Big Data Analysis for Supply Chain Management: Evidence from JD E-commerce, NongFu Spring, Tesla

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Abstract. Contemporarily, companies in this data era confront great opportunities and difficulties, and data is used as a measurement tool for value. Driven by the data era, this study briefly introduces big data analytics and supply chain management, and integrate several managements used for big data. This paper analyzes the implementation of three examples (i.e., JD e-commerce, NongFu Spring, Tesla), examine the principles involved, and explore the challenges and prospects of analytics. This paper focuses on the factors that influence big data work for supply chain and summarizes various aspects of big data analytics in supply chain management. According to the analysis, businesses that successfully apply big data and convert its value into productivity will have a significant competitive advantage and take the lead in their sector. The ability to use big data is a key driver for companies to use analytics to make supply chain decisions. In addition, companies can make business judgments through forecasting to achieve reform in the supply chain to obtain speed and thus get a profitable advantaged. These results shed light on guiding further exploration of the applicability of big data technology on the supply side.

Keywords: Big Data, Supply Chain Management, JD e-commerce, NongFu Spring, Tesla.

1. Introduction

The majority of scholars agree that Keith Oliver invented the term "supply chain management" in an interview with the Financial Times in 1982. Supply Chain Management (SCM), which is covered in management education programs (e.g., the MBA and EMBA), is the process of optimizing supply chain operations to satisfy the end customer at the lowest cost. Overall, people consider using the chains as a virtual corporate alliance, the alliance's internal management falls within the purview of supply chain management. In essence, SCM integrates supply and demand management within and across companies [1].

In reaction to contemporary production techniques, supply chain management is a modern distribution strategy that was developed. In turn, its continuous improvement and increase in level accelerates the development of modern production methods. Another benefit of studying supply chain management is the application of the field in a variety of sectors and positions, which primarily provides transferable skills and knowledge. Cost effectiveness has been the main objective of international supply chain management methods for more than 20 years. However, upheavals (e.g., Brexit, tax hikes, trade disputes, natural disasters, and the COVID-19 pandemic) have made it more crucial for GSCM to be resilient and agile. British management scholar Christopher highlighted the formula for supply chain management advancement in the twenty-first century. There are already some observable trends and indicators it is possible to paint a picture of the challenges that lie ahead for supply chain management [2]. The trend forecasting led by the data era has created a more informed sourcing and forecasting in management.

With the advent of the big data era, the concept of supply chain decarbonization is deeply rooted, and the multi-objective optimization model of green supply chain management scheme is proposed [3]. The model uses big data analysis to adjust parameters to optimize the ecological friendliness of green supply chain management using three scenarios to reduce costs, carbon emissions, and the hazards of hazardous substances. The study combines MODM and MADM methods to solve the model and identify optimal scenarios to help improve green supply chain management practices, thereby promoting sustainable development. Wireless Sensor Networks (WSN) is a distributed

sensing network, scholars developed a real-time perishable food supply chain monitoring system based on this network [4]. This work goes into detail to describe the contributions, hardware design, and software implementation of the system. As the sensor network implements three functions of sensing data collection, processing, and transmission, which includes temperature data, RFID data, etc., is expanding quickly and can open a lot of business opportunities for supply chain finance.

Abdelkarim et al. discussed new ways in which big data analytics that can be applied within logistics and transportation industry and proposed a new method for detecting and identifying container codes based on the open-source distributed computing platform Hadoop big data analytics system [5]. The impact of urban pollution and traffic congestion can be reduced by such analytical projects that combine the power of smart technologies with big data analytics. Angappa argued that as the framework for organizing and carrying out supply chain operations, advances in forecasting technology will enable the generation of large amounts of time series data that will influence supply chain decisions [6]. The study found that sales forecasting in the supply chain is improved by big data-based customer analytics and related technologies, which are translated into more accurate forecasts that are used to make actionable operational decisions.

This study will analyze the implementation of big data for manufacturing and exploiting the feasibility of supply chain management in different fields. The remainder of this text will discuss the following. Firstly, this paper will introduce big data analytics and clarify its role in SCM. Additionally, via the management examples of three organizations, this paper will investigate the components of SCM under the effect of big data, integrate and analyze the working principle of big data analytics by various aspects, then conclude the study with findings and recommendations. This research is a brief and basic research presentation that will hopefully help organizations, strategic decision makers to get started with this new age advantageous tool of big data analytics.

