

Trends in digitization of the supply chain: A brief literature review

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Abstract

The latest advances in technology, reflected as the Industrial Revolution 4.0, have forced the digitization of supply chains and logistics in general. Only companies that can prepare for and embrace change will survive in the new business environment. Businesses in industries that do not adapt to the new rules of the game will become obsolete in market share. The transformation of a supply and logistics chain, from an old model to a digital one, requires strict organization. It is a great effort on a human level, with the ease of requiring low operating costs. The reward for achieving this change is openness to a global business, where the possibilities grow exponentially and proportionally with the capacity of the available work team. Big data emerges as the beginning of the digitization of supply chains and logistics in the global world. The new environment requires a permanent update of the services software based on market needs. Generally, this does not imply changing technology immediately. However, the goal is to be ready for evolution when a novelty means improvement. This paper briefly presents the evolution of supply chains in the digital context of operational functions.

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Keywords: Supply chain digitization, ERPs, big data, digital twins, supply chain management.

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1. Introduction

The network between companies and suppliers created for the production and distribution of a specific product is defined as a “Supply Chain”. A supply chain represents the steps that are necessary to deliver a product or service to customers. Supply chain management is a very important process considering that optimized supply chains lead to lower costs and faster production cycles. However, the traditional supply chain lacks certain attributes that are needed in the business requirements of the future. The traditional supply chain consists of a series of isolated steps that often lack integration. The transformation of a traditional supply chain into a digital supply chain (DSC) turns the former into an integrated system that works interconnected. A DSC does not imply whether the products or services are physical or digital, but rather how the supply chain is managed.

Many different companies from various industries are investing deeply in digitizing their business operations

and supply chains. Examples of these initiatives are logistics operators such as DHL, Fedex, UPS. E-commerce companies like Amazon and Alibaba have invested in digitizing every link in their supply chain.

There are multiple definitions for a DSC. Some authors mention that it is an intelligent supply chain that takes advantage of advances in technology to integrate actors in the supply chain. They also synchronize processes, including warehouse and transportation systems, in order to take advantage of Web-enabled capabilities. These types of networks are characterized by excellent cooperation and communication between the hardware and software of the chain’s stakeholders. The goal is to synchronize the interaction between organizations by performing services.

The following section briefly summarizes current papers related to digital supply chains. A literature review is presented with the most relevant works in the field of digitization of the supply chain.

Section 3 explains how the research work under study was carried out. Several graphs for data analysis are presented in section 4. Section 5 proposes some conceptual drivers of digital supply chains and explains

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each of them respectively. Finally, the conclusions obtained in the literature research are discussed.

2. Literature review

A "smart city" is a place where information and communication become a real subject of study, thanks to the technology and systems that were implemented within the same city. Which helps them build important data, that will be transformed into decision making considering the efficiency and effectiveness of processes and activities.

So, it should be considered that the more this "system" is fed, the smarter the city will be. Because it will be able to describe the economy in real time, the number of buses that people take during the day, or how the government is managing public services for the community [1].

Considering that all this has been achieved thanks to the Internet of Things, which through different IPs has managed to give traceability and follow-up to all this information generated by the different devices. Because it would result in improved and shared communication protocols in the cloud [2].

While for people, the Digital Architecture of Industry 4.0 has helped them improve how they perform their daily tasks. Allowing them to perform them in a more efficient and structured way, which is no longer based on the same task, but on how it is performed. Being able to be considered as routine or innovative work, which allows the differentiation of mechanical and organic organizations.

The mechanical structure is characterized by being highly standardized, meaning that, the worker who performs these tasks can easily be replaced by digitalization. While the organic structure, it differs for being much more innovative, where digitalization is developed by humans [3].

But how should the correct decision-making by companies be?. Considering that, there are different types of organizations and each one has its own logistics and supply chain. How can we help develop the Supply Chain Management? The best would be to provide knowledge to IT, so that they could analyze the information and thus allow the company to benefit from the knowledge decisions that would be made.

The more capacity to generate knowledge, the more accurate and correct this information will be and the risks will diminish. But it is important to mention that knowledge must be well focused on where you want to go as a company, otherwise it will not work (Ling, X., 2014) But, it is important to mention that there are still many challenges regarding digitization field research. Therefore, this generation of data can be considered an area of opportunity for academics to be able to take advantage of it in Supply Chain Management [4].

On the other hand, it is important to consider that Industry 4.0 could also maximize its benefit if companies managed to separate themselves from the traditional supply chain offer, where each step depends on the previous one. Because some error or inefficiency in the chain can result in a whip effect. Digital technologies foster competitiveness, allow data integration to drive the production and distribution of goods and services [5].

