Impact of Artificial Intelligence on Resilient and Sustainable Supply Chain Management Post Covid-19

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Abstract: The long-term viability of supply chains and additionally enhancing the resiliency to events like COVID-19 that can create unforeseen interruptions in the value SCs have become critical in the face of quickly shifting business conditions. Although sustaining a resilient supply chain network have historically been criticized for not having complete control over global supply networks, these issues are now more prevalent because of the unpredictable nature since COVID-19. With the help of artificial intelligence, this study seeks to uncover the difficulties in creating a robust and sustainable supply chain following COVID-19. This study's background was provided by the automotive sector, one of the COVID-19-affected industries with a convoluted supply chain structure. According to the research, the biggest challenges faced by Sustainability Supply Chain Management (SSCM) before COVID-19 were tracing of supply chain, planning of demand, managing production, and planning of purchasing processes based on cause-and-effect categories. The three very crucial problems that must be solved following COVID-19 to guarantee sustainability and resilience of SCs must therefore address these identified challenges as well.

Keywords: Sustainability, Artificial Intelligence, COVID-19, Supply Chain, SSCM

1. Introduction

The supply chain (SC) is becoming an increasingly sensitive and complicated structure because of rising costs, international rivalry, and quick technological improvements (Claudia, 2022). Supply chain management (SCM) has been encouraged to achieve organic advancement even though it is challenging in terms of long-term viability (Dauvergne, 2022). The management, sustainability, and resilience of these Sustainable Supply Chains (SSCs) become difficult to maintain. Additionally, it is generally known that a most crucial factor for businesses with supply chain operations worldwide is being resilient and sustainable (Deiva & Kalpana, 2022).

