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DIGITAL SUPPLY CHAIN 2018-2022– AN ACADEMIC LOOK

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ABSTRACT

Implementing digital technologies in supply chain management is becoming increasingly important as businesses seek to streamline their operations and remain competitive in an ever-evolving global marketplace. We intend to find the existence of any high-level Digital Supply Chain (DSC) conceptualization and theoretical framework in the current literature. Building upon previous research on the digital supply chain's body of knowledge published during the decade ending in 2018, we present some initial findings of our extensive research on the digital supply chain's body of knowledge published from 2018 to 2022. The results of this study will serve as the groundwork for developing future research on the digital supply chain (DSC). Eighty-two peer-reviewed articles have been examined with an emphasis on technology enablers, research methodology, limitations and research of literature, and descriptive analysis of the findings within the digital supply chain's body of knowledge. The study identifies the primary technological enablers as the digitalization and transformation of the supply chain. It concludes that technologies, digitalization, integration, collaboration, and coordination frameworks are the primary drivers behind developing the digital supply chain. The existing research articles on DSC have identified information gaps and highlighted significant DSC constraints and opportunities. According to our findings, most publications did not discuss any DSC's theoretical underpinnings, while less than one-third of all research uses review-type research. The study's findings suggest that researchers often use qualitative case studies

to analyze DSC growth empirically. We intend to use these results to develop high-level DSC conceptualization and theoretical frameworks.

KEYWORDS: Digital Supply Chain, empirical, digitalization, integration, collaboration, and coordination.

INTRODUCTION

Digital technologies have significantly changed how individuals interact with their environment and communicate with one another (Büyüközkan & Göçer, 2018). Multiple potentials accompany the need for new methods and reasoning of value generation in supply chain management, thus necessitating organizational change. Throughout the supply chain, companies may save time and effort by utilizing technological advances in the context of the Digital Industry, particularly CPS (Cyber Physical System) and real-time connectivity. These techniques need low-cost intelligent automation, connectivity technologies, and supply chain uniformity (Müller & Voigt, 2018). It is, therefore, more accessible for businesses to see items at every level of the supply chain, including their identification, location, and other tracking data. As a result, the deployment of the digital supply chain has been recognized as an essential perspective lens for considering how conventional SCM may be adjusted to meet business objectives (Chauhan & Singh, 2020).

Inter-organizational systems (IOSs), referred to as digital supply chains (DSCs), are used by businesses to digitize the transaction and cooperation processes with their supply chain partners (i.e., upstream suppliers and downstream customers) (Xue et al. 2013). In general, supply chain systems across several industries are being drastically altered by digitalization and electronic commerce. Every company's objective is to have a contemporary and flexible supply chain (FSC) since a "digital supply chain (DSC)" is faster, more automated in the process (receive orders, prepare orders, and deliver to consumers), more adaptable, and more transparent. A DSC may also function in dynamic systems with large amounts of data (Abdirad & Krishnan, 2020). Amazon, for example, processes millions of orders each day. Amazon robots retrieve and pick up these orders, delivering them to employees who fill them appropriately (Abdirad & Krishnan, 2020). "DHL is an amazing example of how big data technologies are used in the DSC. Big Data allows for more extensive data analysis than was previously feasible with standard technologies." Gathering and analyzing massive customer data makes safeguarding and improving the supply chain's efficiency feasible while ensuring that the system remains operational and promises to maintain client happiness in the long run.

Once we establish that businesses are using some digitization in their SCM, we would like to investigate how academics define DSC and the type of research incorporated in this area. This paper presents our preliminary findings to test our research methodology while comparing our results with Idrees's (2018) study on the same subject. The following section discusses the background of the DSC, describing the technology enablers and the research methodology. The research of the literature is presented in the subsequent sessions, followed by an illustration of the descriptive analysis. Lastly, the final section analyzes the study's methodology and concludes the paper.

