Research Article *Open Access*

Journal of Scientific Engineering Advances

ISSN: 3071-0723

DOI: doi.org/10.63721/26JSEA0131

Supply Chain and Industry 4.0: A Literature Review

Georgia Prado de Moura de Faria[1*] and Valdinei Trombini[2]

[1]Graduate Student, Federal Institute of Education. Science and Technology of Sao Paulo – IFSP Sorocaba, Sao Paulo, Brazil
[2]Graduate Professor and Coordinator, Federal Institute of Education. Science and Technology of Sao Paulo – IFSP Sorocaba, Sao Paulo, Brazil

Citation: *Georgia Prado de Moura de Faria, Valdinei Trombini (2026) Supply Chain and Industry 4.0: A Literature Review. J. of Sci Eng Advances. 2(2) 1-8. WMJ/JSEA-131*

Abstract

The research presents a modern and global scenario of the need for connection between industries and new technologies. In the context discussed, 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 seeking to integrate the specific needs and preferences of each customer into the product or service, leading to prior customization. This tends to be an additional variable in the manufacturing process, but smart factories will be able to take into account the customization of each customer, adapting to their preferences. Finally, it can be concluded that the connection between Industry 4.0 and the Supply Chain can grow together, considering the high demand for process efficiency, lead time reduction, optimization of operational flows, better communication, and other topics.

***Corresponding author**: Georgia Prado de Moura de Faria, Graduate Student, Federal Institute of Education. Science and Technology of Sao Paulo – IFSP Sorocaba, Sao Paulo, Brazil.

Submitted: 20.03.2026 **Accepted**: 24.03.2026 **Published**: 06.04.2026

Keywords: Internet of Things, Logistics 4.0, Connectivity, Industry 4.0, Supply Chain

Introduction

The supply chain is made up of several interrelated and self-sufficient areas that work in harmony so that the flow of all stages of operations is integrated, fluid and optimized. Industry 4.0 is a concept that proposes a disruptive change in the industry, with a view to integrating devices and systems and improving processes. Both are important topics for studies 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.

Supply chain areas can be considered interdependent,

as they work in alignment with each other. When one of them is starting the process, there are certainly others already in flux or at the end of the course. Processes resist each other and advance as previous and subsequent ones advance. This is why the Supply Chain is such an intriguing area with so many opportunities for development. This work will address some concepts and opinions of some selected authors, providing a brief understanding of what is currently known about the Supply Chain and the need for connection with Industry 4.0 technologies.

Lima et al. explain that some studies call the current innovative changes the "fourth industrial revolution", which is an allusion to past industrial revolutions, seeking to give a comprehensive and profound character to the consequences of new technologies [1]. This study analyzed part of this "revolution" by examining the technologies associated with "Industry 4.0" and "advanced manufacturing", terms used according to the programs (Germany and the USA).

Also known as the fourth industrial revolution, Industry 4.0 represents the integration of advanced digital technologies into the industrial environment. In this connection between Industry 4.0 and Logistics 4.0, we can very well use all the pillars of Industry 4.0, which are: Industrial Internet, Augmented Reality, Systems Integration, Big Data and Analytics, Simulation, Robotics, Cloud Technology, Additive Manufacturing and Cybersecurity (Figure 1).

Figure 1: Nine pillars of Industry 4.0. Source: Adapted from Dyna4cast Technologies Marca.

This research will show in a simple way the pillars of Industry 4.0 in the context of the connection with the supply chain and will also highlight one of the researched references that addresses four main challenges for the expansion of the use of Industry 4.0 technologies in current industries, which are: technical challenges, financial, environmental and legal challenges, technological challenges and sociocultural challenges.

To achieve the objectives proposed in this research, a survey was carried out through bibliographic reviews of articles by renowned authors and, as a result, some results from some authors were demonstrated in more detail, regarding the challenges of the Supply Chain in the context of Industry 4.0.

Objectives

The objective of this research is to show the challenges and the urgent need for new resources to disseminate Industry

4.0 technologies connected to the Supply Chain, as well as to break down technical, financial, sociocultural, environmental and even legal barriers. In a simple way, the aim was to share the tools and introduce the idea of the possibility of using the pillars in a democratic way, so that they are easily accessible and in simple language, reaching from the smallest companies, with few resources, to large corporations, with their grand global operations. This effort aims to provide basic knowledge to those interested in using Industry 4.0 technologies in the Supply Chain.