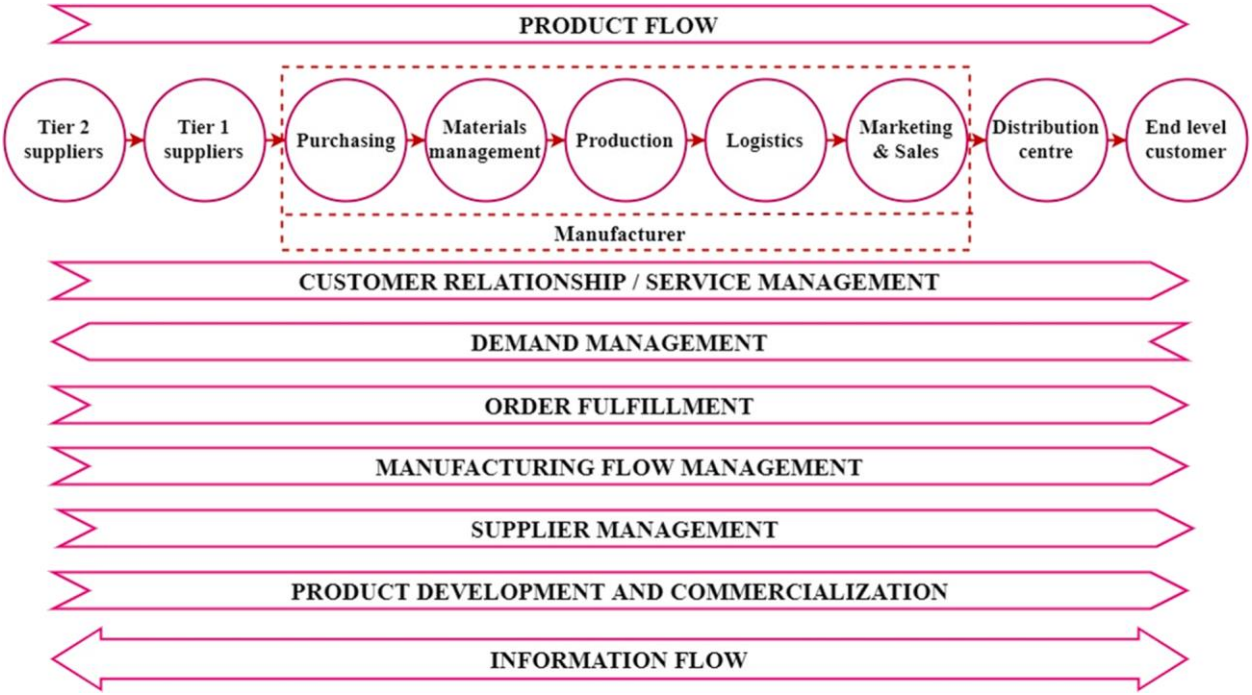

Figure 1: *Supply Chain Management processes*

1.1. Artificial Intelligence

Artificial intelligence (AI)'s primary goal is to develop computer technology that can reflect a human in acts and thoughts. Then, these intelligent machines may mimic, develop, and ultimately take-over human intelligence. Artificial intelligence is a technology that may be implemented specifically for planning a sustainable supply chain, accurately forecast demand, and optimize production. One of the technology's most significant benefits is its capacity for data evaluation and ensuring the continuous improvement of sustainable supply chain procedures (Modgil, Singh, & Hannibal, (2022).

In investigating the studies of AI implementation in SSCs, where action-based capabilities approximate autonomy rather than process-oriented intelligence, the term "machine intelligence" is usually used. All these factors can be effectively managed using AI technology at the lowest cost to the business, automated equipment for logistics and transportation, planning and inventory control (Usman, 2020).

1.2 Supply Chain Resilience

An ability of a supply chain network to deal with unanticipated, disruptive occurrences and to quickly return to its prior capacity, or to an improved capacity necessary to sustain the anticipated operating, financial, and market performance. Companies must recognize and evaluate the points of risks, their gravity, the chance of occurrence, and how these risks can be recognized to create a robust supply chain. Companies do use a variety of measures to maintain the resilience of their supply chains. Some supply chains identified inventory and capacity buffers as a source of resilience during the early stages of Covid-19, while others utilized unused manufacturing capacity. When compared to just one source of supply, some supply chains have benefited from resilience because of multiple sources of supplier techniques. To lessen the geographic dependence on international networks, Covid-19 has also emphasized the need for locality (Stefan, 2022). Local supply networks enable quicker product delivery to customers and enable more inventory control in this way. The more local the network, the more opportunities there are for the manufacturing technology to be synchronized more successfully to provide a smooth flow of goods across the network. Standardizing parts for various goods, particularly those that are not essential and visible to the client, makes sourcing easier and raises the level of robustness. The ecosystem of supply chains ties with contract manufacturers and third-party logistics, in addition to its fundamental components, are essential to its robustness.

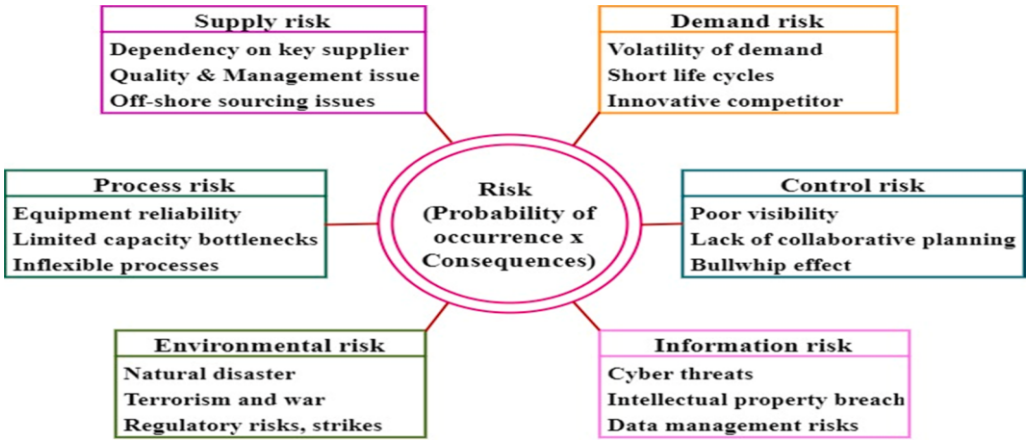

Figure 2: Categories of the risks

1.3 Dynamic Capabilities:

The distribution channels in supply chains can be thought of as information processing and the use of tools to expand, secure, and improve the network to add value for customers (Olan, et al., 2022). Due to the growing complexity of networks, the importance of dynamic capabilities has steadily increased in supply chains. Dynamic capabilities consider a company's fundamental strengths to improve its short-term competitive position and create a longer-term competitive advantage. Dynamic capabilities are especially well suited to building supply chain resilience to establish

an organization's long-term sustainability in a crisis like COVID pandemic where the world was suffering tremendous unpredictability.