Background

Sarkis, Cohen, and Dewick (2021) suggest that the COVID-19 pandemic has highlighted the need for transitioning to sustainable supply and production, which can be achieved by implementing lessons learned from the pandemic. At the same time, researchers argue that supply chain innovation is crucial for businesses to adapt to the post-COVID-19 environment (Kannan, Tan, & Handfield, 2020). According to Guo, Zhang, and Ling (2021), the post-COVID-19 supply chain recovery requires a digital economy perspective (p. 1503).

Enabling technologies such as the Internet of Things (IoT), Cloud Computing (CC), Big Data Analytics, Simulations, Augmented Reality, Additive Manufacturing (AM), Autonomous Robots, and Cybersecurity have risen in interest in DSC during the last decade (Iddris, 2018). These technologies enable DSC to meet customer demand quickly. Concurrently, the increase in data volume has opened fresh possibilities for the digital supply chain, while these technologies have drastically changed the Supply Chain processes (Iddris, 2018).

Iddris's (2018) research on the SC literature review contained data until 2017. His research concluded that more than two third of the analyzed research papers do not use any theory. He also concluded that most of the research papers followed qualitative research. However, he recommended conducting grounded theory research and in-depth interviews as data collection methods. This study follows Iddris's research methodology and investigates publications from 2018 through 2022.

Supply chain and new technology enablers

Internet of Things (IoT): Today, IoT is extensively employed in many areas where automation is required, such as the health sector, government, transportation, manufacturing, supply chain, and so on, where things to things, human to things, and human to human create

a network that is connected to the Internet. RFID, Wireless Sensor Networks (WSN), Software Defined Networking SDN, Cloud Computing (CC), and IoT application software are essential to achieve IoT (Alcácer & Cruz-Machado, 2019).

IoT advances supply chain communications by enabling human-to-things communication and autonomous coordination among "things." At the same time, they are being held in a facility or transported between various supply chain organizations. Yong (2018) suggests that for Industry 4.0 to become a reality, the supply chain must function as a fully integrated ecosystem transparent to all players involved, including suppliers of raw materials, components, and parts, transporters of supplies and finished goods, and customers requiring fulfillment.

Cloud Technology: Cloud systems hold large volumes of data gathered from various "business systems, devices, equipment, and sensors on distant servers." Cloud systems allow for the real-time retrieval of massive amounts of data (Ghadge et al., 2020). "Improved data sharing across departments, value chains, sites, and company/organizational borders is required. Cloud computing continuously grows, resulting in more data-driven and intelligent SC operations" (Alcácer & Cruz-Machado, 2019).

Due to the decentralized and flexible structure of global SCs and the increasing stability and flexibility of IT operations, cloud computing (CC) offers several benefits. Supply chain management (SCM) procedures and associated enterprise information systems can use cloud computing (CC) services for several applications (Jede & Teuteberg, 2015). Looking at the supplier side, SAP, for instance, already provides eight different Cloud Computing services for IT procedures associated with SC, such as B2B trade, purchasing, and exchange of information (Jede & Teuteberg, 2015).

Big Data Analytics: From many data recording tools, big data helps analyze organized, semi-structured, or unstructured formats. "Velocity, variety, volume, veracity, vision, volatility, verification, validation, variability, and value" are all characteristics of the big data acquired (Abdirad & Krishnan, 2020). Big data is crucial to the supply chain as it offers analytical capabilities for business intelligence and decision-making. Big data and digital supply chains are essential for organizations to manage volatile, dynamic, and international value networks (Narwane et al., 2021). The use of information and data flows in supply chain management (SCM) is not new. Still, as technology has advanced, the discipline of SCM is

adopting big data and business analytics to enhance information flows and decision-making in situations where large volumes of multi-dimensional data exceed conventional information technologies (Brinch et al. 2018).

