

Supply Chain Digitalization for Visibility and Sustainability: A Systematic Literature Review

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Abstract

Supply Chain Visibility (SCV) and Supply Chain Sustainability (SCS) are critical aspects and challenges in today's Supply Chain Management, and the rapid adoption of digital technologies and Industry 4.0 tools represents an opportunity to address these challenges. This literature review contributes to the development of a summary on how digitalization has contributed to SCV and SCS. Books, journals, and publications were assessed to identify relevant literature retrieved from Elton B. Stephens Company (EBSCO), Google Scholar, and other academic sources. Results are focusing on the functionalities of the technologies and the difficulties of implementing them. This review contributes key findings about Supply Chain Digitalization (SCD), visibility, sustainability, the relationships between them, gaps in the literature, and important factors to consider before implementing new technology tools.

Keywords

Digital Technologies, Supply Chain, Visibility, Sustainability, and Industry 4.0

1. Introduction

Nowadays, companies are encountering rapid digitalization worldwide. Globalization has brought significant changes in supply chains. Additionally, there is an increasing need for supply chain visibility throughout all of its functions, and how sustainability relates to these changes. This major trend is at the forefront of concern for many firms.

Companies and various industries work with all the processes and activities that create value in the form of a service or product for consumers; this network of organizations is called the Supply Chain (SC) (Christopher, 2022). From suppliers, manufacturers, distributors, and consumers, the flow of materials and information represents a great source of knowledge and responsibility to all stakeholders involved. The SC (supply chain) design should be based on the business strategy; therefore, many are goal-oriented towards customer satisfaction, competitiveness, and economic profitability, resulting in various outcomes and consequences throughout the chain (Sanders, 2020). Intricate supply chain systems, volatile marketplace environments, and decentralized operations can erode the stability of supply chains, rendering them more open to potential hazards and breakdowns (Pettit et al., 2019). The unexpected COVID-19 outbreak created interruptions in global supply chains and significantly leading to significant production delays worldwide (Paul et al., 2021).

Facing those challenges has been demanding for the industries. Over time, more firms are adopting new technologies such as Big Data and cloud computing to enhance their supply chain systems and effectively respond to those changes. In the past decades, there has been an acceleration of digitalization in supply chains, changing the way companies and customers interact throughout the chain, drawing more attention in practice and research fields (Seyedghorban et al., 2019). Digitalization is one of the trends nowadays that transforms companies and society; it has been compared to an industrial revolution and defined as the adoption of digital technologies in various aspects, increasing the use of digital and computer technology in business, industries, organizations, and so forth (Parviainen et al. 2022). This megatrend has led to the creation of an ecosystem in which technology is used to increase the availability of information, real-time data management, and various optimizations by linking the real and digital world and the development of products and business approaches. Through improved visibility and adaptability, digitalized supply chains offer greater efficiency, strengthen resilience, and adaptable operations (Belhadi et al. 2022). With the development of 4.0 Industry, new technologies such as Artificial Intelligence, Cloud Computing, Internet of Things (IoT), and Blockchain have been implemented in various functions of supply chain operations to enable data-driven decision-making by producing a large amount of data and information (Bigliardi et al., 2022). Moreover, a debate has arisen between the idea of glorifying the technology's potential versus the impact of those technologies on humanity (Rasiah et al., 2023).

