Application and Impact of New Technologies in the Supply Chain Management During COVID-19 Pandemic: A Systematic Literature Review

Muhammad Rahies Khan[1], Amir Manzoor[2]

Abstract:

Purpose: The purpose of this study is to examine the application of emerging technologies during the COVID-19 pandemic and their impact on supply chain management.

Design/Methodology/approach: A systematic literature review was conducted to identify the application and impact of new technologies on supply chain management.

Findings: The findings revealed that blockchain technology, IoT, artificial intelligence, big data analytics, cloud computing, 5G and smartphone application, and the use of robots and drones are the key technologies used during COVID-19 in supply chain management, and they showed a substantial impact on the supply chain resilience, agility, and adaptability. Key barriers include higher investment costs, lack of government regulations and support, and deficiency of skilled and technical human resources faced during these technologies' implementation.

Practical Implications: This study evaluated the systematic review through the google scholar search engine and only adopted peer-reviewed scholarly journals, conference proceedings, and opinion papers. The study provides valuable insight to supply chain officials, policymakers, and governments. The emerging technologies have the crucial potential to resolve the supply chain disruptions, if they are addressed seriously.

Originality/ value: This study provides social implications by providing insight regarding the improved standards of living. This study is the first to address emerging technologies in supply chain management during COVID-19.

Keywords: Supply chain, industry 4.0, blockchain, application, impact, IoT.

Paper type: Literature review.

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[1]Ph.D., Scholar Department of Management Sciences Bahria University Karachi, Pakistan, mrahies581@gmail.com;
[2]Associate Professor Department of Management Sciences Bahria University Karachi, Pakistan, amirmanzoor.bukc@bahria. edu.pk;

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1. Introduction

The twenty-first century brings dramatic changes and challenges in the global market for every sector. Due to uncertain reasons, the disruptions and disturbances have brought the world into a state of utter many times in history. Significantly, the change in international policies, oil price crises, and financial crises of 2008 has shaken every area of life (Papadopoulos *et al.,* 2020). Similarly, the outbreaks of certain epidemics and pandemics have almost shut the world down completely. The severe natural disruptions were the Swine flu, Ebola virus, MERS, SARS, and SARS CoV2/COVID-19. These disruptions have challenged traditional thinking and way of doing things. All these natural disruptions impacted the world worse, but the COVID-19 pandemic differently and fiercely affected international businesses. The reason is evident that globalization and technological innovations have made things complicated, interlinked, and interdependent. Distribution of businesses across the world to get competitive and locational advantages is the strategy of present businessmen. To facilitate and fulfill the raw material, finished goods, and intermediate products requirements of these segregated businesses, the supply chain played a key role. Due to the COVID-19 pandemic, the borders and even local movement have been made restricted as an initial strategy to cope with the further spread of this deadly virus. The first measure was the travel ban of humanitarian logistics, which stopped the movements of international supply.

This restricted supply of goods was initially evident in China, where the world's largest firms, like General Electric, Volkswagen, Nike, Airbus, and Toyota, with manufacturing plants at Wuhan city, have stopped their operations. The effects of SARS CoV2 on supply chains and other business operations have already been addressed by different authors and academicians (Choi, 2020; Govindan *et al.,* 2020; Ivanov, 2020a; Lin *et al.,* 2020; Sarkis *et al.,* 2020; Grima *et al.,* 2020). The SARS CoV2 significantly affects the entire business community and affects the efficient operations and supply chain business models. According to Lin *et al.* (2020), COVID-19 has already severely affected operations and supply chain management. Among fortune 1000 companies, supply chains of 94% are disrupted by the COVID-19 pandemic (Fortune, 2020). The studies of Ivanov (2020) and Pavlov *et al.* (2019) revealed that these disruptions had ripple effects. Many companies worldwide, including automobiles, electronics, medical equipment, and consumer goods, face severe disruptions that also experience ripple effects (Dolgui *et al.,* 2018; Ivanov, 2020b). China is considered the world's production hub, the COVID-19 pandemic disruption initially started there and covered the world. The ripple effect requires adequate strategies and actions to minimize these effects, including robust supply chain resilience strategies (Chen *et al.,* 2019; Ivanov and Sokolov, 2019). The supply chain disruption can be responded through digitalization and by promoting flexible operations and supply chain management (Ivanov, 2019).