2. Big data analytics

Big data analytics is a sophisticated method of analyzing extremely large and varied sets of data. Data analytics allows to produce better quality interpretations of data, and analytics with predictive meaning enables businesses or organizations to draw conclusions about the future using data analysis and visual analytics. Mining the value of big data is like panning for gold in the sand, extracting sparse but precious information from massive amounts of data. Besides, only the analyzed data can produce the most important value to users.

In different industries, the technology of big data analytics can help employees engage in industry data collection, organize the collected data, perform in-depth analysis of the organized data, and make industry studies, assessments, and forecasts based on the data analysis results. Some of the greatest benefits of big data analytics include speed, efficiency, which is demonstrated by reducing costs, making forecasts, and developing and marketing new products and services.

Businesses' operations are changing quickly as a result of the expanding diversity of data, from customer preferences to logistics, underscoring the urgent need for improved data management and analytics. Big data analytics can provide value to the digital commerce space in a variety of ways, ranging from supply chain management. Companies that benefit from big data analytics have the right talent pool to be able to embed big data analytics into their supply chain operations. In this case, suppliers can collect a wealth of data about competitors who are out of stock on certain items and then ensure that shipments of those items are significantly increased to attract impatient and eager shoppers. Several uses of big data analytics in supply chain management are listed as follows:

- As shown in Fig. 1, data analytics can successfully halt unforeseen mechanical issues [7]. IoT devices and data systems can work together to deliver notifications about any issues or violations with machinery. Sensors can be used to monitor production, foretell issues, and provide alerts when routine maintenance is required to keep equipment in top working order.
- Data systems can help companies keep up with supply and demand. By importing the historical data of incoming and outgoing inventory into the big data calculation center, the

actual inventory quantity is monitored by comparing the current period's purchase increase and production consumption inventory quantity. Once the inventory quantity is too low, a request will be sent to the replenishment system or transfer system for replenishment or transfer.

- Big data analytics can help companies systematically track and fulfill orders throughout the day. By modifying routes, scheduling, and the placement of shipments, constantly updated information lowers costs. To avoid discrepancies, special sensors record data about packages as they travel across large distances. By maximizing route deployment, delivery schedules, and item locations, up-to-date shipping data can also aid in lowering the cost of delivery fleet management.

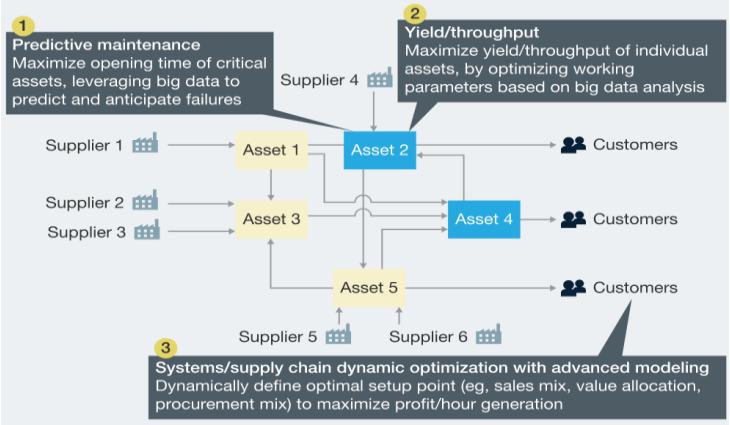

Figure 1. Data analysis related to fixed assets

3. JD E-Commerce Platform

The first case in this study will be looking at is the Jingdong e-commerce platform. Jingdong (JD) is a Chinese e-commerce company. 2021 full-year net revenue reached RMB 951.6 billion. Its Jingdong e-Mall, which allowed customers to buy everyday needs including food, beverages, and condiments online, was launched to the public in 2013 after completing internal testing. In order to build a scalable e-commerce cloud ecosystem based on the benefits of its industry chain, JD developed the Jingdong e-commerce cloud platform based on Jingdong e-mall.