Following COVID-19, it has become crucial to comprehend the value of using artificial intelligence in SSC management and to conduct studies into the difficult areas of resilient and sustainable supply chains that demand usage of artificial intelligence. This research attempts to point out supply chain sustainability and resilience challenges that has occurred post-COVID-19 and to discover an appropriate AI technology to address them.

As a result, the following can be said about the investigation for this research:

- What are challenges faced by resilient and sustainable supply chains following COVID-19?
- Could any artificial intelligence technologies be applied to address the challenges?

2. LITERATURE REVIEW

Different business structures and SC operations were brought about by COVID-19. Because of this, the supply chain issues that arose during COVID-19 might not be the same as those that arose thereafter. This assertion was captured in the discussion below.

2.1 AI implementation to improve resilience and sustainability of SCs:

Artificial intelligence can be viewed as a crucial enabler that improves the supply chain's resilience capabilities (Naz, et al., 2022). Supply chain resilience has been emphasized by covid-19, and this has been amply demonstrated as businesses seek to strike a balance between supply and demand.

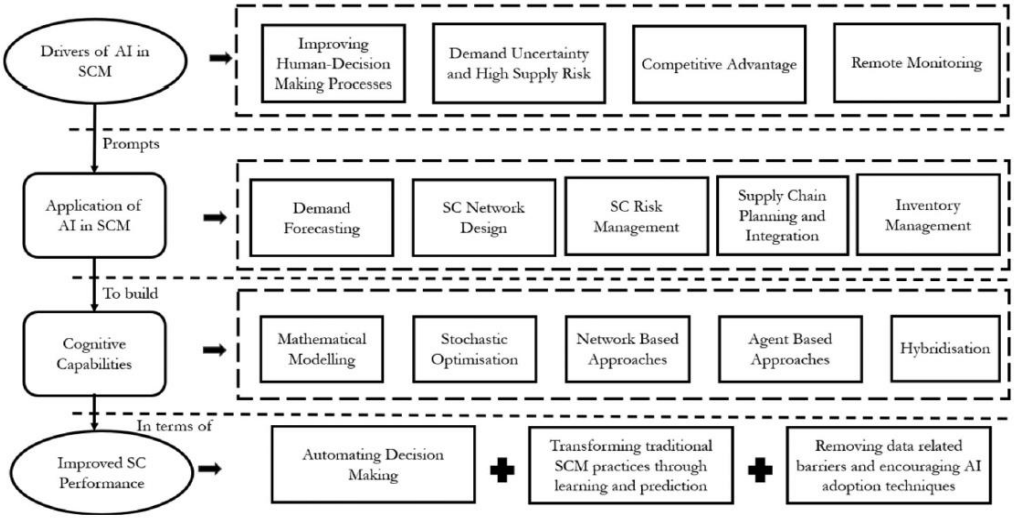

Figure 3: Framework of AI implementation in SCM

Sustainable supply chains (SSCs) may require AI technologies at every level (Modgil, Singh, & Hannibal, 2022). For instance, matching supply and demand is one of the most effective management techniques in SSCM (Dauvergne, 2022). However, information gaps can emerge for a variety of reasons, including poor demand forecasting that results in mismatched demand and supply in SSCs and poor communication between supply chain partners (Stefan, 2022). The sustainability of supply chain networks is distorted because of this circumstance. Due to its ability to match supply and demand in this context and its utilization of actual data, artificial intelligence technology will prevent such an information gap (Olan, et al., 2022).

Recent years have seen the introduction of digital transformations on a global scale, with Industry 14.0 technologies taking center stage in this digital revolution. Artificial intelligence is the most prevalent technology among I4.0 technologies, including blockchain, the internet of things, and cloud computing. Artificial intelligence (AI) is the competence of machines to imitate but then communicate with one another. Artificial intelligence is currently considered a way to get a competitive advantage and to increase the resilience of their sustainable supply chains, many businesses, therefore, like to migrate from remote monitoring to control, optimization and advanced

autonomous AI-based systems (Claudia, 2022). Even though artificial intelligence (AI) technologies can be applied to many fields, including marketing, logistics, and production, they can also be applied to all areas and sub-fields of supply chain management (SSCM), offering benefits like high accuracy, problem-solving with more inputs, and producing high-speed solutions (Deiva & Kalpana, 2022).