Simulation: The SC data obtained and processed by big data and cloud technologies help evaluate all conceivable situations in SC network management using virtual simulation. (Ghadge, et al, 2020). Barykin et al. (2020) developed a digital twin to manage supply chain risks and make them more dependable and sustainable in the case of any breakdowns. Digital twins interact with people, objects, and other networked digital twins while learning from information and its contexts and observing their physical environment using a network of sensors that dynamically collect real-time data (Saénz & Saenz 2020).

Augmented Reality: In SC Augmented -reality-based systems support several services, including picking components at a warehouse, delivering repair instructions to mobile devices, and sending repair instructions using mobile phones or other remote-control devices" (Vaidya et al. 2018). AR, utilized in simulation, helps with decision-making and problem-solving in industrial problems (Alcácer & Cruz-Machado, 2019).

The food sector is debating how augmented reality (AR) may help maintain food supply chains and give their businesses a competitive edge (Rejeb et al. 2021, Crofton et al. 2019). The food-tech sector is predicted to experience exponential growth, and the spread of augmented reality in the food supply chain contributes to this development (Shan, 2015).

Additive Manufacturing (AM): AM is described as creating three-dimensional products by material deposition, layer by layer, or drop by drop, using computer control systems (Alcácer & Cruz-Machado, 2019). One of the crucial pillars of Industry 4.0 and the next industrial revolution is additive manufacturing, which includes 3D printing (3DP). 3DP has advanced dramatically in recent years and has become synonymous with clever and better technology, with several uses in sophisticated economies worldwide (Sepasgozar et al. 2020).

It is critical to comprehend the principles of additive manufacturing (AM) technology and its possible impacts on the manufacturing sector, given the precise impact that AM technology has on production logistics, inventory control, and supply chain management (Araújo, Pacheco & Costa, 2021). Additive manufacturing is helping businesses to reevaluate their Supply chain (SC) design (Verboeket & Krikke, 2019). AM technology frequently eliminates

the necessity to assemble numerous components to generate a finished product, thus reducing the complexity of the supply chain. AM also lessens the need for replacement parts, streamlines the production process, improves the ability to track the materials utilized, and lowers internal production costs (Araújo, Pacheco & Costa, 2021).

Autonomous Robots: The technological advancements in robotics today have produced robots that are flexible, versatile, and come in all sizes. Robots have become more independent and cooperative., They can also talk with e another and function safely alongside humans while they learn from them (Vaidya et al., 2018). Autonomous robots can do tasks accurately and intelligently within a specific time frame while focusing on safety, adaptability, versatility, and collaboration".

The autonomous supply chain (ASC) applies to moving goods without human intervention (to some degree at least) or aiding in achieving inventory accuracy. Currently, ASCs are utilized in warehouses and stores, while the test for autonomous freight trains is underway. Autonomous mobile robots (AMRs) also have a place in many warehouses. Working as Cobots (Collaborative Robots), AMR works with warehouse workers to fulfill orders quickly and efficiently (Yong 2018).

The demand of the marketplace and the boom of e-commerce has resulted in the next wave of technological innovation in Artificial Intelligence (AI) or robotic automation applications leveraging cloud computing and IoT. Out of these innovations is the Automated Guided Vehicles (AGV), an ASRS goods-to-man picking solution that is essentially a robot that utilizes barcodes, QR codes, etc., to navigate the warehouse. This system improves efficiency and accuracy in storing and picking goods (Yong 2018).

Blockchain Technology: Blockchain technology is best described as a distributed ledger database for permanently and verifiably storing records of transactions between participants (Perboli et al. 2018). Blockchain rapidly became a top technological layer for financial applications. Still, researchers and practitioners have recently shifted to how Blockchain technologies might be used in other fields, such as the digital supply chain. Blockchain can enhance the supply chain's efficiency, dependability, and transparency by providing immutable and publicly accessible data streams, which can improve inbound operations (Perboli et al., 2018). As a system that connects all the companies participating in the supply

chain, the blockchain application works flawlessly with the digital supply chain (Susilo & Triana, 2018).

Cybersecurity and 5G technology help enhance the security and reliability of SC. We leave their discussion for our comprehensive paper.

