Big Data Analytics and Data Visualization in Shaping Supply Chain Industry: A Review

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Abstract: *Technology is changing the way we live and organize our days. As the number of smart city projects grows, enhancing Supply Chain Management is a top objective in each smart city program. The study below describes how big data analytics and visualization tools have shaped the supply chain industry today. The different applications identified from big data analytics in the supply chain industry are reviewed as their impact and influence within the industry. The supply chain sector is shown to experience several challenges. Risks and unpredictability are shown to be the main problems. Big data analytics is, however, shown to be an effective tool for effective decision-making. Technology Acceptance Model is shown to inform and guide the entire research process.*

Keywords: Big data analytics, visualization, IoT, Artificial Intelligence, SCM

Introduction

Big data analytics continues to be adopted and appreciated across major industries today. The rise of big data technology has been a rising trend because of the huge data produced daily (Tsai et al., 2015). Data analytics and NLP describe how companies obtain operational and customer data and identify patterns and trends that can be used to make relevant and informed decisions (Dash, 2021; Tsai et al., 2015). Big data describes the large data sets that are collected every day by companies. Humans cannot analyze and identify patterns and trends within huge data sets (Sharma & Dash, 2020). Big data analytics, therefore, engages various tools to effectively analyze the data and present the findings in a well-understandable manner.

Data visualization describes the visualization of big data. Big data can, therefore, be integrated to present large data sets in visual representations (Ali et al., 2016). The visualizations are considered more effective when making business decisions. Visualization remains an effective method of data presentation because it allows stakeholders to understand the trends and patterns more easily (Caldarola & Rinaldi, 2017). Common visuals that could be engaged include pie charts, histograms, line graphs, and corporate graphs. Companies could also implement more complex representations like heat maps (Golfarelli & Rizzi, 2019). Each data-driven visualization is always perfect for specific occasions, suggesting that selecting the correct visualization outcome is crucial (Dash et al., 2018).

The supply chain is among the fastest-growing industries today. The supply chain sector has become a significant success because of the growing demand for supply chains. The supply chain describes the process and parts involved in developing a product and the consumers acquiring the final product (Gurtu & Johny, 2019). A vehicle's supply chain entails the entire process through which the raw materials are obtained and the final process through which a consumer obtains their finished product. The supply chain industry describes the individuals, organizations, technologies, and resources involved in the development and sale of a product (Chauhan & Singh, 2019). This industry has become more demanding because of the growth and development across other industries. The success of e-commerce has especially promoted the supply chain sector.

Objectives

- To describe some of the challenges in the supply chain industry.
- To identify big data analytics and visualization applications in shaping the supply chain industry.
- To recommend actions businesses should take in applying big data analytics in shaping their supply chains.

Literature Review

The supply chain sector is one of the most important industries globally today. Ivanov et al. (2018) describe that every industry today relies on the supply chain network for operational success. The study describes the supply chain network as a crucial element across the success achieved by different sectors. Ivanov et al. (2018) also identified that the supply chain sector is growing rapidly. The study identified the continued success of e-commerce as a significant factor in promoting the growth of the supply chain industry (Ivanov et al., 2018).

Figure 1 below identifies key stakeholders and processes in the supply chain. The image shows the critical processes involved, from obtaining the raw materials to developing goods and finally distributing the goods to the consumer.