At the JD Discovery-2020 Global Technology Explorer Conference, themed "Digital Intelligence-Shaping the Future", developer explains for the inaugural time the next generation of hardware for the next decade, i.e., the JD Digital Smart Social Supply Chain. It utilizes digital intelligence technology to connect and optimize every aspect of social production, distribution, and services in order to reduce social costs and increase social effectiveness. Currently, Jingdong has over 5 million SKUs (number of products) of self-operated products and the inventory turnover days are down to 34 days, which is a world-class level. It is even more amazing is that a nationwide warehouse and distribution logistics system has been built throughout China, and 92% of districts and counties and 83% of townships have been reached in 24 hours, a speed that is also a world-leading level. Behind the strong supply chain infrastructure is Jingdong's leading innovative technology, including intelligent supply and intelligent operation based on big data.

The savings from Smart Replenishment systems largely depend on the gap between smart decision making and traditional customer ordering behavior [8]. The platform will generate replenishment suggestions based on advanced replenishment models and rational and scientific replenishment parameters to improve replenishment accuracy, lower turnover, and inventory costs, and completely enhance each merchant's inventory management capability, and many more benefits as illustrated in Fig. 2 [9]. Jingdong's artificial intelligence technology and big data analytics are used to predict future selling of merchandise. According to the data combined with scientific modeling algorithms, the developer sets the standard values that affect the core fields of the inventory. The system performs

real-time calculations based on this, which in turn enables automatic purchase order placement. In terms of collaborating with the platform or its stores, the platform can coordinate with merchants to customize a high-quality replenishment operation process with in-depth analysis of regional and brand sales data and rationalize the division of labor with merchants to save time and effort.

JD has a sound supply chain management capability, which, combined with blockchain technology, will better ensure the health and transparency of the supply chain. The platform traces the full link of the cross-border e-commerce, including import, inspection, logistics, sales, maintenance of the goods [10]. Jingdong's technology and capabilities, while satisfying its own platform use, also hopes to empower merchants and cooperate with government regulators to jointly maintain and drive the authenticity and transparency of the social supply chain. For the health of inventory, the platform uses a traditional inventory management system, as well as establishing inventory monitoring, inventory diagnosis, and optimization recommendations, it also continuously connects customers with artificial intelligence and accurate placement. The improvement of the entire social retail order will also benefit JD, which will be a mutually reinforcing process.

Figure 2. Benefits of automated Replenishment

4. NongFu Spring

NongFu Spring, which began operations in 1996, and whose headquarters are in Zhejiang Province, is the second case this paper want to examine. The company is mainly engaged in production and sale of natural water, beverages, and packaging bottles. They strictly follow the slogan "the porters of nature" and each bottle of mineral water is clearly labeled with the source of water to ensure consumers' right to know. As a result, NongFu Mountain Spring has invested heavily in supply chain management, including introduction of network planning, repositioning the forecasting management function, and using big data to facilitate scenario marketing.

Traditional tea beverage marketing channels, is the use of various agent’s multi-level distribution strategy to accurately push the consumer crowd. All marketing channels transmission chains are redundant and scattered, and agents at all stages must be burdened with the amount of inventory, marketing, and asset work pressure, prompting an increase in storage and logistics costs. At this point, NongFu Spring took the first step towards reform by first introducing an IT tool, i.e., a supply chain planning type system. Furthermore, they are gradually reducing the percentage of revenue to traditional channels from 2017, reducing multiple mediums and streamlining the supply chain as depicted in Fig. 3. To address the transportation data scenario from fill to shelf, NongFu Spring first introduced LLAMASOFT, one little-known supply network planning tool, in 2010 for capacity

planning, warehouse location planning and shipment route optimization [11]. This led to the introduction of an innovative database platform with graphical controls to understand and analyze data.

