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Supply Chain and Industry 4.0: A Review of Literature

Georgia Prado de Moura de Faria
Undergraduate Student
Federal Institute of Education. Science and Technology of Sao Paulo - IFSP Sorocaba Campus
Sorocaba, Brazil
georgia.faria@yahoo.com.br

Abstract

The research brings a modern and global scenario of the need for industries to connect to new technologies. In the context addressed, the use of Industry 4.0 technologies linked to the Supply Chain is proposed. One of the biggest impacts caused by Industry 4.0 will be a change that will affect the market as a whole. Basically, the creation of new business models. In an increasingly demanding market, many companies are already looking to integrate the specific needs and preferences of each customer into the product. Prior product customization by consumers tends to be an additional variable in the manufacturing process, but smart factories will be able to take the personalization of each customer into account, adapting to preferences. Finally, it can be concluded that connection between Industry 4.0 and Supply Chain can growth together, considering the high demand for process efficiency, reduction of lead time, optimization in operational flows, better communication and other topics.

Keywords

Internet of Things, Logistics 4.0, Connectivity, Industry 4.0 and Supply Chain.

1. Introduction

The supply chain consists of several correlated and self-dependent areas, which work in harmony so that the flow of all stages of operations is integrated, fluid and optimized. Industry 40 is a concept that proposes a disruptive change in the industry, with a view to the integration between devices and systems and process improvement. Both are important topics to study and development of new resources. The topic is also of interest to logistics companies and professionals working in this area, due to the high level of complexity of production chains and the need for increasingly integrated devices, so that they can generate reliable and efficient information.

The areas of the supply chain can be considered interdependent, as they work in alliance with each other. When one of them is starting the process, there are certainly others already in flow or at the end of the course. The processes resist each other and move forward as the previous and subsequent ones move forward. That's why Supply Chain is such an intriguing area with so many opportunities for development. In this work, some concepts and opinions of some selected authors will be shown, giving a strong understanding of what is currently thought about Supply Chain and the need to connect with Industry 4.0 technologies.

To achieve the objectives proposed in this work, a survey was carried out using bibliographic reviews of papers by renowned authors and demonstrated the result of a more in-depth research on the challenges of the Supply Chain in the context of Industry 4.0.

1.1 Objectives

The objective for this research is shows the challenges and the urgent need for new resources to disseminate these technologies, as well as the breaking down of technical, financial, socio-cultural, environmental and even legal

barriers. This effort can bring knowledge to those interested in the use of Industry 4.0 technologies in the Supply Chain and who have not yet had this opportunity.

2. Literature Review

Chen et al. (2021) makes a statement stating that proposal of Industry 4.0 was first publicly introduced in 2011 under an initiative to enhance the industrial competitiveness of German, and the official promulgation of this concept at the Hannover Messe in 2013 has attracted worldwide attention from different fields. The academic research on this topic focused more on Cyber-Physical Systems (CPS) than on the Internet of Things (IoT) in early stages.

Corrêa et al. (2020) affirm that Logistics 4.0 theme is relevant to the academic environment due to its contemporaneity and its intrinsic connection with Industry 4.0 concept.

The basic foundation of Industry 4.0 implies that by connecting machines, systems and assets, companies will be able to create intelligent networks along the entire value chain that can control production modules autonomously. In other words, smart factories will have the ability and autonomy to schedule maintenance, predict process failures, and adapt to the requirements of unplanned changes in production.

Brettel (2014) explain that virtualization of the process- and supply-chain ensures smooth inter-company operations providing real-time access to relevant product and production information for all participating entities. Boundaries of companies deteriorate, as autonomous systems exchange data, gained by embedded systems throughout the entire value chain. By including Cyber-Physical-Systems, advanced communication between machines is tantamount to their dialogue with humans. In the SC, it presents applications that include material flows (such as production status, process and quality monitoring, inventory handling, logistics, research and development, and collective solutions in Supply Chain 4.0.

Martins et al. (2020) affirm that procurement and distribution functions), information flows (such as demand management, supply chain event management, vendor negotiation, risk management, problem identification, automated-decision support and customer management) and financial flows (such as customer segmentation, demand modeling, new business model design, pricing and assortment, and financial aspects of human resources).
Because of such situations it becomes relevant to transform the traditional product-oriented business model into a service-oriented business model. Such transition enables the creation of intelligent factory networks that encourage effective collaborations (Ordieres-Meré 2019).

With these statements, it can be seen that the need for Industry 4.0 technologies in companies is increasing, as they are present in most sectors. This information may be latent, but it is visible that all of them can become accessible, adapting to the size of each business and the existing physical structures.