MATERIAL AND METHODS

Following the latest research methodology trends, the present study undertook a systematic review of the digital supply chain, considering the existing body of research in this domain. Given this field's novelty and rapid growth, the study followed the lead of prior scholars and adopted a single keyword strategy to search for relevant Literature (Kamal & Irani, 2014; Delbufalo & Cerruti, 2012). Guidance was taken from Idrees (2018), who highlights the importance of a theoretical foundation for two types of research reviews, i.e., mature topics and emerging issues, based on Webster and Watson's classification.

Limitations and research of literature

The scope of a literature review study requires defining a clear boundary. This study identified three significant points related to its limitations and research. Firstly, the analysis was restricted to peer-reviewed, English-language literature from various fields, such as Engineering, Business, Economics, Environment, Automotive, Education, Transportation, Manufacturing, Material Sciences, and Computer Sciences. Secondly, we excluded papers discussing digital entrepreneurship and digital healthcare from the study. Thirdly, the search method employed digital, supply, and chain keywords. This ensures the article's applicability. Only papers that used this phrase in the title, abstract, author keywords, and all fields were included.

The literature search was conducted using the Eastern Michigan University e-search library. The library offers access to various electronic databases, such as Digital Library, Emerald, IEEE Access, ScienceDirect, IOP conference series, MDPI, SpringerLink, Taylor & Francis Online, EMJ, Elsevier, Web of Science, and Wiley online library. The search process began with the single keyword "digital supply chain," limited to publications from 2018 to 2022, resulting in 773 publications, including Newspaper Articles, Journal Articles, Trade Publication Articles, Magazine Articles, Newsletter, book/E-book, Book Chapters, Web Resources, Paper, Report, Conference Proceedings, and Dissertation/Thesis.

Further analysis was conducted by restricting the search to peer-reviewed and full-text sources, resulting in 188 articles in 50 scholarly journals. The Article Titles, Abstract, Author Keywords, Publisher, and Publication Year were exported to Microsoft Excel for additional analysis. The Titles and Abstracts were carefully examined to identify the most pertinent articles related to Digital Supply Chain. During this process, the 188 items were categorized into three lists: A, B, and C. List A comprised unquestionably pertinent studies. List B included those with initial significance but little ambiguity. List C contained studies lacking sufficient rigor or ambiguous study objectives. Of the 188 items analyzed, 82 publications addressing the digital supply chain were identified, with 45 papers eliminated from the analysis due to being outside the research parameters. The full text of the 82 articles deemed relevant was then exported to Microsoft Excel for the final analysis phase.

RESULTS AND DISCUSSIONS

Based on the findings, it was observed that a total of 82 articles were identified as relevant to the digital supply chain. The data revealed that the highest number of publications, 24, were published in 2021, followed by 18 publications in 2022. The literature review included articles from 25 different nations, with the United States having the highest number of papers (C=11, 13.41%), followed by Italy, India, and Brazil (C=7, 8.54%). These countries align with those identified in Idress' research (Iddris, 2018).

The majority of studies employed the review technique (C=26, 31.71%), followed by conceptual analysis and survey (C=22, 26.83%) and case study (C=4, 4.88%). Notably, three papers employed mathematical modeling and simulation (C=3, 3.66%), indicating a new trend in data analysis. The continued use of qualitative techniques in DSC studies confirms previous research and reflects the growing nature of the field, with researchers striving to conceptualize and develop new DSC theories (Iddris, 2018).

Identifying the theoretical foundation supporting a research study is vital in conducting a comprehensive literature review, as it helps generalize research findings (Iddris, 2018). Consistent with Iddris' findings, the present study indicates that a significant proportion of the reviewed publications (C=47, 57.32%) failed to cite any theoretical underpinnings. The study also identified five key factors contributing to DSC: integration, technology, digitization, collaboration, and coordination.