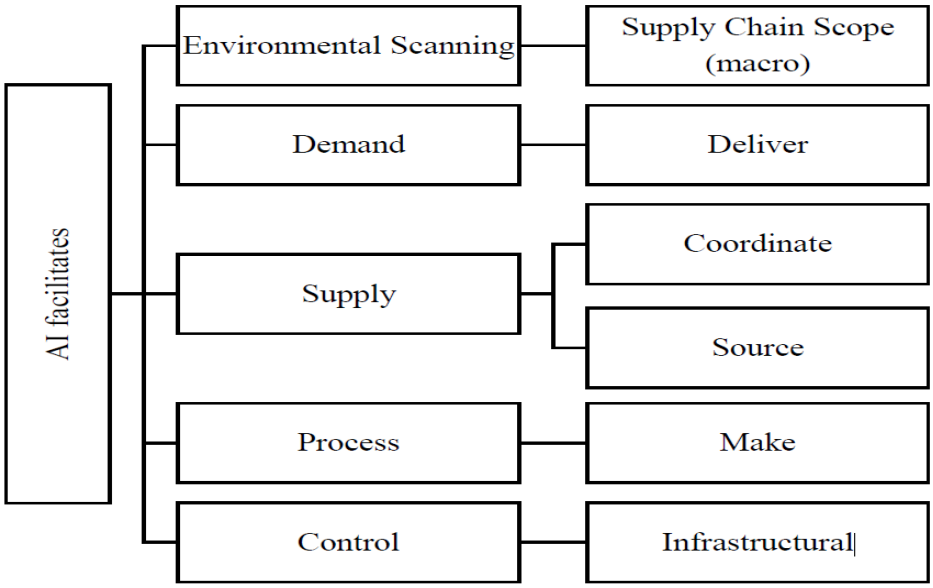

Figure 4: Impact of AI on different dimensions of Supply Chain resilience ((Stefan, 2022) (Sathyan, Parthiban, Dhanalakshmi, & Minz, 2021))

3. METHODOLOGY

The DEMATEL approach would be adopted in this research, and it is a technique for identifying elements that have an impact on developing events laden with a complicated structure (Sathyan, et al., 2021). The DEMATEL method's significant benefit is that it encompasses indirect connections with a weakened cause-and-effect model; it illustrates the connections between criteria, their relative importance considering those connections and how seriously the affect the other criteria. Concerning shortcomings, this approach is predicated as a direct link between criteria, whereas the method of interpretative structural modeling examines the two-way relationships between criteria. This technique seeks to produce significant answers by picturing complex cause-and-effect connections. Determining the extent of interaction between the variables in these correlations, however, is quite challenging (Kao, Huang, & Lo, 2022) because it is difficult to represent the relationships between different components (artificial intelligence, SC stability and resilience) numerically.

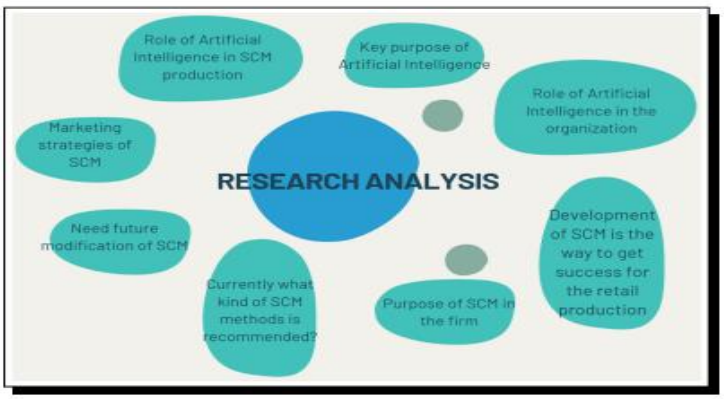

Figure 5: *Research Process adopting the DEMATEL approach*

Some of the major artificial intelligence technology use particular cognitive capacities akin to learning and comprehending natural perception. It is crucial to note that these types are not extensive, but have instead served as the center of Recent commercial explorations and applications of artificial intelligence. The majority of these are Robotics, "Natural Language Processing," and "Machine Learning," which are displayed in the figure below:

