" AND "Big Data Analytics"),

("Supply Chain Management" OR "Facilities Management" OR "Retail Management" AND "Analytics"), etc.

We limited the duration of our study requirements from March 2008 to March 2020. Search keywords have been used to search anywhere in the article, i.e., title, abstract and main text. The titles and summaries of the search results were read and picked based on the phrase context as keywords. This lead to the selection of 68 relevant papers for review.

The abstracts and full papers were retained for detailed investigation, and an excel sheet was maintained where the data was saved in the following manner:

"Paper Name," "Publication Journal," "Date Published," "Purpose," "Methodology," "Findings."

Descriptive Analysis

The International Journal of Logistics Management (with eight papers) was the journal with most papers, followed by the International Journal of Operations and Production Management (with seven papers). Five articles were published in the International Journal of Physical Distribution and Logistics. Those three journals accounted for 30% of the records to be analyzed.

The number of research documents released in the timeframe is seen in Figure 1. The below statistics suggest the growing interest in the emerging topic.

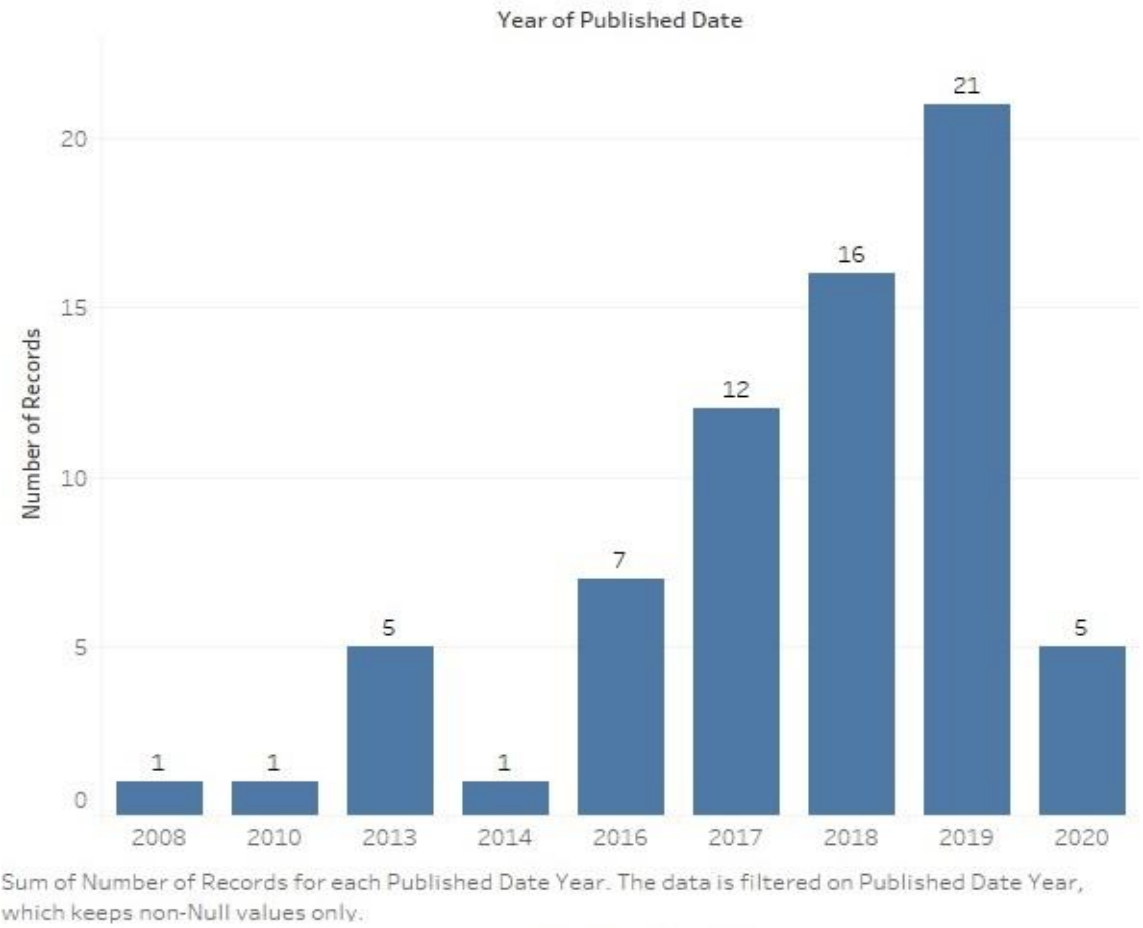

Figure 1: Journal Statistics by Published Year

Analysis of the data

To analyze the data through the content analysis approach, text analysis is used. An article by Jeff Tollefson in 2018, citing the statistics projected by US National Science Foundation (NSF), states that over 25 million research and scientific papers are published every year (Tollefson, 2018). These articles are likely to contain a large amount of information and reflect accurate facts in a nuanced, rich, and vague way. Hence, it cannot be analyzed using traditional predictive data mining techniques as compared to qualitative data. Text Analytics is used to extract insights by processing a large array of textual data, based on identifying useful patterns and facts suggesting trends and features on key topics (Nasukawa & Nagano, 2001). Word Cloud is a graphic representation of textual data points in which words are displayed, depending on their number of occurrences. They are a great tool to visualize unstructured text data and provide insights into trends and patterns. Word clouds visualize the words in colors and font size according to their frequency (Heimerl et al., 2014).