As our first example reviewed, is the Supply Chain Operations Reference Model (SCOR), which is a tool that allows diagnoses of the supply chain, which allows to approach, improve and communicate the decisions of supply chain management within the company, with its suppliers and customers. As well as, it provides a methodology to manage the activities of the supply chain, which are used to analyze supply chain management practices. Considering the above, for SCOR the use of digital technologies is of utmost importance, since these directly impact performance gains by improving and transforming the supply chain. Because it improves the ability to reduce operating costs, improve quality, more sales, development of new products that meet the needs of customers [5].

Another example is the Digital Supply Chain (DSC), in which the author also describes the importance of keeping connected suppliers, companies, distributors and supply chains considering all the information they share on a daily basis. Which it describes as an intelligent, efficient and value-based process in order to generate new income, taking advantage of the use of digital technologies. It is important to emphasize that DSC is not about using these, instead it is about managing the supply chain using digital technologies [6].

But, another way to streamline Supply Chain operations is all the information obtained from the ERP together with blockchain, which manage to provide transparency, efficiency and cost reduction. As well as we can improve the processes of sales and production, planning, demand and supply, logistics, among others [7].

Therefore, mobility must be a priority factor for the supply chain, since today the most important thing is to evaluate the information obtained from end to end in order to horizontally integrate and convert it into knowledge. The more a Supply Chain adapts to this new way of working, the better benefits the company will obtain [8].

But focusing the benefits towards the supply chain of the company, it would be good to be able to consider the cloud computing tool to precisely manage all the supply chain management.

Because the interaction with information between customer and supplier, for example, would be much simpler, efficient and true. It could also provide

feedback to the supply chain. Which would generate a much more intelligent and complete system [9].

Considering that each time Big Data for the management of Supply Chains is generated at a higher speed, seeking quality information and usefulness. All this so that the "knowledge" or information generated can add value, for example, in the company's forecasts considering adjusted and real demand histories [10].

An example would be how the Supply Chain of agri-food sector has been digitalized. Which currently has good digitization initiatives, but the real challenge is to make it provide positive results [11].

Today, the Supply Chain is defined as a series of interconnected activities, which will seek new approaches, in order to create competitive value. These transformations consider the scanning of barcodes, services offered by location, which can be performed thanks to these smart technologies that are working together with the Supply Chain[12].

In [2, 3, 5, 6, 8–25].

3. Research methodology

In this section, it is described how the process was carried out for the literature search, in order to select the most appropriate for the article. Considering that the main objective is to map and evaluate existing literature to identify new or future fields of study. As well as an analysis was carried out on the reviewed articles, with the main objective of looking for trends on the topic studied.

3.1. Search methodology

Editorial websites such as Science Direct (<https://www.sciencedirect.com/>) and Springer (<https://link.springer.com/>) were used primarily. It is important to consider that publications from 2010 to date are considered.

The search cycle was performed to conclude with a total of 114 articles obtained from Science Direct and 166 articles obtained from Springer. Table 1 and Table 3 detail the different selections, considering publications by year. While tables 2 and table 4 consider the category of the publications.

3.2. Methodology implementation

Therefore, to map the existing literature, it was necessary to define the key words that would allow the most relevant literature to be compiled on the topic of this article. To carry out the search, the following topics were defined "Digital Supply Chain", "Digitized Supply Chain", "Digitization of the Supply Chain", "Industry 4.0", "Blockchain and Supply Chain", "IoT and Supply Chain", "Smart Supply Chain", see fig 1.

Table 1. Publications per year in sciencedirect

Year	Publications
2010	1
2011	2
2012	0
2013	1
2014	1
2015	2
2016	2
2017	9
2018	15
2019	50
2020	30

Table 2. Publications per year in springer

Article Type	Publications
Review Articles	10
Research Articles	86
Encyclopedia	1
Book Chapters	9
Correspondance	1
Editorials	2
Other	5

Table 3. Publications per year in sciencedirect

Year	Publications
2010	11
2011	0
2012	6
2013	2
2014	6
2015	3
2016	8
2017	6
2018	22
2019	59
2020	43

Table 4. Publications per year in springer

Article Type	Publications
Article	38
Conference Paper	40
Book Chapters	125
Reference Work Entry	3

4. Data visualization analysis of literature

The analyzed publications are divided into books, articles, books chapters, editorials, proceedings, among others.

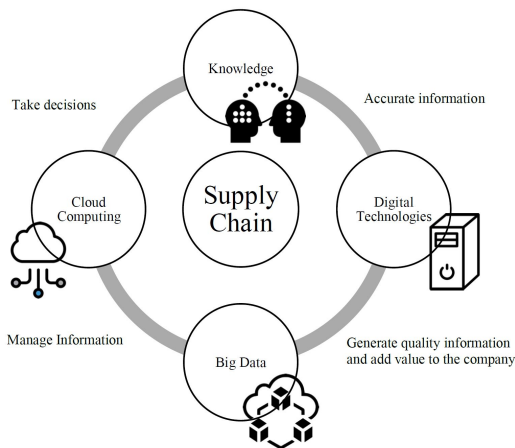


Figure 1. Conceptual Digital Supply Chain.