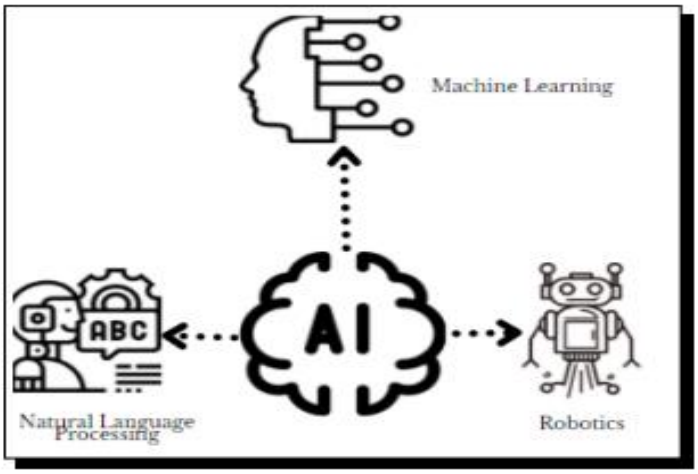

Figure 6: *Branches of AI*

Machine learning is one of the aspects of artificial intelligence that is significantly relevant in the sustainability of supply chain resilience. The supply chain process generates an increasing amount of data that would be analyzed and compiled into a report, which is an extremely time-consuming operation. Consequently, the clustering idea used in machine learning would be great for analyzing and reporting. The clustering theory applies many different methods for analyzing the data, the unique clustering type - Louvain Clustering algorithm is used.

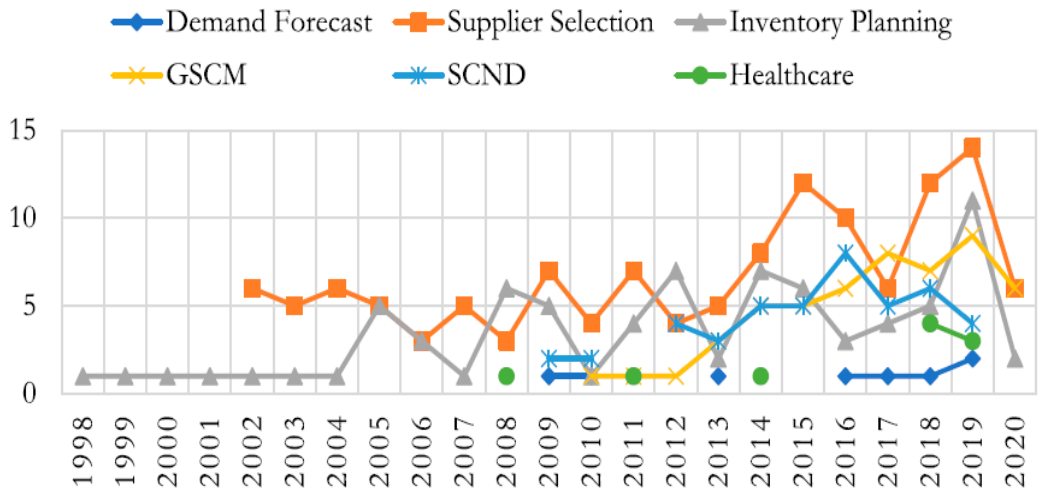

Figure 7: *Yearly trends of AI-SCM implementation and their improved areas (Usman, 2020)*

4. FINDINGS

Through this research, the findings demonstrate the criticality of the planning of the purchasing process, both with and without sustainable supply chain disturbances. It is found that if an organization can't trace, it can't manage their supply chain activities. According to this study, managing demand is one of the most problematic aspects in supply

chain management after COVID-19. According to experts, issues arise when demand changes and delivery deadlines are missed. This has grown because of COVID-19. Problems with production planning could also result from declining production capacity and staff availability.