It is evident from the supply chain management literature that different authors have investigated the different epidemics for different purposes. For example, an outbreak of Ebola, influenza Cholera, and malaria has been discussed by Buyuktahtakm

(2018), Mamani *et al.* (2013), Anparasan and Lejeune (2017), and Parvin *et al.* (2018), respectively. Most of these studies have paid particular attention to allocating resources, procurement and distribution policies, and quick health care responses. Despite this, recent supply chain literature has also made a profound contribution towards supply chain response and operations in response to epidemic outbreak (Aldrighetti *et al.,* 2019; Paul and Venkateswaran, 2020), but the role of technology and innovation in supply chain resilience and operations management has not been adequately investigated.

The literature revealed that digital technology's adoption as a strategic tool could enhance business performance, production capabilities, effectiveness, and resilience (Bruque and Moyano, 2007; Chan *et al.,* 2019; Dibrell *et al.,* 2008; Kleis *et al.,* 2012). The supply chain faces crises at different times, and these events compel the organizations to adopt adequate measures to combat these crises. Use of digital and emerging technologies such as mobile and associated technologies, internet like 3G/4G and now 5G, business analytics, use of artificial intelligence, industry 4.0, and social media add value creation and provide organizations a competitive advantage in their business operations. However, there is still insufficient literature regarding the use, adoption, and incorporation of these information technology tools in supply chain operations, especially in supply chain resilience. This paper discuss the application and impact of new technologies used by the organizations to combat the situation created by the COVID-19 pandemic through a comprehensive literature review from December 2019- December 2020. In this regard, the following research questions and research objectives were formulated.

- *RQ1: What are the new technologies used in supply chain management during the COVID-19 pandemic period?*
- *RQ2: How these emerging technologies impact supply chain resilience and operations?*

Based on these research questions following research objectives were formulated.

- To identify the new emerging technologies used during the period of the COVID-19 pandemic.
- To identify the sectors/areas where these emerging technologies have provided efficient value for the supply chain management.
- To identify the impact of these new emerging technologies in supply chain management.
- To identify the barriers in implementing the emerging technologies in supply chain management.

The rest of the paper is designed as section 2 discussed the methodology and inclusion/exclusion criteria. Section three will address the application and impact of emerging technologies in the supply chain during intense disruption due to the COVID-19 pandemic. We then outline potential research avenues and reflect on the

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managerial implications of using new technologies in supply chain resilience to combat the situation caused by the COVID-19 pandemic. The last section of the paper presented the conclusions.

2. Research Methodology

2.1 Initial Selection Criteria of Selected Articles

For the initial search, the google scholar database was used and identified 78 articles using a custom search option, i.e., from 2019-2020. The articles of 2019 are then identified based on month, i.e., December 2019 and later. The initial search was done by using keywords like "emerging technologies," "New technologies," "supply chain," and "COVID-19". In the second phase, each technology was separately searched with keywords like "blockchain," "artificial intelligence," "IoT," "cloud computing," "smartphone technology," "5G technology," "supply chain," and "COVID-19" respectively. Google Scholar was searched for up to 20 pages for general technology search, and independent technologies search separately. To maintain quality control, as described by David and Han (2004), only the published peer-reviewed scientific and impact factor journal along with conference proceedings and opinion papers are selected. Hence, the books, book sections, and trade journals were excluded.

2.2 Content Screening and Complementary Search

For content screening, a broad definition of supply chain management, new emerging technologies, and independent technologies like AI, IoT, cloud computing, blockchain smartphone technologies, and 5 G technologies were selected to identify and include the relevant articles. For inclusion criteria, we had gone through the keywords, title, and abstract of the articles. Moreover, the main body of the text was also critically observed during inclusion. Articles that reported the use of emerging technologies in supply chain management during COVID-19 were selected. On the other hand, articles that did not correctly define the use of technologies in the supply chain and mentioned the use of new technologies in other fields besides the supply chain were excluded. The initial literature search was done in September 2020. In December 2020, an additional search was also made using the same method. Through this criterion, we successfully obtained 28 articles for final review. The finalized articles are shown in Table 1.

3. Discussion

3.1 RO1 Application of Emerging Technologies in Supply Chain Management

The spread of the COVID-19 pandemic severely disrupted the supply chains across the world, and disruptions are the happenings that interfere with the normal flow of raw material, finished goods, and services in a system (Blackhurst *et al.,* 2011). These extreme levels of disruption in the free flow of goods and services severely and

negatively impact the growth of business and supply chain efficiency (Papadopoulos *et al.,* 2017). Hence, to cope with such types of disruptions and interferences, new digital technologies are exponentially used across the world in global supply chains.