Literature Review

Chen et al. state that Industry 4.0 proposal was first publicly presented in 2011 under an initiative to increase Germany's industrial competitiveness, and the official promulgation of this concept at Hannover Messe in 2013 attracted worldwide attention from different fields [2]. Academic research on this topic focused more on Cyber-Physical Systems (CPS) than on the Internet of Things (IoT) in the early stages. state that the topic of Logistics 4.0 is relevant to the academic environment due to its contemporaneity and its intrinsic connection with the concept of Industry 4.0 [3].

The Fordism emergence is closely linked to Taylorism principles, which established the classic separation between planning and execution, as well as a detailed division of labor, in order to achieve efficiency and productivity gains in factories. These principles follow

a strong standardization of times and movements, a strict separation between manual and intellectual labor, and the control of the time of each operation, among other techniques and work processes [4].

According to evolutionary literature, industrial revolutions result from the introduction of new technologies into the economy that transform the system through qualitative changes. In this process, initiated by the action of entrepreneurs seeking new profit opportunities, countless imitators are seduced, who, for a long time, are seduced by, on the one hand, generating new and extraordinary investments and, on the other, can collaborate by improving technological opportunities. Thus, new and important technologies sustain economic and social development for a certain period of time, until they are replaced or replaced by new and more efficient ones [1]. The post-Fordism expansion is accompanied not only by the so-called flexible specialization in the sphere of production, but also by the end of the welfare state and the frantic search for the flexibilization of labor relations through neoliberal practices of economic austerity. Thus, with regard to labor rights, there is a deregulation aimed at adapting to new ways of organizing work. Workers' rights and historical achievements are replaced and eliminated from the world of production [4]. (Table 1).

Table 1: Comparison: Fordism, Post-Fordism and Cyber-Fordism. Source: Adapted from Paula et al. [4].

	Fordism	Post-fordism	Cyber-fordism
Mechanization Level	Man-Machine Rigidit	Man-Machine Flexibility	Man-Machine Systemic Integration
Workforce	Workforce Over-Specialization	Workforce Specialization	Workforce Automation
Workers and Managers Relationship	Manual and Intellectual labor Separation	Manual / Automation and Intellectual labor Connection	Automated labor and Artificial Intelligence Connection
Labor and Capital Relationship	Labor Regularization	Labor Deregulation	Post-labor
Industry Paradigm	Industry 1.0 and 2.0	Industry 3.0	Industry 4.0
Economic Paradigm	Keynesianism Welfare state	Neoliberalism Minimal State	Ultra-neoliberalism State as market guardian

Lima et al., highlight two aspects that characterize these transformative processes [1]. First, new technologies are not introduced into the system at the same time or in their best or most suitable version, but, on the contrary, they require different and varied improvements. Second, even if they are individually relevant, the complementarities and synergies between innovative technologies are vital for the structural transformations that are to come. Thus, considering that these innovations depend on overcoming technical bottlenecks, which require time (and changes in the scientific, institutional, and productive spheres), the mutations are uneven between economic activities (different technical and scientific knowledge) and nations (different skills). leave a question: Studies on the subject are still scarce, as we have seen in the literature and in the research carried out, so for future research, we recommend that researchers debate our propositions, both theoretical and empirical, in papers, addressing industries and service organizations; as well as research centers at universities and researchers focused on the topic [4]. Does Industry 4.0 bring more benefits than harm? Is this really a new industrial revolution? Is cyberfordism really a new production paradigm? We address these questions to the academic community in the area, which can continue this debate and present its possible differences.

Faria summarizes that the basic basis of Industry 4.0 implies that, by connecting machines, systems and assets, companies will be able to create smart networks along the entire value chain that can control production modules autonomously [5]. In other words, smart factories will have the capacity and autonomy to schedule maintenance, predict process failures and adapt to the requirements of unplanned changes in production.

Brettel explains that process and supply chain virtualization ensures smooth inter-enterprise operations by providing real-time access to relevant product and production information for all participating entities [6]. Business boundaries are blurred as autonomous systems exchange data obtained by embedded systems across the value chain. By including cyber-physical systems, advanced machine-to-machine communication is equivalent to their dialogue with humans. In the SC, it presents applications that include material flows (such as production status, process and quality monitoring, inventory movement, logistics, research and development, and collective solutions in Supply Chain 4.0.