These consequences are linked to various aspects, and a delicate one is sustainability. Digitalization enables the efficient implementation of actions with a view to sustainability (Bigliardi et al., 2022), but it can produce negative side effects. Sustainability has been a significant issue, especially in supply chains, which highlights the importance of an equilibrium between environmental, social, and economic factors. The strong relationship between digitalization and sustainability lies in their interconnected consequences. These megatrends are revolutionizing the way major stakeholders invest, behave, or perform, often guiding their objectives toward a more sustainable and digital atmosphere (Brenner and Hartl, 2021). Limited visibility in the supply chain restricts an organization's ability to anticipate and respond to operational disruptions (Khan et al. 2022). Digitalization, on the other hand, can also enhance Supply Chain Visibility (Al Tera et al., 2024). Over time, this term has taken on various meanings and perspectives, but it fundamentally refers to the traceability and transparency of all supply chain processes. This is achieved through information sharing, often enhanced by digital technologies (Roy, 2021). Visibility enhancement is a key driver for cost-effectiveness, increased profitability, and advancing sustainability, as well as for improving agility, planning, and decision support systems (Kalaiaresan et al., 2022). Therefore, it is crucial to evaluate the consequences of using digital technologies in various supply chain functions on the visibility and sustainability of the supply chain as a whole.

1.1 Objectives

This study aims to conduct a comprehensive literature review on the impact of digitalization on supply chain visibility and sustainability. By constructing an extensive quest, finding key terms and gaps, this work will synthesize key findings. The purpose of this research is to analyze the impact and influence of emerging technology tools on today's supply chain, focusing on how digitalization impacts sustainability and visibility within supply chains. Specifically, address the following research question: What is the impact of digital technologies on supply chain visibility and sustainability?

2. Methodology

This research was conducted with the objective of collecting, analyzing, and synthesizing information on supply chain digitalization, visibility, and sustainability, aiming to identify and analyze scholarly contributions. The articles and books were searched in August 2025. Articles and books were retrieved from Elton B. Stephens Company (EBSCO), Google Scholar, and libraries from Tecnológico de Monterrey and the University of Regina. The main analysis comprises only relevant studies from 2018 to 2025, the literature was conducted using multiple word combinations, search strings included: “supply chain digitalization” AND “sustainability” AND “visibility,” “digital transformation + sustainability,” “Industry 4.0” AND “sustainable supply chain,” “digital technologies” AND “visibility,” and “supply chain visibility + sustainability.” The combination of words was chosen to account for differences in terminology and increase the range of literature that could be found. To ensure the quality and relevance of the review, only peer-reviewed articles were included, and articles were classified in relevance to certain topics to construct a systematic literature review. Figure 1 presents the number of articles or books analyzed per topic.

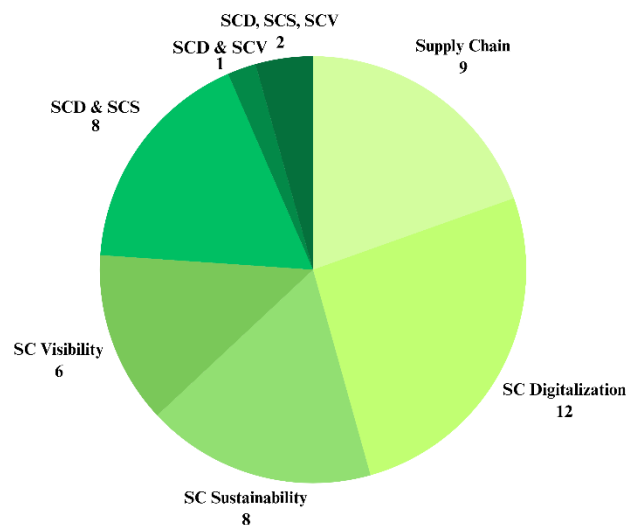


Figure 1. Pie chart on the distribution of literature per topic
Source: author creation

3. Literature Review

Today’s digitalization is influencing every aspect of the global overview. All the different scales and areas nowadays are experiencing a significant level of digital transformation. As we look toward the future, it is crucial for main stakeholders to pay special attention to their impact and determine a new decision-making process (Brenner and Hartl, 2021). Organizations strive to become digital, but successful implementation requires a clear understanding of the effects and benefits on their business (Agrawal and Narain, 2018).