Table 1. *Finalized articles*

Topic	Publ.Year	Publisher	Article Type	Technology	Industry	Application in the supply chain during COVID-19 Pandemic	Impact / Findings
Redesigning Supply chains using Blockchain-Enabled Circular Economy and COVID-19 Experiences	14.10 2020	Santosh Nandi , Joseph Sarkis , ArefAghaeiHervani	Opinion paper	Blockchain	Overall Supply chains of firms	Provide insights from the COVID-19 pandemic for making supply chains more resilient, transparent, and sustainable. These insights include supply chains needing to develop localization, agility, and digitization (LAD) characteristics. They linked LAD to a potential solution using blockchain technology and circular economy principle capabilities.	Localization, agility, and digitalization of products enhance the supply chain agility, resilience, and adaptability.
Improvement of public distribution system efficiency applying blockchain technology duringthe pandemic outbreak (COVID-19)	10/31/2020	Emeraldinsight	Rees. Article	Blockchain in	Distribution & Logistics	To analytically examine the usage of blockchain technology in public distribution system SC to overcome the issues of ghost demands, shrinkage, and misplacement	The results show that the adoption of BT in a charitable supply chain can reduce pilferage and ghost demand significantly
Does digitalizing the supply chain contribute to its resilience	9/22/2020	Emeraldinsight/ DorsafZouari SalomeeRuel	Res. paper	Digitalization in	Supply chain	The purpose of this paper is to investigate the link between SCR and SC digitalization.	Digitalization of supply chains has increased supply chain resilience.
Artificial Intelligence in the Agri-Food System: Rethinking Sustainable Business Models in the COVID-19 Scenario	6/14/2020	MDPI/Sustainability/ Assunta Di Vaio, Flavio	Res. paper	Artificial	Agri-food systems	To investigate the artificial intelligence (AI) function in the agri-food industry, as well as the role of stakeholders in its supply chain	The findings highlight interesting issues about AI towards a "space economy" to achieve sustainable and responsible business models, also in the perspective of the COVID-19 pandemic scenario.
Artificial Intelligence in Supply Chain Operations Planning: Collaboration and Digital Perspectives	9/22/2020	Emeraldinsight/ DorsafZouari SalomeeRuel	Res.paper	Digitalization in	Supply chain	To investigate the link between SCR and SC digitalization	Results show that hybridization man-machine and collaboration and ethical aspects are understudied.
The potential of remote sensing and artificial intelligence as tools to improve the resilience of agriculture production systems	9/22/2020	ScienceDirect	Rese.paper	Remote Sensing		This review focuses on the use of recent technological advances in remote sensing and AI to improve the resilience of agricultural systems	This review focuses on the use of recent technological advances in remote sensing and AI to improve the resilience of agricultural systems,
A digital supply chain twin for managing the disruption risks and resilience in the era of Industry 4.0	5/9/2020	Taylor and Francis	Conceptual paper	Industry 4.0	Supply chain	Theytheorize a notion of a digital supply chain (SC) twin–a computerized model that represents network states for any given moment in real-time. They explore the conditions surrounding the design and implementation of the digital twins when managing disruption risks in SCs.	The results of this study contribute to the research and practice of SC risk management by enhancing predictive and reactive decisions to utilize the advantages of SC visualization, historical disruption data analysis, and real-time disruption data and ensure end-to-end visibility and business continuity in global companies