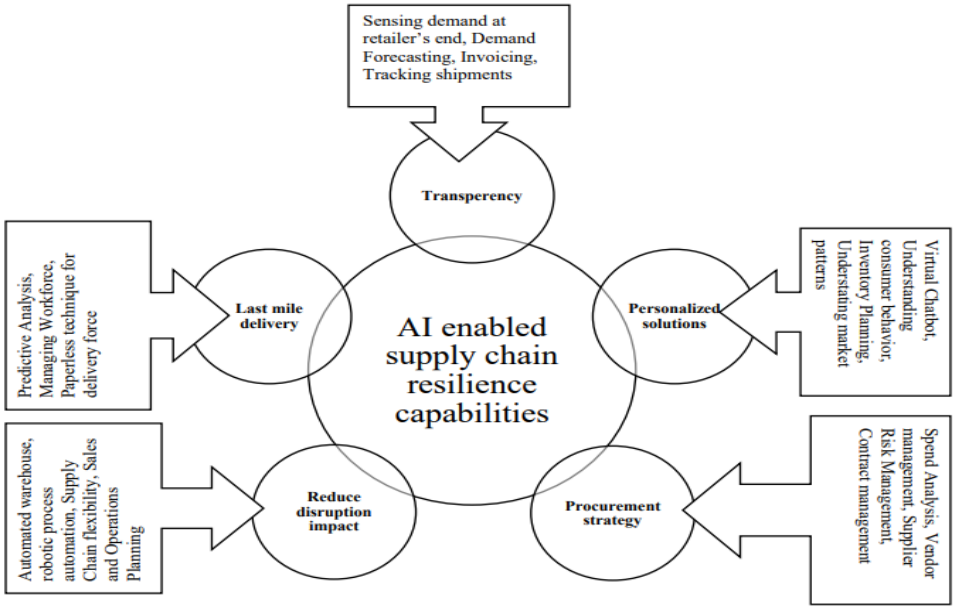

Figure 8: *AI enabled supply chain resilience capabilities*

Implications

Businesses are increasing their investments in artificial intelligence as they become more aware of its value. Because of the additional problems that have evolved since COVID-19, businesses are increasingly willing to invest in supply chains that are assisted by AI. Based on their conversations with the experts, they identified three supply chain operations – control of inventory, planning of demand, and purchasing—that should implement artificial intelligence technologies. Businesses also suggest employing AI technology because of the many benefits it provides, such as the capacity to analyze data, estimate demand, and optimize stock levels in an increasingly competitive market.

CONCLUSION

As SSC structures get increasingly intricate and global in scope, their resilience is put in jeopardy, and they become more susceptible to disruptions brought on by unexpected events. On a global scale, the COVID-19 pandemic has had a negative impact on various activities throughout many nations in addition to harming people's health. Every industry's sustainable supply chain structure has been impacted since the pandemic first emerged in China due to the continued reliance of other nations on China for manufacturing. According to this research, when it comes to sustainable supply chain framework, manufacturing is one of the industries that has been most impacted globally from a standpoint of resilience and sustainability. Automotive is the most affected and challenging industry in production because their sustainable supply chain processes are intricate and difficult. Furthermore, COVID-19 has made the issues with supply chain operations' resilience and sustainability worse.

The Delphi technique is proposed for assigning these challenges with appropriate artificial intelligence technology. The Delphi technique yields recommendations for solutions by applying genetic algorithms for inventory management issues; employ artificial neural networks and machine learning for demand planning and production management issues. All artificial intelligence technologies have the potential to be helpful in managing sustainable supply chains for management issues. Artificial neural networks, genetic algorithms, ant colony optimization, and data

clustering are useful for supply chain traceability. To optimize logistics operational challenges, machine learning and ant colony optimization are essential. To solve problems with planning and purchasing, data clustering is useful.

Future Work

The results show how AI might affect several areas of supply chain resilience without considering the financial implication of implementing AI technologies, which is another intriguing area for future research, and it is possible that future studies will investigate AI capabilities based on social media that can make supply chains more responsive to client demands. Subsequent research could also examine the function of artificial intelligence from the organizational information processing theory and resource-based perspective while considering the supply chain companies' policies, political strategies, and negotiation strategies to build the necessary level of resilience in unpredictable times.

Future research studies are encouraged to adopt any other methodologies to either validate or scrutinize the findings of this research.

Further studies can test the many supply chain resilience strategies made possible by artificial intelligence to uncover the similarities between how AI helps the adoption of various technologies in different industries. In essence, this research offers numerous opportunities for additional, innovative, modern work.

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