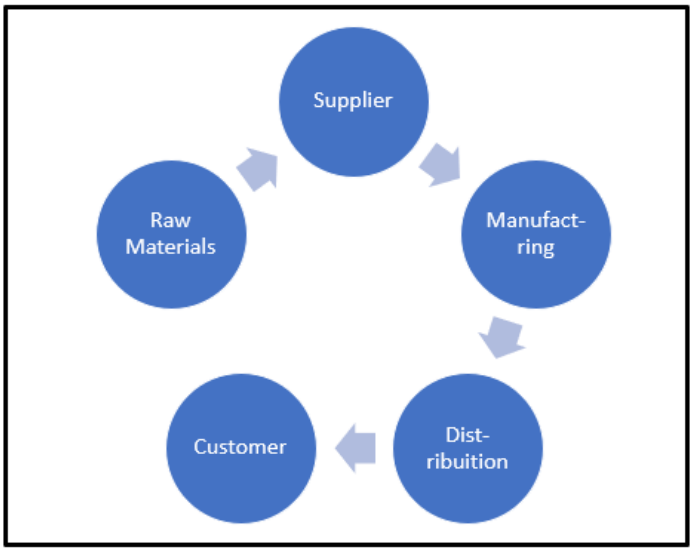

Figure 1: Supply Chain Network

Technology has become a crucial tool within the supply chain (Frederico et al., 2019). Artificial Intelligence and Machine Learning have been identified as crucial in improving efficiency within the supply network. Gurtu & Johny (2019) support that blockchain has also become a relevant tool in promoting transparency in the supply chain sector. The study found that blockchain was increasingly becoming popular within most industries. The technology helped in reducing intermediaries within the supply chain sector.

Zhong et al. (2016) focuses on some of data analytics applications in the service and manufacturing industries. The study identified that big data analytics allow businesses to make informed decisions

(Zhong et al., 2016). The study also identified that the increased development of big data promotes many opportunities within these industries. Mishra et al. (2018) focused on how big data analytics could help improve supply chain management. The authors reviewed data from 2006 and found that big data has a significant role in better and more effective management. The study, however, proposed the need for more research within this sector. Mishra et al. (2018) identified that future research should examine how Big data impacts the supply chain industry. These gaps are identified within the current study. The study describes the different applications of big data in shaping the entire supply chain sector.

Methodology

Theoretical Framework

The research study is guided by the Technology Acceptance Model. TAM is an acceptance theory describing that actual technology use is influenced by the technology's usefulness and ease of use (Susanti & Astuti, 2019). The theory identifies that people will use a specific technology if it is easy to use and if it serves its purpose. Therefore, this research identifies that big data analytics technology will be used in the supply chain if it serves its usefulness and is easy to use. The actual usage of big data and visualization tools in the supply chain sector will, therefore, be influenced by these two aspects (Hoong et al., 2017). The research will investigate some of the applications of big data analytics and how managers and business leaders can benefit from visualization in their management. These factors will indicate significant changes within the supply chain industry. Figure 2 below represents the model and how it has shaped the research process. The model shows that changes in the supply chain result from big data analytics and visualization shaping the industry.

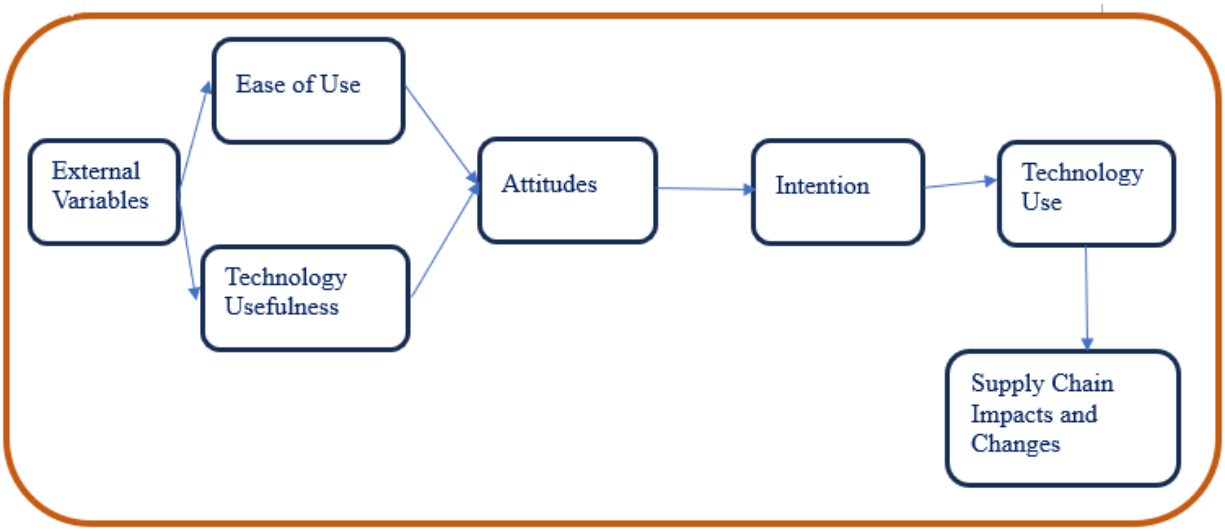

Figure 2: TAM Theoretical Model

Data Collection and Analysis

The research will collect data from secondary sources. The secondary sources include articles from well-respected journals. The various studies collected will be reviewed, and the results analyzed, therefore answering the research objectives identified above. The articles will be obtained from databases that have various journals published. Google Scholar will be used as a search engine for