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Title	Date	Source	Type	Technology	Industry	Purpose	Findings
Crashed! Why Drone Delivery Is Another Tech Idea not Ready to Take Off	6/1/2020	Research Gate	Conceptual paper	Robotics	Food industry	To examine why drone delivery is another tech idea not ready to take off	Factors that were hindering consumers' behavioral intentions to use drone food delivery services were consumers' unfamiliarity and negative perceptions toward drone delivery in that it is unregulated, dangerous, risky, lack of quantified risk assessments, intimidating, related to military and defense, and lengthy in the process to obtain authority's permission to operate food delivery services by drones
A Comprehensive Review of the COVID-19 Pandemic and the Role of IoT, Drones, AI, Blockchain, and 5G in Managing Its Impact	5/1/2020	IEEE	Review Paper	IoT, Drones, AI,		This study highlights its impact on the global economy. In drawing things to a close, we explore the use of technologies such as the Internet of Things (IoT), Unmanned Aerial Vehicles (UAVs), blockchain, Articial Intelligence (AI), and 5G, among others, to help mitigate the impact of COVID-19 outbreak.	The study identified the effective use of industry 4.0 technologies during the pandemic to address the delivery of medical equipment in medical sciences.
A proposed collaborative framework by using artificial intelligence-internet of things (AI-IoT) in COVID-19 pandemic situation for healthcare workers	8/1/2020	Taylor and Francis	Lit. Review	Artificial Intelligence	Healthcare	To identifythe challenges faced by healthcare sectors in dealing with this epidemic outbreak and to propose the potential solutions in terms of popular technologies like AI and IoT by doing a critical analysis of literature	The study provides evidence regarding the use of industry 4.0 technologies in combating the health professionals' issues.
A Review on Blockchain for Medical Delivery Drones in 5G-IoT Era: Progress and Challenges	7/12/1905	IEEE	Conference Paper	Blockchain,	Medical science	Discussedthe importance of blockchain to improve decentralization, privacy, and consensusaware medical product delivery by drones. We firstly review the background of blockchain, 5G-IoT ecosystem, and unmanned aerial vehicles (UAVs). Secondly, we review existing UAVs capable of performing medial delivery.	We learn that effective articulation and augmentation of 5G-IoT aware architecture shall provide enormous business opportunities in futuristic medical delivery drones.
A Review on Drone-Based Data Solutions for Cereal Crops	8/12/2020	MDPI/Sustainability	Review Paper	Drones Technology	Food industry	To present a deeper understanding of how the drone-based data solutions can help to combat food insecurity caused due to the pandemic, zoonotic diseases, and other food shocks by enhancing cereal crop productivity of small-scale farming systems in low-income countries.	To identify the impact of the COVID-19 pandemic infood systems and beyond. Synthesis of the use of drone-based data solutions and highlight the need to capitalize on this development towards improving cereal crop productivity of small-scale farming systems in low-income countries. Discussed the availability of suitable sensors, platform choices, and the benefits of utilizing novel machine learning methods.
Address business crisis caused by COVID-19 with collaborative intelligent manufacturing technologies	6/1/2020	The Institution of Engineering and Technology	short communication	Collaborative manufacturing	Manufacturing industry	This study tries to discuss how collaborative intelligent manufacturing technologies can help to address these challenges through (i) optimal design of resilient collaborative supplier networks; (ii) collaborative planning of manufacturing operations among geographically distributed manufacturing plants; (iii) functional redundancy and dynamic reconfiguration of different shop floors; (iv) dynamic intelligent rescheduling of workforces for factory/shop floor operations; (v) remote testing and maintenance of manufacturing equipment with the support of digital twins technologies.	These methods deeply integrate emerging ICT, including cloud/edge computing, IoT, 5G, big data, digital twins, software agents, to provide manufacturing enterprises and supply chains with the ability to quickly respond to unpredicted disturbing events like the COVID-19 pandemic and ensure the resilience and viability of the manufacturing industry.