3.1 Supply Chain Digitalization (SCD)

Supply Chain Digitalization is a trend that involves digital technologies, such as Blockchain, Internet of Things (IoT), and Machine Learning, to improve the competitiveness and performance of organizations, becoming a great component of them. However, the implementation of these technologies presents various challenges, especially for Small and Medium Enterprises (SMEs). These challenges include difficulties in accessing bank loans, getting external financial investors, and managing high personnel costs. Artificial Intelligence (AI) techniques are mostly applied in manufacturing, for pattern identification and data forecasting. The Internet of Things (IoT), consists of a network of physical objects connected to the internet, which give agility, visibility, and tracking. Machine Learning enables predictions and simplifies processes, while Blockchain offers transparency, tracking, and ease of data sharing (Bigliardi et al., 2022). Table 1 presents specific benefits and challenges from these technology tools on sustainability. There are various applications of emerging technology tools in supply chains, including optimization, automation, visibility, and real-time tracking. Over the years, these technologies have evolved, necessitating that stakeholders keep

pace to remain competitive. More developed countries typically have higher levels of digitalization within their organizations due to superior infrastructure and greater financial and human resources. Future research could focus on comparing organizations in developed countries to analyze commonalities and challenges on a global scale (Bienhaus and Haddud, 2018).

In response to varying customer demands, highly standardized supply chains are changing their business models for adaptation. Traditional supply chains are evolving into sensitive demand networks influenced by increasingly high internet usage among consumers. Some anticipated challenges for the coming year include globalization, sales growth, supply chain visibility, and flexibility in volatile markets. Overall, digitalization transforms work patterns and accelerates the rate of change within companies (Agrawal and Narain, 2018).

3.2 Supply Chain Visibility (SCV)

Around ten years ago, literature stated that over time, visibility has been defined in various ways. In the 1990s, the basic concept relied on having enough information about the supply chain to make better decisions by enhancing performance. One popular model from this era was created by the Industrial Marketing and Purchasing Group, known as the A-R-A model, which stands for Agents, Resources, and Activities. This model emphasized the importance of shared information among these components. As digital and internet resources were introduced, the inclusion of global information became increasingly important. Afterwards, the amount of information available at the time started to improve the effectiveness and efficiency of industries. By the year 2000, after some adaptation to digital technologies, the information was shared between companies, giving industries a global overview.

Nowadays, while visibility has several definitions, its meaning relies on the ability to access the required information about the entities involved to make better decisions regarding the supply chain. Generally, visibility encompasses awareness of the current state of operations, knowledge of competitors, gathering general information, and utilizing tools to support better decision-making (McIntire, 2016).

Visibility and transparency are often misunderstood as being the same. Achieving visibility within the supply chain is essential for acquiring and sharing information. While visibility addresses the requirements of a company's internal stakeholders, transparency focuses on the needs of external stakeholders such as customers, investors, non-governmental organizations (NGOs), regulators, and oversight bodies (Juhart and Vide, 2025).

Supply Chain Visibility (SCV) can be seen as a crucial enabler for acquiring and distributing information, which can be captured and administered using information and communication technologies (ICT), through the integration of inter-organizational information systems and communication technology. However, there are still a few quantitative metrics available to measure the effectiveness of SCV practices (Somapa et al., 2018).

Due to the increased attention on supply chain visibility (SCV) in recent years, events like the COVID-19 pandemic have revealed vulnerabilities that companies face due to a lack of visibility. From suppliers to customers, the emphasis on SCV is crucial for achieving sustainable and competitive business performance, particularly in manufacturing. It is critical to understand the conditions and factors affecting SCV, and the number of articles on this topic has increased since 2019. However, research still lacks a comprehensive view.

Improving visibility can enhance performance by leveraging an organization's resources and capabilities. Access to high-quality information that is accurate, timely, and complete is necessary, which highlights the importance of different digital transformation tools.

According to Kalaiarasan et al. (2022), there are several challenges, including a lack of skills and knowledge, budget constraints, the complexity of supply chains, and poor data quality. Nevertheless, inter-organizational collaboration is a key enabler for organizations to utilize emerging technologies and improve visibility. Trust is another critical component, as it is fundamental for facilitating a bilateral information flow in organizational relationships.