all the articles needed for the study. The articles were screened based on the year of publishing. The criteria is that the article should have been published in the past six years. The identified papers were screened, and the results were reviewed and analyzed.

Qualitative data can effectively be analyzed using the content analysis approach. Content analysis focuses on obtaining data and reviewing whether the content answers the above objectives (Adu, 2019). The discussion below presents the analyzed data, where they are grouped into key areas from which the data was grouped. Common themes were also analyzed to provide a common answer from all studies collected.

Results and Discussion

The supply chain sector is identified to be critical in the success achieved by businesses. The sector includes all the processes and stakeholders involved in product development and distribution. The sector has continued to grow at an increasingly high rate because of the significant growth in the e-commerce industry. The e-commerce sector depends on the supply chain industry for product distribution. Technology has become critical in the success achieved within the supply chain sector (Gurtu & Johny, 2019). Technology remains a critical element and tool necessary to improve operations and transparency within the sector (Gurtu & Johny, 2019).

The supply chain has been affected by several challenges that affect operations and overall growth (Ivanov et al., 2018). The rise in risks is a major challenge affecting most supply chain businesses. Many markets are volatile today due to changes in consumer demand, raw material shortages, and climate change impacts. These challenges increase the difficulty of managing supply chain businesses effectively (Mishra et al., 2016). These risks also contribute to significant challenges for most businesses, which increasingly depend on the supply chain sector.

There has been a significant rise in freight prices due to the rise in energy prices. The increase in freight prices has also been attributed to the increased demand for freight services. Inventory management has also become increasingly challenging because of the volatility in predicting market behavior (Chauhan & Singh, 2019). These challenges force companies to experience significant losses. The supply chain industry also becomes overwhelmingly impacted by these challenges (Jose & Shanmugam, 2019). Identifying ways to solve and adapt to these challenges has become an effective approach through which businesses can benefit from the supply chain.

Big data and visualization tools are very effective, especially in decision-making (Ali et al., 2016). Big data and visualization are critical tools that are very effective in allowing managers to make decisions and take action (Dash & Sharma, 2021). Figure 3 below identifies how Big data is adopted and used in decision-making. The image shows that descriptive and predictive analytics allow business leaders to identify effective actions and solutions to address specific situations that impact and influence the business' success. Business leaders are, therefore, able to guide their actions through the use of big data analytics (Ali et al., 2016). Predictive analytics is especially crucial in informing supply chain managers on which decisions have the best impact.