Title	Date	Source	Paper Type	Technology	Sector	Purpose	Findings
An investigation into emerging industry 4.0 technologies as drivers of supply chain innovation in Australia	8/1/2020	ScienceDirect	empirical article	Industry 4.0	Supply chain organizations	To utilize the experience of supplychain practitioners, to ascertain the current level of adoption of several key Industry 4.0 technologies, understand what preparatory measures are being taken by firms to ensure they are digitally-readyto utilize Industry 4.0 technologies, recognize how and where these technologies are likely to impact supply chains, and investigate whether the organizational size is a factor in technology adoption	Industry 4.0 technologies are still in the infancy stage. The adoption level is different according to the sectors.Significant gaps were identified between expected impact and expected investment, meaning little spend iscurrently projected for certain technologies that are expected to have a significant impact.
Application of additive manufacturing in challenges posed by COVID-19	8/1/2020	ScienceDirect	empirical article	additive	Healthcare manufacturing	Discussed how additive manufacturing has played a role in this time of crisis. There has been increased adoption of additive manufacturing to overcome the demand created by this pandemic.	The application of Additive Manufacturing has been in ventilators, splitter multiplying ventilator capacity, face shield, swabs for testing, 3-D bioprinting, antimicrobial polymers, non-invasive positive end-expiratory pressure (PEEP) masks, oxygen valves, lung models, etc. helped in the fight against COVID- 19
Application of Blockchain Technology in Optimizing E-tailer Supply Chain Costs: Public and Consortium Blockchains	8/1/2020	ScienceDirect	conference paper	Blockchain	Supply chain operations	Investigate the cost determinants of public and consortium blockchains in an operational framework of the e-tailer supply chain.	The findings emphasize that the transaction fee is a determining factor, and the public blockchain operations are costly in long term operations than the consortium blockchain operations
Applications of industry 4.0 to overcome the COVID-19 operational challenges	7/1/2020	ScienceDirect	Review Paper	Industry 4.0	Medical supplies	To identify the operational challenges faced by retailers in providing efficient services. The study also aimed to propose the roadmap of Industry 4.0 to reduce the impact of COVID-19.	Identified twelve significant challenges for the retail sectors that are acting as operational barriers and provided the application of Industry 4.0 technologies to deal with it.
Artificial Intelligence in the Agri-Food System: Rethinking Sustainable Business Models in the COVID-19 Scenario	6/14/2020	MDPI/Sustainability	Review Paper	artificial Intelligence	Agri-food	To investigate the artificial intelligence (AI) functions in the agri-food industry, as well as the role of stakeholders in its supply chain.	The findings highlight the use of AI towards a "space economy" to achieve sustainable and responsible business models, also in the perspective of the COVID-19 pandemic scenario
Artificial intelligence in supply chain management: A systematic literature review	12/1/2020	science Direct	Review Paper	artificial Intelligence	Supply chain management	To identify the contributions of artificial intelligence (AI) to supply chain management (SCM) through a systematic review of the existing literature. To address the current scientific gap of AI in SCM, this study aimed to determine the current and potential AI techniques that can enhance both the study and practice of SCM.	Our results indicate that the most prevalent AI technique is ANNs, which are usually used to find complex patterns that humans cannot find. ANNs can be applied to approximation, optimization, clustering, function, and prediction, retrieval by content, and process control. Furthermore, we find that the network-based nature of SCM and logistics provides a natural framework with which to implement AI.
Big data use and its outcomes in supply chain context: the roles of information sharing and technological innovation	8/1/2020	ScienceDirect	Research paper	Big Data	SME' s	To investigate the use of big data (BDU) in predicting technological innovation, supply chain and SMEs' performance and whether technological innovation mediates the association between BDU and firm performance. Additionally, this research also seeks to explore the moderating effect of information sharing in the association between BDU and technological innovation.	The findings suggest that BDU is positively related to technological innovation (product and process) and organizational outcomes (e.g., supply chain and SMEs performance). Technological innovation (i.e., product and process) significantly mediates the association between BDU and organizational outcomes. Moreover, information sharing positively moderates the association between BDU and technological innovations.
Blockchain Technology and Its Role in Enhancing Supply Chain Integration Capability and Reducing Carbon Emission: A Conceptual Framework	12/1/2020	MDPI/ Sustainability	Conceptual paper	Blockchain Technology	Medical sciences	Presents a conceptual framework to understand the role of blockchain in low carbon supply chain management.	The results indicate that blockchain technology may be viewed as a strategic management approach to enhance supply chain integration and reduce carbon emissions.