The automation of processes and the growing development of technology have generated a new demand for resources that enable the connection between factories or companies and professionals, while the opposite path also exists, where old concepts are no longer used, as they no longer keep up with the rapid evolution that has taken place. Manual and repetitive work is increasingly being replaced by robots, and with Industry 4.0 this is likely to continue. At the same time, the research and development sectors will offer opportunities for technically skilled professionals with multidisciplinary training to understand and work with the variety of technology that makes up intelligent systems.
Established manufacturing companies have recognized that customers are not willing to pay large price premiums for incremental quality improvements (Brettel 2014).

Industry 4.0 will transform the economy by combining several existing phenomena, such as digitalization, 3D printing, the Internet of Things and Big Data. These phenomena can cause major disruptions not only in business models but also in the labor market during the coming years, as the security of systems may be at risk, causing vulnerability and uncertainties about application and use (Brettel 2014).

Martins et al. (2020) affirm that moreover, the full integration of the internal activities in SC functions and the activities of customers and suppliers requires greater synergy among companies and researchers regarding investments, studies, and further technology development. At present, studies report partial integrations of functions and activities. While

the theme is still at an early stage of development, obtaining practical data for analysis and comparison with the theory is difficult.

The implementation of industry 4.0 represents a challenge of considerable magnitude for developing countries. There has been a (relatively recent) interest in studying the implications of the use of 4.0 technologies on the performance of operations in these economies, with which various initiatives have emerged (governmental, industrial, academic, etc.), to provide inputs / guidelines in this regard (Tascón et al. 2022).

The Supply Chain has undergone major transformations due to the need to implement new Industry 4.0 technologies, such as Internet of Things, Big Data, Cyber-Physical Systems and Cloud Computing. Thanks to these technologies, as well as to their subsystems and components, full integration of the supply chain is becoming possible. However, it is observed that the real impacts of Industry 4.0 technologies, rather positive or negative, are not yet totally clear and identified (Martins et al. 2020). Industry 4.0 seems to be the response to the today's competitive world that imposes increasingly stringent requirements, such as tighter deadlines, competitive inventory levels, uncertain demand management, process standardization, and product diversity. This results in constant and new challenges for companies, as they are compelled to stay at the forefront of management strategies that efficiently articulate recent technological developments in their daily operations (Tascón et al. 2022).

Corrêa et al. (2020) explain that it is important to understand the impacts of emerging technologies linked to the concept of Logistics 4.0 and its potential benefits for companies and society, for example, reducing road traffic by the use of shared freight, optimizing delivery routes to decrease the number of vehicles used in the last mile and decreasing the time of business transactions.

Manufacturers and service providers look to operate globalized manufacturing networks. Such option allows to address challenges, such as increased product complexity and decreasing life-cycles. These factors, caused primarily by mass customization and demand volatility, generate a number of issues related to the design and planning of manufacturing systems and networks (Ordieres-Meré 2019).

In the current context, many companies do not use Industry 4.0 resources due to lack of knowledge. They may be considered inaccessible or complex to understand and integrate, but the presence of trained professionals is necessary to instruct this new and growing demand for services.

Jiang et al. (2021) mentioned that the rapid rise of Internet of Things (IoT) brings new demands and scenarios for humans daily life. For example, development of applications such as wearable devices, smart appliances, autonomous driving, intelligent robots, have prompted billions of new devices to connect by each other, which is accelerating interconnection in IoT system.

Jiang et al. (2021) complement that industrial logistics is the guarantee of timely and effective transportation system, which can help improve the efficiency of industrial production.

Thus, it can be seen that production chains are increasingly complex and demanding and need mechanisms that make them more efficient, reducing physical distances, increasing productivity in a sustainable way and generating maximized results, so that they meet the demands in various aspects, including financial.

The development of strategies and tools promoting the dynamic configuration automatic routing through manufacturing networks and facilities under cost, time and environmental constraints to support advanced integration of products by means of smart services will become a needed context in the near future (Ordieres-Meré 2019).

The idea of using Industry 4.0 concepts in the current supply chain brings up several discussions about how prepared the world's current industries are. In most countries, the scarcity of technological resources and the lack of intelligent interaction with suppliers and customers makes them weak and uninteresting to potential investors. Only a few countries stand out as holders of high technology, but even so, they are not self-sufficient in resources, which causes a certain dependence, but which can be interpreted with positivity. There is a perception that Industry 4.0 is not a

continuous advance, where there will be time to adapt, but a step towards the total restructuring of the industrial culture and mentality. Only those who are highly prepared and who are less resistant to change will endure.