Martins et al. state that procurement and distribution functions), information flows (such as demand management, supply chain event management, supplier

negotiation, risk management, problem identification, automated decision support, and customer management), and financial flows (such as customer segmentation, demand modeling, design of new business models, pricing and assortment, and financial aspects of human resources) are all subject to change [7]. Due to such situations, it becomes relevant to transform the traditional product-oriented business model into a service-oriented business model. This transition allows the creation of smart factory networks that encourage effective collaborations [8].

Faria points out that, with these statements, it is clear that the need for Industry 4.0 technologies in companies is increasing, as they are present in most sectors [5]. This information may be latent, but it is clear that all of it can become accessible, adapting to the size of each business and the existing physical structures.

Process automation and the increasing development of technology have generated a new demand for resources that enable the connection between factories or companies and professionals, while the opposite is also true, where old concepts are no longer used because 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, research and development sectors will offer opportunities for technically qualified professionals with multidisciplinary training to understand and work with the variety of technologies that make up intelligent systems. Established manufacturing companies have recognized that customers are not willing to pay large price premiums for incremental improvements in quality [6].

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 may cause major disruptions not only to business models but also to the job market in the coming years, as the security of systems may be at risk, causing vulnerability and uncertainty about application and use [6].

Martins et al. state that, in addition, the full integration of internal activities into SC functions and customer and supplier activities requires greater synergy between companies and researchers regarding investments, studies, and technology development [7]. Currently, studies report partial integrations of functions and activities. Although the topic is still at an early stage of development, it is difficult to obtain practical data for analysis and comparison with theory.

Industry 4.0 implementation 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 several initiatives (governmental, industrial, academic, etc.) have emerged, to provide inputs/guidelines in this regard [9].

Bibliometric analysis is used to investigate scientific progress. It can perform quantitative analyses of publications so that qualitative analyses can be generated and, thus, knowledge can be distributed. This research method is widely used by researchers, as it can cover a large number of reputable and reliable publications, generating an efficient and well-prepared result.

This example corroborated the structuring of this research, where being a bibliographic review, it already speaks for itself that this would be the most appropriate methodology for the research process.

Table 2 below shows the reasons why decided to use bibliometric analysis for their research. Topics such as concepts, basic technologies, enabling technologies and promising areas were taken into consideration to interconnect the pillars of Industry 4.0 [1].

Table 2: Sets of terms Selected for Bibliometric Research and Analysis. Source: Adapted from Lima et al. [1].

Concepts	Industry 4.0, Integrated Industry, Industry Intelligent Industry, Industrial Internet, Manufacturing Advanced Manufacturing, Intelligent Manufacturing, Fourth Industrial Revolution.
Basic Technologies	Internet of Things, Internet of Services, Cyber-physical systems or cyber-physical systems, factory Smart Factory.
Enabling Technologies	Big data, cloud computing, 3D printing, Systems Integration, Human-Machine Integration, Artificial Intelligence, Internet of Commerce Internet of Things, Additive Manufacturing, Machines autonomous machines, autonomous systems.
Promising Areas	Intelligent automation, precision manufacturing lightweight materials, robotics, Advanced sensing.

Lima et al. explain that this methodology was chosen instead of patent analysis because the topic contains recent technologies and is an ongoing process [1]. Since there is still no definition of the technologies that will have the greatest impact, the analysis is able to outline the technologies that will be consolidated in the future as a component of Industry 4.0 based on what is currently being researched.

The Supply Chain has undergone major transformations due to the need to implement new Industry 4.0 technologies, such as the Internet of Things, Big Data, Cyber-Physical Systems, and Cloud Computing. Thanks to these technologies, as well as their subsystems and components, the full integration of the supply chain is becoming possible. However, it is observed that the real impacts of Industry 4.0 technologies, both positive and negative, are not yet fully clear and identified [7].

Industry 4.0 seems to be the answer to 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 forced to remain at the forefront of management strategies that efficiently articulate recent technological developments in their daily operations [9].

The presence of terms referring to Industry 4.0 is mostly present in the publications analyzed and has shown high growth rates in recent years. The recent and high-growth scientific interest in this field is a good indicator that the selected technologies are nascent or emerging, endorsing the proposal of this study [1].