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Title	Date	Source	Type	Technology	Application	Objective	Findings
Blockchain technology in supply chain management: insights from machine learning algorithms	10/1/2020	Emeraldinsight	Technical Paper	Blockchain	Supply chain management	To retrieve key components of blockchain applications in supply chain areas. It applies natural language processmethods to generate useful insights from academic literature.	The research findings are three-fold. While challenges are of concern, the focus should be given to the design and implementation of blockchain in the supply chain field. Integration with the internet of things is considered to be of higher importance. Blockchain plays a crucial role in food sustainability.
Blockchain–Internet of things (IoT) Enabled Pharmaceutical Supply Chain for COVID-19	8/1/2020	International Conference	Conference Paper	Blockchain	Pharmaceutical industry	To propose the Blockchain-Internet of things that enabled the pharmaceutical supply chain through a literature review process	The developed framework will help in maintaining trust among stakeholders. It would improve the visibility, transparency, and privacy of medical essentials and data. The adoption of technologies will reduce the direct involvement of workers can reduce the chances of infections. The framework has several other advantages for the proper control and management of the COVID-19.
Digital technology and Industry 4.0 for global value chain resilience: The case of COVID-19 and beyond	10/1/2020	Research Gate	Research Article	Industry 4.0 and	Global value chains	How the COVID-19 pandemic accelerates the adoption of digital and industry 4.0 technologies in global value chains (GVCs).	As a result, both MNEs and SMEs that already have access to advanced digital technologies should determine how best to implement them throughout their GVCs. For MNEs and SMEs that do not yet have access to such technology must make their acquisition a strategic priority.
Do drones have a real place in a pandemic fight for delivering medical supplies in healthcare systems problems?	5/1/2020	Chinese Journal of Aeronautics		Drones	Medical supplies	Offers a summary of the medical drone manufacturing, with a specific emphasis on its approval by the pharmaceutical sector to solve logistical problems in healthcare during times of sensitive need.	Drones will be able to optimize the way of eliminating contamination with a very high percentage (through the reduction of human contact) with the increase of the flexibility of the flight (reaching the less accessible regions every hour of the day).
Identifying Digital Transformation Paths in the Business Model of SMEs during the COVID-19 Pandemic	10/1/2020	MDPI	Research paper	Digitalization	SME's	To analyze how small and medium enterprises (SMEs) cope with environmental changes due to the COVID-19 pandemic by pursuing the business model transformation with the support of digital technologies	SMEs adopt a different degree of digital transformations, which can be summarized into three paths, depending on the firms' contextual factors.
Internet of Things Based Blockchain for Temperature Monitoring and Counterfeit Pharmaceutical Prevention	7/1/2020	MDPI/Sensors	Research paper	IoT based	Healthcare industry	An Internet of Things (IoT) sensor-based blockchain framework is proposed that tracks and traces drugs as they pass slowly through the entire supply chain.	On the one hand, these newtechnologies of blockchain and IoT sensors play an essential role in supply chain management
IoT in Supply Chain Management: Opportunities and Challenges for Businesses in Early Industry 4.0 Context	11/1/2020	Research Gate	Research paper	IoT	Retail industry	Investigates the opportunities and challenges of IoT use in the supply chains using grounded theory based interviews with managers from the Australian retail industry.	IoT deployment improves visibility of goods movement, data capture, partner communication, and business intelligence. However, retailers face challenges due to the lack of top management initiative, new technology acquisition cost, stakeholders' reluctance to accept change, unwillingness to share data, and inadequate interoperability of software systems
Setbacks to IoT Implementation in the Function of FMCG Supply Chain Sustainability during COVID-19 Pandemic	9/1/2020	MDPI/Sustainability	Research paper	IoT	FMCG	To analyze the setbacks to the digitalization of business processes and the sustainability of the FMCG supply chain based on the implementation of IoT	The results showed significant differences between business sectors in terms of the intensity of setbacks to successful IoT implementation.

Source: *Own creation.*

These emerging technologies include artificial intelligence, big data analytics, blockchain, cloud computing, the internet of things, machine learning, smartphone technologies, and 5G technology. All of them are categorized under the industry 4.0 revolution, and the use of these technologies immensely impacts the operations and

innovations in global supply chains. The use of these technologies across global supply chains enhanced the connectivity and increased the reciprocal trust among the global partners. Due to accuracy in recording transactions, emerging technologies served as a medium of trust among participants (He *et al*., 2020).

3.2 RO2 Sectors Where Emerging Technologies Were Implemented

The extensive use of emerging technologies and business model innovation like ambidexterity, agility, adaptability, and improvisation has never been witnessed in history as used during the COVID-19 period (Dilyard *et al.,* 2020). The wide use of these technologies among all the industries has also been witnessed during this period. The famous industries that adopted the emerging technologies in supply chain operations and business models include the pharmaceutical industry, Agri-food industry, manufacturing, service industry, electronic industry, and construction industry (Dilyard *et al.,* 2020; Manalu *et al.,* 2020; Salah *et al.,* 2020). The adoption and implementation of emerging technologies in these industries provide substantial support to combat the pandemic effects.