As you can see in the figs 2 and 3, from the year 2018 to date the works have increased exponentially. The graphs above correspond to what was found in sciencedirect and springer respectively. This confirms the current trend to digitize the supply chain. The development of new technologies, data analytics and cloud computing have been facilitators for the evolution of the traditional supply chain.

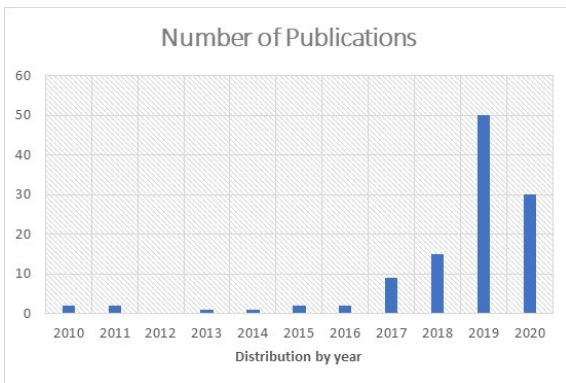


Figure 2. Publications in sciencedirect.

Likewise, figs 4, 5 represent the classification of the works found in the analyzed databases.

5. Conceptual drivers of Digital Supply Chain

After analyzing the existing literature, see fig. 6, some common elements that any DSC should have are:

1. Agility.
2. Integration of supply chain stakeholders.
3. Real-time performance and visibility.
4. Global web-based connectivity.

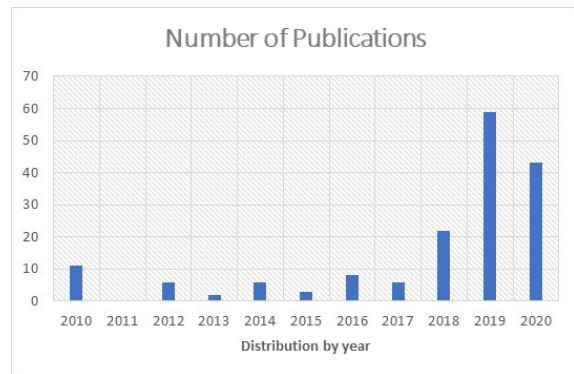


Figure 3. Publications in springer.

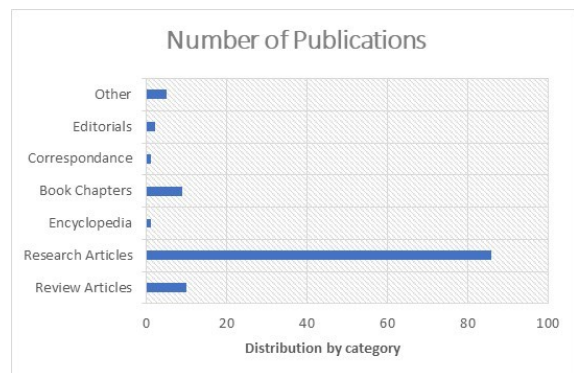


Figure 4. Type of publications in sciencedirect.

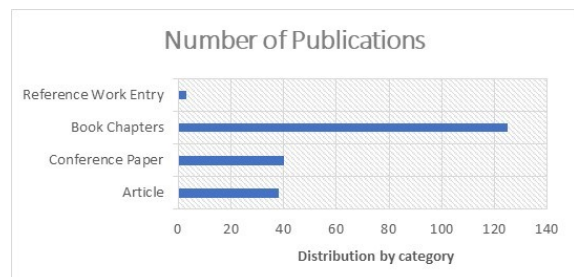


Figure 5. Type of publications in springer.

5. Scalability and flexibility.
6. Open flow of information.
7. Smart processes.

5.1. Agility

The ability to easily respond to opportunities and problems facing the operational side of the business. Implying that the supply chain can predict and respond to demand, especially when it is not planned. So the supply chain needs to provide a profitable engine for growth made up of a strong infrastructure



Figure 6. Drivers of Digital Supply Chain.