Corrêa et al. explain that it is important to understand the impacts of emerging technologies linked to the concept of Logistics 4.0 and their potential benefits for companies and society, for example, reducing road traffic through the use of shared freight, optimizing delivery routes to reduce the number of vehicles used in the last mile, and reducing the time of commercial transactions [3].

Manufacturers and service providers are seeking to operate globalized manufacturing networks. This option allows them to address challenges such as increased product complexity and decreased life cycles. These factors, mainly caused by mass customization and demand volatility, generate a series of problems related to the design and planning of manufacturing systems and networks [8].

According, in the current context, many companies do not use Industry 4.0 resources due to lack of knowledge [5]. 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. mentioned that rapid rise of the Internet of Things (IoT) brings new demands and scenarios to human daily life [10]. For example, the development of applications such as wearable devices, smart appli-

ances, autonomous driving, and smart robots has led to billions of new devices connecting to each other, which is accelerating interconnection in the IoT system. Jiang et al. add that industrial logistics is the guarantee of a timely and efficient transportation system, which can help improve the efficiency of industrial production [10].

Thus, it is clear 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 demands in various aspects, including financial ones [5].

The development of strategies and tools that promote automatic routing of dynamic configuration through networks and manufacturing facilities under cost, time and environment constraints to support advanced product integration through smart services will become a necessary context in the near future [8].

Faria summarizes that 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 [5]. In most countries, the scarcity of technological resources and the lack of intelligent interaction with suppliers and customers make them weak and unattractive to potential investors. 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 positively. 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 industrial culture and mentality. Only those who are highly prepared and who are less resistant to change will resist.

Methods

Martins et al. reported that the articles were analyzed according to the inclusion and exclusion criteria, resulting in a total of 88 selected articles [7]. They developed this method of selecting articles by keywords to identify and measure the challenges of the Supply Chain in the context of Industry 4.0. In the research, they found 351 articles searched by title, abstract and keywords and among them, 195 duplicate articles. Of this total, they read 84 articles in full and highlighted 88 as references. In this present research, the same quantitative method was used to search for articles. In the research, 37 articles were found searched by title, abstract and keywords and among them, 4 duplicate articles. Of this total, 12 articles were read in full and highlighted as references. The number of articles, filtered according to each criterion for this research, are shown in the Table 3 below:

Table 3: Results of the Stages of the Systematic Literature review Process. Source: Adapted from Martins et al. [7].

Filters			
Title, abstract and keywords	Duplicate Papers	Full reading	Used as Reference
37	4	13	13

Results and Discussion

Martins et al. identified twenty challenges grouped into four macro-groups: technical challenges, financial, environmental and legal challenges, technological challenges and socio-cultural challenges [7]. It is worth noting that these challenges require greater attention and in-depth studies by academia to support the industry in order to mitigate them and, thus, allow better use of available technological resources, optimizing the performance of Supply Chain operations. This information is illustrated in Figures 2 and 3:

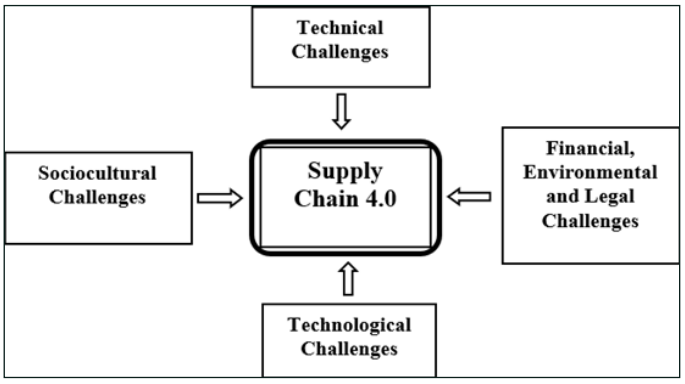

Figure 2: Classification of Supply Chain 4.0 challenges. Source: Adapted from Martins et al. [7].

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 3: Details of the classification of Supply Chain 4.0 challenges. Source: Adapted from Martins et al. [7].

The challenges listed above by Martins are intrinsically mentioned, individually or collectively, in most of the researched materials, leading to a common thought for present research: that there are many needs in this innovative environment that technology presents [7]. This context also shows that practices applied in a given global region cannot be effectively used in others, as each region has its own cultural, geographic and economic characteristics, directly impacting the full use of Industry 4.0 technologies.