Table 2. *Sectors Where Emerging Technologies Were Implemented*

No	Technology Used	Industry	Application
1	Blockchain	Pharmaceutical	Blockchain improved the tracing, responsiveness in supply chain resilience.
2	Artificial intelligence	Agri-food	Artificial intelligence provides sustainable business models.
3	Internet of things (IoT)	Pharmaceutical	Internet of things enabled tracing and prediction of future supply chains through integration.
4	Cloud Computing	Livestock	Reduces transaction costs and create metadata for future use.
5	Smartphone Technology	Manufacturing	Helpful in remotely control the machines
6	5G Technology	Manufacturing	Successfully expedite traditional transactions.
7	Additive manufacturing	Manufacturing	Additive manufacturing provides fast pace manufacturing of medical appliances.
8	Big data predictive analytics	Supply chain/ manufacturing	BDA provides secure, transparent, and accurate transactions among partners and increases trust.
9	Drones technology	FMCG	Export and deliver medical appliances and other products to remote areas.

Soucre: *Own creation.*

3.3 RO3 Impact of Emerging Technologies on Supply Chain Resilience during COVID-19

Through a comprehensive literature review, we identified the use of emerging technologies in supply chains during COVID-19 and their impact on supply chain

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resilience and performance. The studies' findings revealed that the use of blockchain technology in public distribution systems reduces the pilferage and ghost demands significantly. Moreover, the shrinkage and misplacement of procured grains can be minimized using RFID technology (Kumar, 2020). Blockchain has decentralized consensus and information sharing characteristics, and they can be used to increase the SC visibility and transactional efficiency, which are more important points to be kept in mind while making decisions during any disruption. Precautionary measures like alternate supply arrangements through negotiating and incentivizing blockchain attributes can be easy to adopt during hard times (Nandi *et al.*, 2021). During the disruption, localization of products, agile production, and digital visibility of required supplies through blockchain technology, adoption can be made (Nandi *et al*., 2021).

Ray *et al.* (2020) conducted a study and provide evidence of blockchain use in medical delivery drones in 5 G-IoT periods and find that medical deliveries can be made easy and possible through 5 G-IoT integrated drones. They identify the uses of 5G-IoT integrated drones in reaching disaster-affected areas, looking after patients away from hospitals, helpful in hospital operations, supporting the delivery of blood, sputum, vaccines, surgical appliances, and human organs. Ray *et al.* (2020). Shen, Yang, and Gao (2020) address the crisis caused due to the COVID-19 pandemic and discusses the role of manufacturing technologies in business. They point out that the company's resilience and survivability during the pandemic need strong collaborations among the supply partners by incorporating the intertwined supply chain networks. They also highlighted IoT and cloud computing's role in enhances transparency and manufacturing procedure by collecting the relevant data from ERP, social networking, and logistics and operation systems.

Similarly, (Hopkins, 2021) investigated the role of industry 4.0 as an innovative tool in the Australian context and finds that the adoption and incorporation of industry 4.0 technologies are at the infancy stage in the country, and larger firms are more ready to adopt and incorporate than the smaller once. Moreover, he mentioned the impact of digital technologies according to different sectors. He discusses the role of long autonomous vehicles in the supply chains and finds strong evidence of lower shipping costs, reduced drivers' daily wages, reduction in accidental events, and reliability.

According to previous literature discussed by Hopkins (2020), big data analytics make the firms capable of correctly forecasting future demands and consumption improve supply chain agility, hence enhancing marketing sales. Similarly, through the internet of things (IoT), firms can enhance the prediction power of supplies by incorporating the sensors in containers, vehicles, and products.On the other hand, blockchain technology usage can improve transparent, secure, and accurate transactions and improve collaboration among supply chain partners.

Moreover, their empirical findings reported that 18% using artificial intelligence, 12% report that their organization is already using autonomous vehicles, 44% of organizations are already users of BDA, only 11 % of organizations are using blockchain technology, 16% of them already using drones for their supply chains,

48% of them are using IoT technology in practice and 29% of the responding organizations are using robotic technology. Alongside these emerging technologies' adoption and usage during COVID-19, additive manufacturing also played an essential role in responding to the pandemic. Immediate medical supplies provision by integrating technologies in existing manufacturing and delivery processes has provided a sustainable measure against this pandemic. On this front, Arora (2020) provides evidence of the application and role of additive manufacturing in combating the pandemic. They provide evidence of production and delivery of ventilators, testing swabs, face shields, splitting ventilators for multiple patients, hand sanitizers and their holders, oxygen masks, and non-invasive positive and expiratory pressure masks(PEEP) through additive manufacturing.