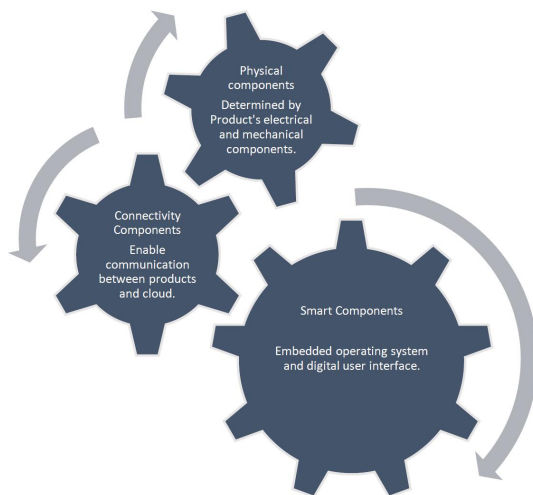


Figure 7. Towards smart processes.

of partnerships and technology platforms with the ultimate goal of continually improving asset utilization.

5.2. Integration of supply chain stakeholders

In its simplest form, a supply chain is made up of a company, suppliers and customers of that company. This being the basic group of participants that creates a simple supply chain, while extended supply chains contain more suppliers, customers or companies, see fig 7.

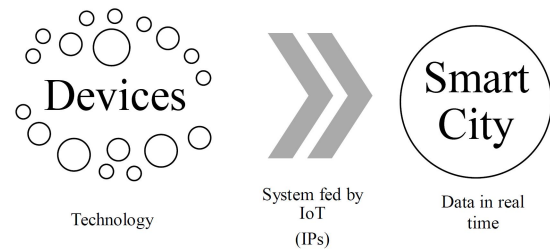


Figure 8. Towards smart cities.

5.3. Real-time performance and visibility

Visibility and real-time performance in the supply chain means you can access the information you need when you need it, and you can quickly integrate that information across the organization to drive the decision-making process. Whether you need to know how much inventory is in stock, or current shipping, you need to be able to take advantage of the right tools to find out the exact status of your products.

5.4. Global web-based connectivity

The Internet has brought new opportunities to use in the field of supply chain. Making companies adapt their supply chain to the Internet and connect through web technologies with their business partners to create supply chain networks. The combination of the concepts of SCM (Supply Chain Management) and the Internet resulted in a web-based application called e-SCM aiming to satisfy customer requirements in the best possible way and in real time, see fig 8.

5.5. Scalability and flexibility

Supply chain flexibility and scalability enables chain responsiveness to achieve a higher level of service, delivery, and faster product customization. Without these 2 characteristics, supply chains would lag behind their competition. Because they allow them to adapt to the rapid changes that customers demand every day.

5.6. Open flow of information

Allowing the flow of information results in the analysis of activities within the supply chain and illustrates the importance of the relationship between the movement of goods and the exchange of information. The information must be present at any time, either before making a sale, and during the post-sale, concluding that the ability to respond to customer demand and satisfaction cannot be achieved without the exchange and flow of information.

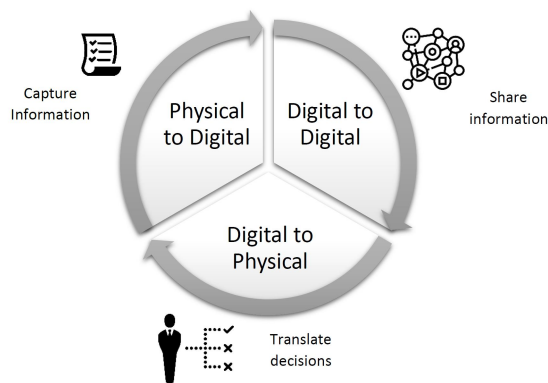


Figure 9. Digital Supply Chain Cycle.

5.7. Smart processes

Enabling the supply chain to have much smarter processes presents unprecedented opportunities to achieve cost reduction and improve efficiency improvement. Whereas now the supply chain has more objects integrated with sensors and better communication, see fig 9.

6. Conclusions

DSCs integrate information from various sources and locations to drive the physical process of production and distribution. The result is a virtual environment, which reflects and informs the physical environment. By leveraging information gained from classic processes and new processes, such as sensor-based data sets (unstructured data), DSCs enable a comprehensive view of the supply network, as well as fast and efficient responses to risky situations and changing. Transitioning from a traditional supply chain to a DSC enables companies to change their strategies, competing at different links in the supply chain simultaneously, rather than simply focusing on one area. However, once organizations have determined how they want to win, they should consider how to effectively configure their DSCs to successfully execute their plan. One of the main benefits of DSC is its agility. This allows for rapid response to variations from what was originally planned. The shift to real-time data access and analytical intelligence is known to have benefited supply chain operations. Once organizations make the decision to adopt a DSC, they should consider how to develop, connect, and use the various technologies powered by Industry 4.0. Before developing a DSC, the process of creating information, analysis and action should be considered as a cycle. Physical to Digital - Capture information from the physical world and create a digital record from physical data Digital to digital: share information and discover meaningful

insights using advanced analytics, scenario analysis and artificial intelligence Digital to physical: Apply algorithms to translate decisions from the digital world into effective data, to optimize processes and changes in the physical world.

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