3.3 Supply Chain Sustainability (SCS)

Sustainability is a term that has been used since the late 1960s, in the context of social inequality and environmental problems. Developing ways in which the present needs are fulfilled without affecting future generations, by the integration of cultural, environmental, social, and economic aspects (Mangla and Ram 2020).

It was noted that a significant gap still exists in the literature regarding a thorough methodology and classification of sustainability indicators that are essential for sustainable project management in construction firms. Although there have been attempts to classify these indicators, the absence of comprehensive sustainability assessments continues to pose a challenge in supply chains (Cataldo et al., 2025).

According to Juhart and Vide (2025), a great opportunity is that adopting mandatory and regulated sustainability reporting is becoming important, helping firms to identify risks and understand performance. This evolution brings new challenges and opportunities. Corporate Sustainability Reporting provides information about performance and impact, as well as a transparent view of sustainable, environmental, and labor practices. Companies with transparent and sustainable practices can differentiate in the market, drive innovation, increase adaptability, and gain more trust and satisfaction with all stakeholders. A research gap in existing literature is the need to identify the perception of multinational corporations regarding the mandatory sustainability requirements for companies.

There are many benefits in integrating sustainability into SC, like reducing the negative environmental impact, improving reputation, enhancing cooperation with stakeholders, and enhancing work culture. SC disclosure is mainly influenced by regulatory requirements, investor and customer pressures, governance, and competitive pressures (Bayne and Wee, 2022).

3.4 SCD on SCV

According to Wagner (2022), there is significant potential for firms to enhance their visibility; however, many of them have only partial visibility. SCV can obtain the key information it needs and also improve reverse supply chain logistics. There are numerous software and technology services that companies use. Still, the difficult part is to define in detail what they need to achieve and then select the best digital technology. For data capturing, monitoring, or sharing, the different technologies are connecting the physical and digital worlds for greater accessibility to information. On the other side, there is a high cost of operation, energy, and human resources for their usage, often. Some recommendations are aligned with combining technology to ensure great data accuracy and capacity, using information smartly to help make better decisions, to mitigate climate change, enhance sustainability, reduce costs, improve customer service, optimize services, and grow the company into a better one.

Generally, they first need a clear strategy and objective for visibility. They then select the technology that best fits, connect with the correct stakeholder, and use that information to improve the connection between Supply Chain Digitalization and Supply Chain Visibility.

3.5 SCV and SCS

Supply Chain Visibility and Sustainability are closely related; without transparency, it is very challenging to ensure there are sustainable practices in all the functions of SC (Khan et al., 2022). With visibility, stakeholders have access and can share important information, which helps achieve sustainable objectives with the help of all stakeholders. It may improve social, ethical, and performance throughout the chain by sharing key findings, which can reduce many risks and identify problems. Such as responsible human practices that enhance skills, motivation, and work conditions; establish better workflow, policies, and standardizations; and monitor the environmental impact of the SC (Apeji and Sunmora, 2022).

3.6 SCD on SCS

Recent technological developments require greater attention to the impact on sustainability. Currently, various digital actions focus on promoting sustainability and a circular economy, including resource optimization, selecting environmentally friendly options, minimizing waste and CO2 emissions, and improving recycling efforts. However, there is an opportunity to emphasize how these actions evolved (Bigliardi et al. 2022). There is limited information on

how different actors interpret the relationship between digitalization and economic, environmental and social sustainability.

At the firm level, sustainable corporate development is essential for maintaining responsible and equitable practices (Brenner and Hartl, 2021). According to Bag et al. (2021), Industry 4.0 implies more automated processes without operator inspections; therefore, the number of job positions decreases, but productivity increases at the company. Improving skills, redefining traditional organizational structures, and effective change management are essential in the era of digitalization, but choosing the wrong technology can result in substantial financial losses for firms. Companies are incorporating sustainability technologies and practices, pushed by different stakeholders like the government, investors, and consumers. Even though it is a big challenge due to the complexity of global supply networks, uncertainty, and a competitive environment. Therefore, innovative solutions, transformative tools, and adaptation are needed. Sustainable SC means that actions made in the management and operations minimize the negative impact on the environment, improve social conditions, and ensure long-term economic sustainability for the business (Popova and Popov, 2024). Another factor to consider is that the governmental legislation on cybersecurity is crucial to eradicate any possible threats and vulnerabilities (Bag et al., 2021).