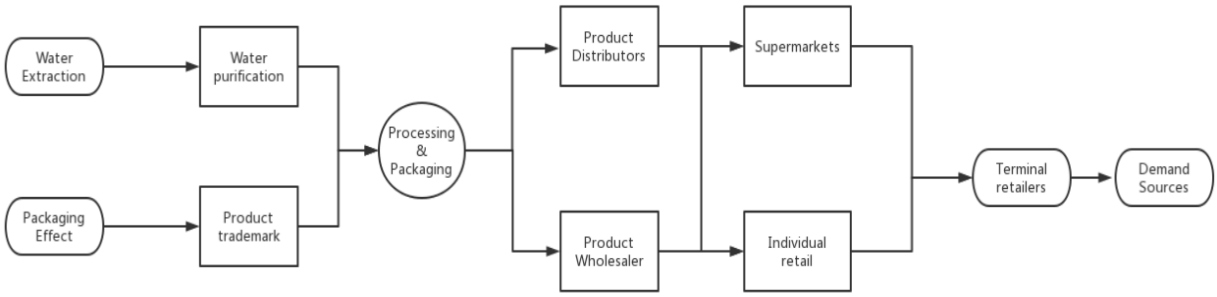

Figure 3. NongFu Spring's chain

The data was examined, and NongFu Spring came up with a set of storage and transportation options that were ideal, so that information such as the transportation cost of each route and the best place to set up logistics centers are presented in a timely manner; more than ten water sources, hundreds of offices and distribution centers across the country are integrated into one system, forming a dynamic mesh structure for immediate control. NongFu Spring has gained a better understanding of the situation of terminal points after gathering data on them in previous years, thus it can start to drastically reduce the number of distributors to maintain complete control over the terminal points. They finally solved the persistent problems on the line of procurement, storage, and distribution, and realized the intelligence of product transportation decisions, the accuracy of logistics cost and the rationalization of transportation resource allocation. In addition, at the same time, Nongfu Spring is the first batch of brands to achieve logistics cooperation with e-commerce platforms. They use differentiation strategies through platforms, membership benefits and specialized community stores to capture high-frequency consumer users in multiple scenarios.

However, according to the data obtained by the questionnaire, sales volume of Nongfu Spring in urban and rural areas vary greatly [12]. Since some small surveys usually have flaws and defects in their data reliability. Especially, the data can lack information from the elderly, people living in rural areas due to age, working group and geographical location.

5. Tesla

The third case will focus on is the car brand Tesla, which has been a big hit in recent years. Electric cars, solar panels, and energy storage equipment are all produced and sold by an electric car and energy company with its corporate headquarters in Palo Alto and a $210 billion market value. Its uniqueness lies in the fact that it does not adopt the philosophy of the typical car manufacturers exemplified by Detroit. The Silicon Valley-based Tesla new energy vehicle startup company builds cars using the IT concept. Unlike many of its rivals who depend on automakers, Tesla has more autonomy in the creation of its hardware and software. The ability to design autonomously has given the company the flexibility to adapt components and has allowed it to respond to supply chain crises that have hit other automakers hard.

After a fatal accident involving a self-driving car, Tesla is still sticking to its business decision to put self-driving cars on the road. In fact, the continued rollout of 900,000 Tesla cars means that Tesla has gathered far more data from the numerous on-road sensors than most of its rivals in Silicon Valley or Detroit. Tesla efficiently gathers information on all automobiles and their drivers, combining it with sensors both internal and external that collect data to find hidden problems caused by the engine and what the driver is doing on the dash, helping Tesla improve its systems and gain a quality advantage over its competitors on the supply side.

Tesla's supply chain is a "unique hybrid of the traditional automotive and high tech industries" which means its pace is faster than traditional automotive supply chains [13]. Tesla has weak cash

flow on hand, but it is able to design a better AI-driven supply chain by eliminating the "slower" suppliers with a lot of data from global suppliers. While its competitors rely on suppliers to provide this expertise, Tesla has developed an internal capability to write the software code that powers its automobiles. This gives Tesla the advantage of reducing the number of vectors in the industry chain, making it tight and quick. At the same time, this speed is also reflected in their development decisions. While many automakers have cut chip orders in 2020 as a result of the epidemic and embargo measures that have hit demand for cars, Tesla is not cutting chip orders in anticipation of its own rapid growth.