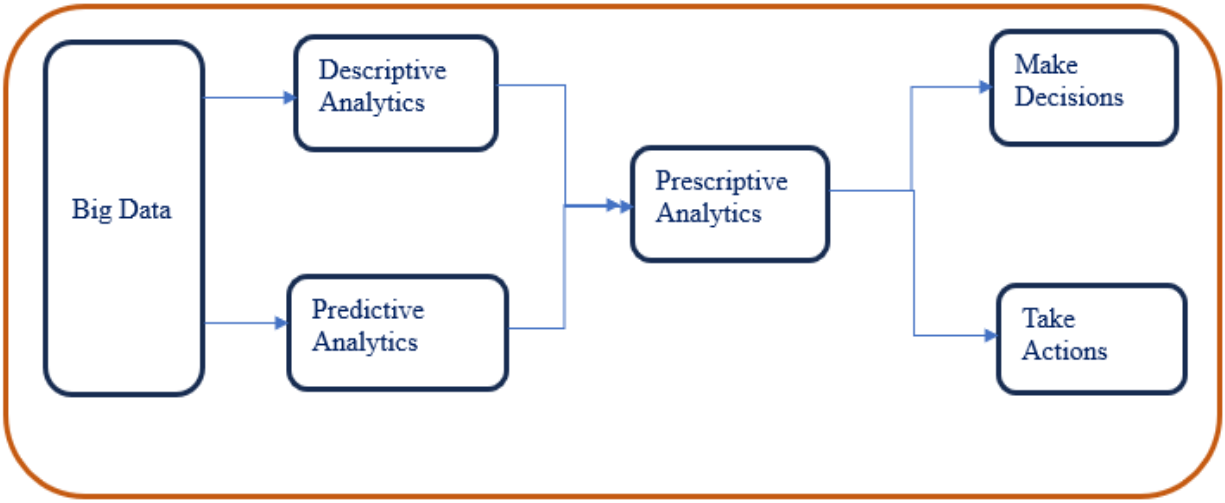

Figure 3: Descriptive and Predictive Analytics in Decision Making

Big data analytics is a crucial tool in modeling and simulation. Simulation describes the integration of large data sets and real-life situations to determine what impacts can be expected (Dash & Sharma, 2021). Research and development within the supply chain has significantly benefitted from integrating simulations (Zhong et al., 2016). Simulations use big data analytics and visualization to provide supply chain managers with a better understanding of effectively managing their supply chain networks. Therefore, the various technologies introduced in the supply chain industry are tested and simulated to determine their effectiveness and overall impact.

Optimization is another crucial application for big data. Optimization of processes within the supply chain industry is improved by engaging large data sets in business decisions (Mishra et al., 2016). Business leaders are today able to plan their supply chain processes by engaging various visuals obtained from big data analytics.

Inventory predictions have become a crucial factor promoted by the integration of Big data analytics into the supply chain industry. Predicting demand has been a significant challenge for most businesses (Rahimi et al., 2020). This challenge makes it difficult to guide when to order inventory effectively. However, big data can use past sales trends and analyze them to provide managers with reliable visuals to guide their decisions. Inventory predictions are a crucial factor that helps businesses cut significant costs by avoiding wastage.

Risk mitigation is another major application of big data and visualization tools in supply chain management. Climate is one of the major issues impacting the supply chain sector. Big data analytics has proven to be a reliable technology for predicting weather changes (Zhong et al., 2016). Adverse weather events are predicted earlier today through big data analytics and visualization. Supply chain companies can then effectively implement strategies and measures to protect their business from these adverse weather events (Rahimi et al., 2020). Risk mitigation also ensures that wastage has been reduced and that companies operate more effectively.

Big data analytics and visualization have also promoted sustainability within the supply chain industry. Predictive data analysis is an effective concept in reducing waste within the supply chain industry (Mishra et al., 2016). Supply chain managers can make informed decisions based on the visuals obtained. Better inventory management also helps reduce energy consumption, improving

overall sustainability (Rahimi et al., 2020). Supply chain companies can meet environmental and social responsibility goals today due to data analytics and visualization.

Recommendations to Business Leaders

- Business leaders should integrate technologies into their supply chain operations.
- Decisions within the supply chain industry should be guided by big data analytics and visuals that help reduce risks in the industry.
- Investing in IoT technologies will allow the supply chain industry to collect more sensor data, promoting effective decision-making.
- The outcomes associated with big data outweigh the costs of investing in the different technologies needed within the industry.
- Sustainability within the supply chain industry can be improved significantly by integrating big data analytics and visualization in decision-making.
- Business leaders should invest in training and development for the staff members, allowing more people in their companies to understand and adopt big data analytics.

Conclusion

Big data analytics and visualization have become reliable in improving operations and minimizing wastage in the supply chain industry. Big data analytics continues to be applied in different supply chain sectors. More supply chain managers implement big data analytics to inform their business decisions. These trends have been critical in promoting several changes within the supply chain sector. The industry has showcased more sustainability due to business leaders making informed decisions. The challenge of inventory management has also been reduced through technology. These contributions have all played a major role in improving the supply chain sector.

The main limitation of the current study is that only a limited number of articles were reviewed. The study also focused on journals in the US and the journals in English. There is vast knowledge that was not analyzed within the current study. Future research studies should focus on obtaining more studies to obtain more qualitative data. This action will help identify all the challenges within the supply chain sector and how big data analytics and visualization have contributed towards solving these issues.

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