In this paper, text analysis was used for the content analysis of the data collected. Word Clouds were created using the papers' titles to represent the main textual data points and

analyze the frequent words to present the pool of knowledge available in the collected studies. To create the Word Cloud, a Python program was written that reads through a .csv (comma separated values) file which contained the data set.

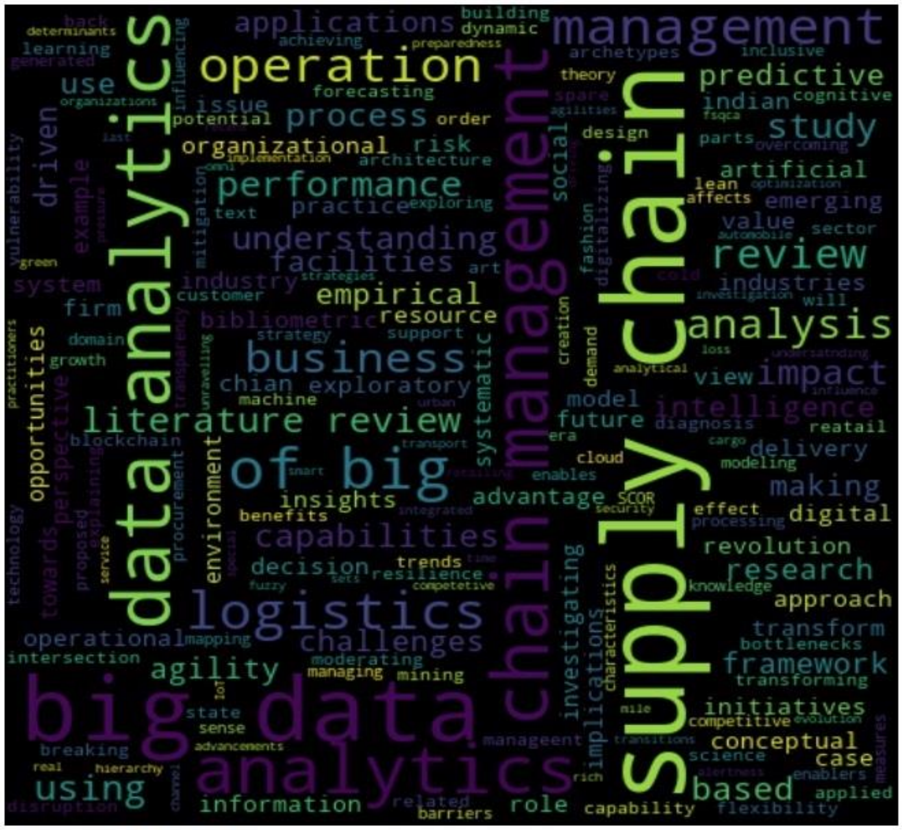

Figure 2: Word Cloud 1

Content analysis findings

We easily get a vague understanding of the text, skimming through the word cloud in Figure 2. The most prominent words and subjects are instantly communicated.

As most of the words conveyed here represented the words related to the topic and were not as useful, we removed them from the list of words and generated another word cloud. This led to better visualization and highlighted important terms, as shown in Figure 3.

Figure 3: Word Cloud 2

A frequency table was generated, and the important terms were analyzed by going back through the abstracts. The papers were grouped according to the terms present in Table 1 below shows the term and the frequency of occurrence associated with the same.

Frequency	Word
12	Logistics
6	Operations
4	Capabilities
3	Agility
3	Performance
2	Artificial
2	Risk

Table 1: Word Frequencies

Logistics

Logistics is a key component of supply chain management, which is used to satisfy the customer demands by planning, monitoring, and implementation effective movement and storage of relevant information, products, and services from the source to the destination. Implementation of Big Data within an organization can provide valuable insights into industry dynamics, customer purchasing habits, maintenance cycles, methods to minimize costs by enhancing strategic decision making (Wang et al., 2016). The identification and analysis

of big data over a long period can be utilized in decision making for cold-chain logistics firms to unearth patterns leading to product deterioration, which could lead to transportation network redesigning to minimize quality loss (Chaudhuri et al., 2018). To investigate the delivery vulnerabilities, a study was conducted via the diagnosis of day-to-day logistics risks. The study revealed that the tightly coupled logistics system (a system where buyers and suppliers enjoy a close relationship) could align with normal accident theory (an event where accidents are the inevitable outcomes) (Wu & Chaipiyaphan, 2019). Another study was conducted to analyze the causes of cargo loss severity and the development of cargo loss mitigation strategies. The study identified factors such as shipping destination, product categories, and transit types behind the cargo loss severity. Using this study, organizations may recognize cargo-loss factors and employ cargo loss mitigation (Wu et al., 2017).