The following table (Table 1) represents some examples of the consequences different digital tools have on Supply Chain Sustainability.

Table 1. Industry 4.0 digital tools on Sustainability

Digital Technology Tool	Function and behavior	Benefits	Challenges	Reference
Artificial Intelligence (AI)	Forecasting, prediction of future consumer behavior, inventory management, and real-time planning.	Reduction of waste and overproduction due to forecasting and cost reduction.	Cybersecurity threats, possible electronic waste, and increased energy consumption.	(Popova and Popov, 2024) (Narkhede G., et al. 2024)
Machine Learning	Can discover patterns in information	May indicate potential weaknesses in environmental practices, which can prevent risk situations	An excessive dependence on this technology can disrupt the supply chain.	(Popova and Popov, 2024) (Narkhede G., et al. 2024)
Big Data Analysis	Increase traceability and transparency	Identify suppliers that don't meet environmental standards, enabling the reduction of the carbon footprint	Increased energy consumption.	(Popova and Popov, 2024) (Hussain, C.M., and Di Sia, P., 2022)
Blockchain technology	Improve mapping and traceability	Visualize data to identify wastes and safe work practices for human rights improvement.	Cybersecurity threats and increased energy consumption.	(Khan et al., 2022) (Narkhede G., et al. 2024)

Cloud Computing	Data sharing in an organization, improves flexibility and agility	Reduce energy consumption and improve resource utilization	Usage of much hardware, resulting in electronic waste and energy consumption.	(Jamwal et al. 2021) (Hussain, C.M., and Di Sia, P., 2022)
Internet of Things (IoT)	Provides real-time insights, data to enhance decision-making	Improve quality, manage a great amount of data and predict, for reducing waste and water consumption	Technical skills required, poor discharge of waste, use of energy, and information	(Khan et al. 2025) (Oláh, J. et al. 2020)
Virtual and Augmented Reality (VR/AR)	Visualize real-time physical entities, view stages of a product or material flow simulator	Identify production capacities of industries, meet market demand	High volume of plastic is required and it is difficult to repair these technologies.	(Jamwal et al. 2021) (Hussain, C.M., and Di Sia, P., 2022)
Robotics	Sensors and machinery are often used in manufacturing	Efficiency of industries, enhancing productivity, minimizing errors, and automation	New devices are required, obsolete equipment, and an increase in energy consumption	(Jamwal et al. 2021) (Oláh, J. et al. 2020)

4. Results and Discussion

Digitalization has come through time as a game-changer. The adoption of different technologies is being enhanced over time, applied to different functions of the supply chain from different industries. They may be implemented by trend, pressure, or market factors. The purpose is crucial for the enhancement of visibility and sustainability, relying on good SC Management. It is known that digital technology tools have multiple purposes, but the crucial aspect is the intervention before acquiring a technology. Identifying problems, following a strategy, visualizing future consequences and impacts, and then acquiring them can make a significant difference for firms. A prior methodology is needed to maximize the potential of the technology tool. If there are some stakeholders and money invested, it is worth implementing in a follow-up and correct manner, rather than acquiring before knowing the problem to be solved. Even though there are still some challenges regarding this topic, understanding the effects is a key aspect, and questioning the necessity of implementing such technologies.

The impact of digitalization has highlighted visibility as a significant challenge for SC in companies and has been an ally to sustainability in enhancing decision-making. Therefore, connecting Digitalization with Visibility and Sustainability through decision-making across all functions of the Supply Chain.