3. Methods

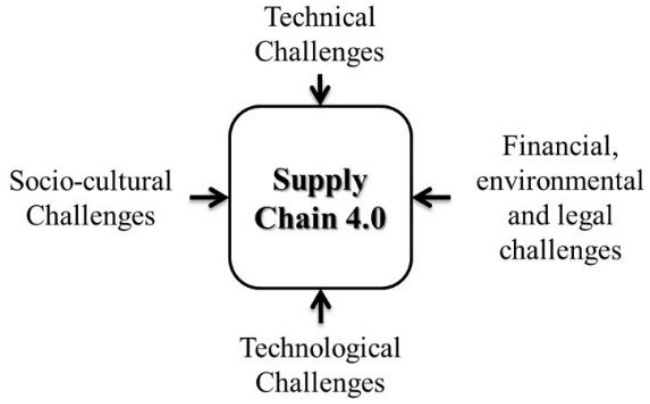
Martins et al. (2020) informed that the articles were analyzed according to the inclusion and exclusion criteria, resulting in a total of 88 selected papers. They developed this method of selecting papers by key-words to identify and measure the challenges of Supply Chain in the Industry 4.0 context. The quantities of articles filtered in each criterion are shown in Table 1:

Table 1. Results of the systematic literature review process' steps. Source: Adapted from Martins et al. (2020).

Filters			
Title, abstract and keywords	Duplicate papers	Complete Reading	Snowballing
351	195	84	88

4. Results and Discussion

Martins et al. (2020) identifies twenty challenges grouped into four macrogroups were identified: (1) technical challenges, (2) financial, environmental and legal challenges, (3) technological challenges, and (4) sociocultural challenges. It should be noted that these challenges require greater attention and more in-depth studies on the part of the academy to support industry in order to mitigate them and thus allow better use of the available technological resources and optimize the performance of Supply Chain operations. Information are illustrated in Figure 1:



High degree of computerization / Computing requirements and strategies Compatibility of systems Complexity of systems Reliability, robustness and interoperability of systems Challenges in storing, discovering and sharing data Scalability Security / Privacy	**Technical Challenges**
Environmental Challenges Financial investiment Standardization / Legislative policies	**Financial, environmental and legal challenges**
Different dynamics and time structures of manufacturing processes Lack of initiative, skills and / or insufficient knowledge Immature Technologies	**Technological Challenges**
Adapting to new business models Strategic alignment between functions, companies and governance SC's participants cooperation Lack of ability to combine data / obtain quality data Fear of change Man-technology relation Human Resource Replacement / Dismissal	**Sociocultural Challenges**

Figure 1. Supply Chain 4.0 challenges classification. Source: Adapted from Martins et al. (2020).

6. Conclusion

It can be concluded from this research that there is much to be explored about the use of new Industry 4.0 technologies in the Supply Chain. A wide and inviting path of research and studies is open to identify new possibilities of connection between technologies, as well as the training of people and companies, so that the use and enjoyment of technologies can be available in any sector, including Supply Chain. It also generates an expectation about the benefits that these technologies bring when they are part of the supply chain, in addition to the numerous possibilities for innovation, efficiency in processes, product improvement and fluidity in communication. In addition, it is possible to highlight the visualization of some points of deficiency in the communication system between Industry 4.0 and the Supply Chain, expressed as challenges such as breaking down technical, financial, socio-cultural, environmental and even legal barriers.

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Biographies

Georgia Prado de Moura de Faria is an undergraduate student in Specialization in Industry 4.0 course from Federal Institute of Sao Paulo – IFSP Sorocaba Campus, Specialist in Project Management from National Trade Apprenticeship Service – SENAC Sorocaba campus, holds a Bachelor Degree in Business Administration from University of Sorocaba – UNISO Sorocaba and Technologist in Human Resource Management from Federal Institute of Sao Paulo – IFSP Sorocaba Campus.

Valdinei Trombini is a permanent Professor at the Federal Institute of Technological Education of São Paulo – IFSP Campus Sorocaba. He holds a Bachelor's degree in Business Administration from Cruzeiro do Sul University, a Master's degree in Communication and Culture from the University of Sorocaba, and a PhD in Communication from UNIP - Paulista University.

Reinaldo Squillante Junior is the Research and Professor of Electro-electronics and Mechatronics at Federal Institute of Education, Science and Technology of São Paulo - IFSP Sorocaba Campus. He received B.S. in Electrical Engineering from University of São Judas - Brazil; Master in Science in the area of Automation and Control Engineering from University of São Paulo - Brazil, and Doctor in Science in the area of Automation and Control Engineering from University of São Paulo - Brazil. He is author of books Applied Computing and Factory and Industrial Installations Project. Dr. Squillante have been developing research in the area of Automation and Mechatronics Engineering with a focus on control systems directed by events with experience in modeling, analysis and validation of control algorithms for advanced manufacturing systems; diagnosis of critical failures on the Process Industries based on Bayesian networks; modeling of accidents on the Process Industries from incomplete databases, and design of safety instrumented systems (SIS). Furthermore, he has over 20 years of experience working in technology companies, and finally, he has interested in Industry 4.0 and new approaches of education 4.0.