According to the article Challenges for Industry 4.0 in Brazil (2016), in the medium and long term, the incorporation of new technologies into a strategy for the development of Brazilian industry will be essential for the country's competitiveness and to improve its participation in global value chains. (…) Furthermore, as has been happening in other countries, the diffusion of Industry 4.0 technologies in Brazil will not reach all sectors in the same way and at the same time. The level of heterogeneity in our industry will require policies to be adapted for different sets of sectors and companies, which will assume different speeds and conditions.

Conclusion

It can be concluded from this research that there is much to be explored regarding the use of new Industry 4.0 technologies in the Supply Chain, including in Brazil. It opens up a broad and inviting path of research and studies to identify new possibilities for connecting technologies and companies, as well as training people and companies, so that the use and expansion of technologies can be available to any sector, including the Supply Chain.

It also generates expectations about the benefits that these technologies bring when they are part of the supply chain, such as increased production efficiency, route optimization, automation in warehouses, reverse logistics, waste utilization, integrated purchasing, in addition to the countless possibilities for innovation, process efficiency, 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, previously expressed as challenges, such as breaking down technical, financial, sociocultural, environmental and even legal barriers.

The constant search for knowledge, evolution and intellectual development has increased research on the subject, expanding dissemination among researchers and students, facilitating understanding and making it known that little by little, technologies will become part of all operations, deeming the use and practices of these technologies. In the industrial sphere, research and development advances in step with globalization, with the aim of offering better quality, efficiency and safety in processes, making cultural, geographic and economic differences increasingly narrower and generating greater connectivity between the Supply Chain and Industry 4.0 technologies.

Acknowledgements

The author would like to thank Professor Dr. Adm. Valdinei Trombini for his guidance in the research, support and teachings during the course, and Professors Dr. Sergio Shimura, Dr. João Lúcio de Barros and Dr. Reinaldo Squillante Junior, from IFSP Campus Sorocaba, for their support and teachings during the

course.

References

1. Lima F R, Gomes R (2020) Industry 4.0 concepts and technologies: an analysis bibliometric. Rev. Bras. Inov. Campinas (SP) 19: e0200023.
2. Chen L, Ye, Z, Jin (2021) A Security, Privacy and Trust Methodology for IIoT. Tehnički vjesnik 28.
3. Corrêa J S, Sampaio M, Barros, R C (2020) An exploratory study on emerging technologies applied to logistics 4.0. Gestão & Produção 27: e5468.
4. Paula A P P, Paes K D (2020) Fordism, post-Fordism and cyber-Fordism: the (mis) paths of Industry 4.0. Cad 19.
5. Faria G (2024) Supply Chain and Industry 4.0: A Review of Literature, Proceedings of the 14th International Conference on Industrial Engineering and Operations Management, Dubai, UAE,
6. Brettel M (2014) How virtualization, decentralization and network building change the manufacturing landscape: An Industry 4.0 Perspective, International Journal of Mechanical, Industrial Science and Engineering 8: 37-44.
7. Martins F C, Simon A T, Campos R S (2020) Supply Chain 4.0 challenges. Gestão & Produção, 27: e5427.
8. Ordieres Meré J, Villalba-Díez J, Zheng X (2019) Challenges and Opportunities for Publishing IIoT Data in Manufacturing as a Service Business. Procedia Manufacturing 39: 185-193.
9. Tascón D C, Mejía G, Rojas-Sánchez D (2022) Flexibility of operations in developing countries with industry 4.0. A systematic review of literature. Production 32: e20210055.
10. Jiang B, Li J, Yue G, Song H (2021) Differential Privacy for Industrial Internet of Things: Opportunities, Applications, and Challenges. IEEE Internet of Things Journal 8: 10430-10451.
11. Corrêa J S, Sampaio M, Barros R C, Hilsdorf W C (2020) IoT and BDA in the Brazilian future logistics 4.0 scenario. Production 30: e20190102.
12. Indústria C N (2016) Desafios para an indústria 4.0 no Brasil – Brasília: CNI 34.
13. Dynacast T (2023) Nine Pillars of Industry 4.0. 2023. Nine Pillars of Industry 4.0 | Dyna4cast.
14. Martell F, Lopez J M, Sanchez I Y, Paredes C A, Pisano E (2023) Evaluation of the degree of automation and digitalization using a diagnostic and analysis tool for a methodological implementation of Industry 4.0. Computers & Industrial Engineering 17