There are still gaps and a need for future research on the topic, as indicated by the literature review. Specifically, the Venn Diagram (**Figure 2**) represents areas where future research should focus.

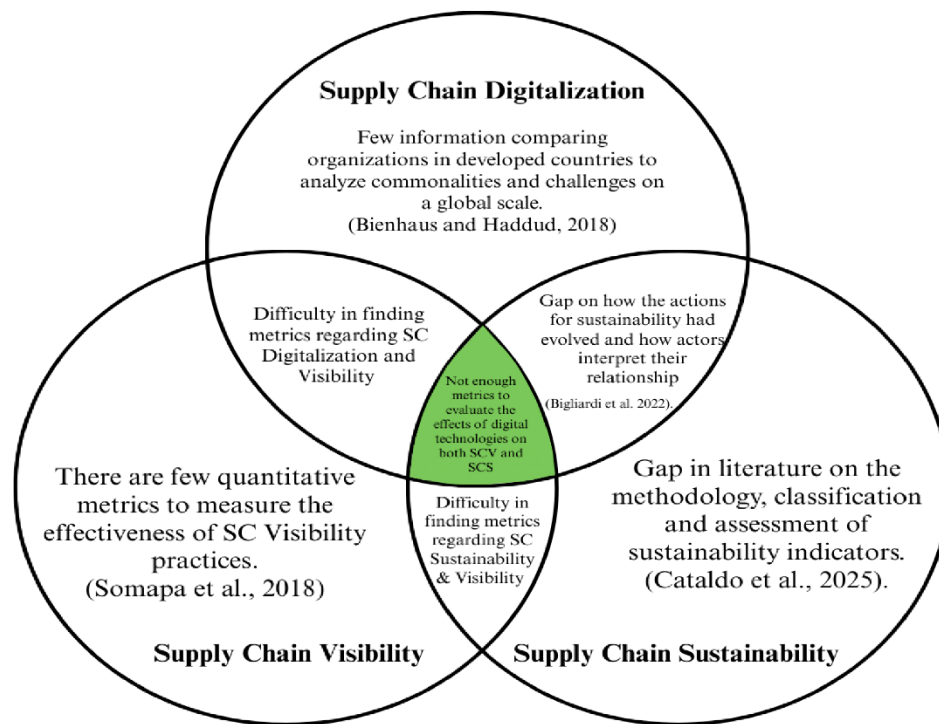


Figure 2. Venn diagram on main literature gaps.

Source: author creation

5. Conclusion

There are many industry and firm changes due to digitalization, but also a need for visibility and sustainability. The new usage of digital tools calls for a crucial evaluation of consequences before acquiring these technologies. The comprehensive literature review revealed that as the tools improve the competitiveness and performance of organizations, there are also many challenges related to their implementation, including economic, social, and other aspects. The future and present challenges, such as globalization and volatile markets, highlight the need for reliable information to make better decisions and enhance performance. The integration of cultural, environmental, and economic aspects has played an interesting role. Although there are still gaps in how actions have evolved and how actors interpret their relationship today, they are all related to the reliability of information and the use of digital technologies. The results are related to a better understanding of the consequences of acquiring technologies and the need for information for all stakeholders for better decision-making.

5.1 Future research directions

The purpose was to understand the general impact of digital technologies on SCV and SCS, but a critical finding of the research was some gaps in this topic. Each digital technology can be assessed in terms of specific effects on the firms, such as efficiency, productivity, and other key performance indicators (KPIs). There is a need to find metrics, classifications, or indicators for the effectiveness of implementing such technologies on SC Visibility and Sustainability. Based on the metrics, it can be easy to examine the better strategies organizations can adopt to enhance their sustainability and visibility with digital technologies. Another area of study can be the relationship between those technologies for each of the different functions of the supply chain, comparing the consequences of acquiring the technologies in SCV and SCS for each one. On a global scale, there is a gap for comparison between different industries' behavior towards these technologies and the perspective from different global stakeholders.

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