COVID-19 pandemic has imposed certain restrictions and challenges to supply chains across the world. The most influential sector damaged by the COVID-19 pandemic is supply chains of different products and services. In this context, Kumar *et al.* (2020) identified twelve significant operational challenges faced by retailers in providing efficient supplies of medical equipment to the end-users and propose the use of industry 4.0 as a countermeasure to cope up with these challenges. Lack of flexibility, lack of trust, lack of government incentives, communication issues, security concerns in supply chains, imbalance in supply and demand, etc., are the significant challenges he identified in delivering medical equipment during the pandemic. They have provided industry 4.0 like good relationships with supply partners through information sharing, provisions of incentives by governments and cost-sharing, enhanced trust through blockchain and technology integration in systems, and IoT can overcome these challenges, respectively.

3.4 RO4 Barriers in Implementing the Emerging Technologies

As the emerging technologies have played a vital role in the fight against the COVID-19 different authors also identified 19 pandemic but certain crucial obstacles in the implementation of these emerging technologies. Koncar *et al.* (2020) identified the potential barriers in implementing industry 4.0 or emerging technologies in supply chain operations. They identified that the higher investment cost, lack of trained workers in implementing and operating the technologies, especially IoT, lack of modern infrastructure to support industry 4.0 are the critical barriers in incorporating these technologies in supply chains. Similarly, the previous studies also reported the same results regarding the acceptance and implementation of emerging technologies in supply chains (Končar *et al.,* 2020; Majeed and Rupasinghe, 2017; Oláh *et al.,* 2020; Rehman *et al.,* 2020; Shahzad *et al.,* 2020). Yadav *et al.* (2020) also reported the lack of government regulations and lack of trust among the agro-stakeholders as the critical barriers to implementing blockchain technology. Previous literature also supports these findings and evident the organizational and end-users-related challenges and technological and operational challenges as critical barriers to implementing blockchain technology in supply chain management (Wang *et al.,* 2019).

4. Practical Implications and Future Research Directions

Our study has some practical implications for policymakers. Through a comprehensive literature review, we find that emerging technologies serve as the backbone for the sustainability of supply chains and business operations worldwide. Keeping in view the successful implementation of these technologies during the pandemic, we recommend that proper adoption, routinization, and incorporation of industry 4.0 technologies are crucial for the success of supply chain operations in the future. Moreover, we also concluded that firms' competitive advantage has almost been sifted from the traditional resource-based view to the technologically oriented view. Companies need to focus on these emerging technologies critically to get a competitive advantage in the coming era.

Along these, policymakers and governments have to focus on the identified barriers in implementing the emerging technologies in supply chain management. In this context, developing nations need to be more severe and conscious to address the barriers of high investment costs, development of modern infrastructure, and skilled and technical human resources to implement these technologies in their daily operations. Similar to other studies, our study also has some limitations. We have gone through google scholar to get the articles related to emerging technologies in supply chain management. Future studies can be conducted to search for other search engines like Scopus, web of science, and Ebscohost to get more articles related to our topic.

Moreover, we selected published articles and conference papers. Future studies can induct books, book sections, and trade journals in their study to get more insight into the use of emerging technologies in supply chain management during COVID-19. Our review identified that most of the papers had discussed the use of emerging technologies without properly grounding the theoretical background. As theory is the essential part of the research, future research can be conducted to deeply understand these technologies' theoretical and empirical groundings, especially the survivability and resilience of intertwined supply networks. Moreover, the so-far research on digital and emerging technologies is not backed and supported through theoretical grounds. Future research on the use of emerging technologies in the supply chain can be addressed through the theoretical lens to enhance these technologies' understanding and authenticity.

5. Conclusion

A comprehensive literature review has been conducted to identify the use of emerging technologies during the COVID-19 pandemic. We have gone through the google scholar database to collect the scholarly published peer-reviewed journals and identify the 78 articles, opinion papers, and conference proceedings from December 2019- December 2020. The literature has provided strong evidence of the successful implementation of emerging technologies in supply chain management in different industries across the world. Further, we identified the different technologies used

during this pandemic to support the supply chain of products and services. Blockchain technology.Internet of things (IoT). Artificial intelligence (AI), big data analytics (BDA), the use of robotics, drones, UAVs, and 5G technologies are found to be the most prominent technologies used in supply chains during this period. Besides this, we also identified the potential impact of these technologies on the resilience, agility, and performance of supply chain operations. We also provide critical barriers to implementing these emerging technologies. Higher investment costs, technological infrastructure, lack of funds, government incentives and regulations, and insufficient trained and skilled human resources to implement these technologies were the chief barriers. In the end, we provided the practical implications and future research directions.

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