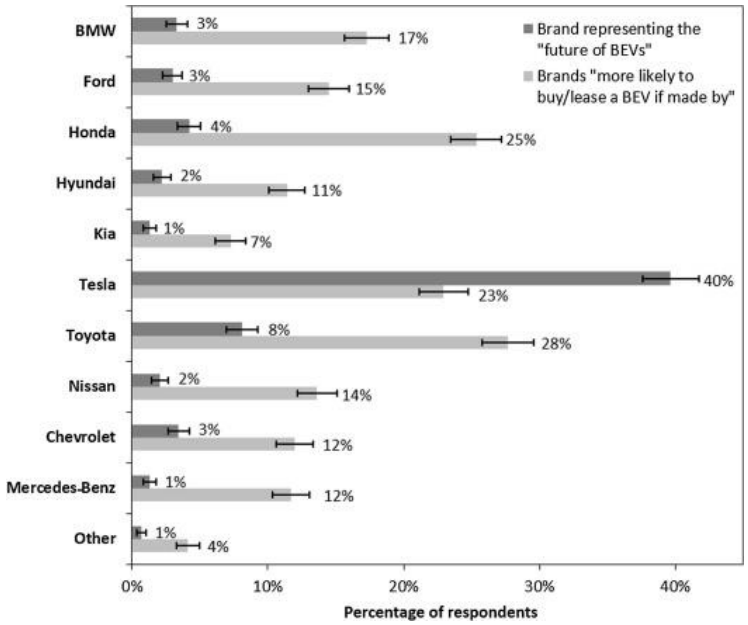

Figure 4. The relevance of brand and battery electric vehicles

As exhibited in Fig. 4, Tesla is the most associated with the future of battery electric vehicles, but is not the majority of choices, which is not unrelated to their "invasive" data collection [14]. There are privacy and security concerns regarding the collection of data in Tesla's supply chain management. According to Tesla's privacy policy, data generated by a vehicle while it is being driven is anonymous because Tesla does not link it to the owner's identity or account. Nevertheless, the distance traveled, and the location recorded make this data impossible to completely anonymize. Furthermore, after the accumulation of massive amounts of data, whether this data can have an impact on national security is subject to further research, analysis, and evaluation.

6. Limitations & Prospects

In the era of Big Data, business landscapes and business models are evolving to become more intricate, volatile, diverse, and individualized. Despite the numerous examples of big data supply chains mentioned in the previous section, big data analytics technology is still in its infancy at this time. While the advocates see great potential in the utilization of Big Data, there are privacy advocates who are concerned that as more and more people and businesses begin to collect relevant data, whether intentionally or not, there will be privacy leaks to the general public. Analyzing these huge data sets can give rise to false information about our predictive capabilities and will lead to many significant and harmful bad decisions being made. In addition, supply chain management using big data analytics requires huge costs. Each of the three examples studied in the previous section is large and has some financial or technical capital. In addition, there are technical challenges. The extension of information and data is seen as a major technical issue in the use of analytics in any organization. Data quality is likewise key, and the accessibility of real-time information is critical to improving outcomes.

7. Conclusion

In summary, this paper investigates big data analytics uses in SCM based on companies' cases from JD e-commerce, NongFu Spring, Tesla. To be specific, this study demonstrated how big data analytics has long been utilized by multinational corporations in supply chain operations. SCM has been using statistical data and optimization methods for relevant operational research, and these companies that benefit from big data analytics have something in common. To be specific, they embed big data analytics within their supply chain operations, enable them to generate powerful enterprise-level analytics strategies from big data predictions, and all have a long history of research and deep understanding of data and systems technology. To fully benefit from big data analytics throughout the supply chain or throughout the enterprise, adjustments must be made that go beyond technology and IT. Companies must be prepared to support a new way of thinking, foster a culture of openness to innovation and technology, and challenge traditional supply chain management approaches.

Finally, this study expects that most companies are not yet positioned to embrace digital supply chain transformation, although from a human, technical capital perspective. Nevertheless, more companies will gradually invest in and implement big data analytics in supply chain management to allow blending of resources, information between businesses. Consequently, this paper focuses on integrating supply chains' fundamental applications of big data analytics, analyzing examples from three big-headed companies in different countries to derive the characteristics of big data supply chains in order to organize the process. Overall, these offer a guideline for continued development of future big data applications.

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