Furthermore, a vast amount of data such as customer demand and travel times is used in the recent advances of urban transport and logistics firms through optimization and analytics since urban transport planning is challenging due to traffic and increasing customer demand. Transportation models such as vehicle routing could be improved by stimulating and implementing real-time data and online decision-making (Campbell & Van Woensel, 2019). Based on the analysis of previous Big Data and Supply Chain literature, four reasons are established for the firm's decision to incorporate Big Data Analytics in its operations. These possible causes can be categorized as technical, operational, environmental, and supply chain factors. Environmental considerations, such as government policy, access to the supply chain, and the implementation of big data by rivals, are defined as driving factors for the intention to implement big data. However, the top management of the organization and their views on the perceived benefits of the adoption can also significantly influence the adoption intention (Lai et al., 2018).

Operations

With the growing reliance of big data on operations, studies have been carried out on how these big data approaches could be implemented in the different areas of Operations Management (OM), including demand forecasting, inventory management, supply chain management, and transport management (Choi et al., 2018). Supply chain businesses implement emerging technological developments individually in order to achieve a strategic edge over their competitors. There is also a need to recognize where the digitizing supply chain will provide companies with the ability to build on those benefits. Five chosen lean operating practices were analyzed, and the digitization of the supply chain specifically strengthened these lean operating practices and the overall supply chain and company process (Haddud & Khare, 2020). Another research provides a roadmap for sustainable improvement, which generates a strategic edge by setting higher standards of success and market agendas (Matthias et al., 2017).

Capabilities

The next frontier in the automation of the supply chain is Big-Data driven supply chain analytics capability. According to the research, which targeted practitioners with

expertise in analytics, the influence of BDA management capabilities is the core driver of supply chain stability (Mandal, 2019). Another similar study in the USA identified that the analytics-driven supply chain agility is the significant mediator between the overall supply chain analytics capabilities and firm performance (Fosso Wamba & Akter, 2019). Supply chain data analytics, industry size, company age, and annual sales were suggested to be sufficient and appropriate conditions to achieve higher supply chain agility scores by applying the qualitative comparative analysis fuzzy sets (fsQCA) technique on data obtained from UAE operating companies (Shamout, 2020).

Agility

The Supply Chain Analytics Architecture (SCA) consists of three resource sets, Data Management Tools, IT-enabled planning resources, and performance management resources. The relationship between these tools, Supply Chain Planning Efficiency, and Organizational Output was investigated using data obtained from 537 manufacturing plants. It was found that manufacturers with sophisticated planning technologies were likely to take advantage of data-driven processes and quality control practices (Chae et al., 2014). Another related research, where data was obtained from 145 service providers, showed that with larger data sets, more companies used BDA to perform current algorithms faster. It was also observed that BDA has a strong and important relationship with firms' ability to handle data protection and a positive effect on service supply chain growth and service supply chain efficiency (Fernando et al., 2018).

Performance

The efficiency of the entire supply chain largely depends on the system's bottlenecks. By digitizing the supply chain by utilizing the simulation model in a manufacturing organization and encouraging the machine to make autonomous planning and scheduling decisions on the basis of environmental adjustments, the order lead time could be substantially reduced (Feldt et al., 2019).

Risk

By developing BDA capabilities within their organizations, businesses may develop enterprise risk tolerance from supply chain disruption events. Data obtained from 225 companies around the US and Europe show that internal expertise in handling supply chain disruption incidents is counterproductive to firms' ability to improve their risk resilience. However, if the business adopts BDA capabilities, it can efficiently exploit firm expertise and enhance supply chain risk resilience capabilities. (Singh & Singh, 2019).

Conclusion and Limitations:

In this article, text analytics approaches, such as word clouds, were used to evaluate previous articles on the application of big data in operations management. We reviewed 68 articles written in the field of operations and summarized the dynamics and themes of previous publications. It is among the few papers that relied on previous studies using a word cloud tools.

This analysis has revealed the main data points, like logistics, operations, capabilities, agility, performance, and risks. The study outlined the reasons intended for the implementation of big data in a logistics

business and how well big data is being applied in companies to improve competitive decision-making and unravel consumer buying trends. This helps the organizations to make an accurate demand forecast for the future sales of the product. Big data-driven supply chain analytics has improved the organizations' operational efficiency by improving decision-making at strategic, operational, and tactical levels.

In future studies, we expect to perform a more in-depth study of a particular operational aspect, such as distribution, shipping, supply chain, etc. We could examine the additional papers. We could also implement many other text analytics methods that could also be considered, such as cluster analysis, to divide papers into clusters of similar papers.

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