New digital technologies have disrupted almost every aspect of conventional supply chain management, including manufacturing, with a more extensive digital infrastructure becoming crucial (Oswald & Kleinemeier, 2016). Digitization emerged as a critical element in the supply chain literature, with 32.93% of the reviewed publications (C=27) mentioning its relevance. This significantly differs from previously non-digital objects or relationships supporting socio-technical forms into structures mediated by digitized artifacts and relationships (Iddris, 2018). Given the rapid shift from values generated by physical artifacts to those provided by smart products such as mobile phones, wireless devices, and scanners, digitization will likely continue driving DSC (Hofmann et al., 2019).

Integration was identified as one of the most frequently mentioned elements influencing the digital supply chain (C=15, 18.29%). The effectiveness and success of e-supply chains depend on integration, which can enhance productivity, efficiency, and the ability of the supply chain to deliver quicker and better products/services, improve the balance between supply and demand, and reduce costs through better coordination and information sharing (Iddris, 2018). With the growth of supply chain process integration, businesses can improve their performance, particularly regarding operational excellence and revenue growth.

Effective supply chain management is driven by collaboration, which may be the ultimate core competency (Min et al., 2005). Collaboration emerged as another essential element in DSC, with only 13.41% of the reviewed publications (C=11) mentioning its relevance. Collaboration involves two or more businesses sharing the responsibility of discussing details on shared strategy, management, execution, and performance measurement (Xue et al., 2013). With the exponential rise of digital platforms, businesses require communication within and across firms. Collaboration strategies with important supply chain participants are essential for efficiently using data analytics and information availability throughout the supply chain (Iddris, 2018).

Coordination is an essential aspect of digital supply chain management (DSC), as noted by Iddris (2018) and corroborated by the reviewed publications (C=11, 13.41%). Coordination refers to controlling closely related tasks to achieve a goal, which is crucial for gaining flexibility and enhancing logistical processes in response to rapidly changing market conditions (Simatupang et al., 2002). Despite its significance, organizations often face challenges in coordinating the various tasks that make up the supply chain, including marketing, logistics, inventory, manufacturing, operations, purchasing, and procurement.

Technology is the second most frequently mentioned necessity in DSC (C=18, 21.95%), highlighting the significant impact of technology on the supply chain. Iddris (2018) identifies various technologies that are transforming the dynamics of the supply chain, such as blockchain, the Internet of things (IoT), Big Data Analytics, additive manufacturing, and radio frequency identification (RFID). These technologies can enhance supply chain collaboration and visibility and bring evolutionary change by integrating legacy systems with real-time supply chain management (Büyüközkan & Göçer 2021; Chang & Chen, 2020).

CONCLUSION

This study enables us to test the methodology we plan to utilize in our forthcoming research by presenting an initial perspective on the ongoing research activities in digital supply chains. The conclusions derived from this study serve as the basis for conducting future research on the digital supply chain.

Examining the digital supply chain challenges highlights the potential benefits of utilizing cutting-edge technologies to improve supply chain efficiency and effectiveness. Based on a review of selected publications, the study argues that digitalization will continue to impact every aspect of corporate operations, including supply chain management. The study proposes a conceptual framework based on the literature review to guide future research.

However, the study also reveals a lack of theoretical support for the papers examined, with over 57.32% failing to provide any theoretical underpinnings and lacking consensus on a unified theory in the supply chain area. To overcome this challenge, the study recommends using qualitative and quantitative research methods to analyze the future of the digital supply chain.

The study found that the most commonly employed research approach is the literature review, survey type, and conceptual analysis. However, the study suggests that case studies, mathematical modeling, and analytical hierarchy process utilizing various methodologies and theoretical frameworks are also necessary. Therefore, the paper recommends that researchers and academicians use qualitative research methods to empirically analyze the development of DSC using mathematical models and simulations with various theories. Overall, this study contributes to the literature on the digital supply chain by providing insights into the challenges and potential benefits of utilizing digital technologies and highlighting the need for further theoretical and empirical research.

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