Logistics 4.0: Fundamentals and importance

https://doi.org/10.56238/Connexpemultidisdevolpfut-071

Djalma Alves Cabral Filho
Professor/ Doctor UNITINS.
E-mail: logcabral@hotmail.com

ABSTRACT
The innovations of Logistics 4.0 are achieved with the implementation of characteristics that put the company ahead of competitors, through services that may have something practical or that simply have some item that identify them as a growing trend in Logistics for the coming years. With this information comes the following question: can one distinguish and choose, among the different logistics processes of Logistics 4.0, their fundamentals and trends, understanding their particularities, their uses and their strengths and weaknesses?
The methodology applied to the work regarding the type of research was exploratory. As for the methods employed, it was bibliographic and documental. Regarding the data collection technique, the bibliographic research was applied. The data analysis technique was qualitative.

Keywords: Logistics 4.0.

1 INTRODUCTION

The current trends for Logistics 4.0 are linked to the evolutions of society, technology, Industry 4.0 and the corporate world. For this, the professionals who work with Logistics will need to improve the integration of critical organizational processes, from the end user to the original suppliers, so that they provide products and services of excellence, highlighting the information that adds value to customers, to other partners and that will change the ways of doing Logistics.

The innovations of Logistics 4.0 are achieved with the implementation of characteristics that put the company ahead of competitors, through services that may have something practical or that simply have some item that identify them as a growing trend in Logistics for the coming years.

With this information comes the following question: can one distinguish and choose, among the different logistics processes of Logistics 4.0, their fundamentals and trends, understanding their particularities, their uses and their strengths and weaknesses?

The methodology applied to the work regarding the type of research was exploratory. As for the methods employed, it was bibliographic and documental. Regarding the data collection technique, the bibliographic research was applied. The data analysis technique was qualitative.

This study was carried out within a fundamentally deductive scientific methodology, focused on doctrinal research related to the theme. The interdisciplinarity is clear in the lines of this publication, as the thought of some learned people such as Amarildo de Souza Nogueira, Antônio Galvão Novaes,

Hong Yuh Ching is cited and discussed. Marco Aurélio P. Dias, Paulo R. Bertaglia, Ronald H. Ballou and many others who focus on supply chain management.

To this end, it was proposed with the work to present a brief reasoning about Logistics 4.0, in its fundamentals and trends, referring to the set of work, facilities and resources that make up the business capacity, highlighting the Logistics Service Level, e-commerce, technology, outsourcing, Reverse Logistics and other management practices.

2 LOGISTICS 4.0

Logistics 4.0 arrives in the day-to-day life of the industry, along with the so-called fourth industrial revolution, industry 4.0, under the guidelines, which use technology to make the operation "smart", defined with criteria to be specific, measurable, attributable, realistic and temporary. This strategy serves to help companies determine their goals more intelligently, creating a cohesive, efficient, automated and high-visibility production system.

As a history of the process, it is considered that from 1780, the 1st Industrial Revolution occurred with the improvement of steam engines (use of hydraulic force). In the 1870s, the 2nd Industrial Revolution happened with the application of Mass Production with steel, electricity and petroleum products.

In the 1970s, the 3rd Industrial Revolution emerged with the use of computers and robotization. At the beginning of the XXI century, the 4th Industrial Revolution manifested itself, with Cyber-Physical Systems of Artificial Intelligence (cybernetics).[1]

Characteristics of Logistics 4.0 are to provide support in the areas of supply, transport, among others, in the context of Industry 4.0, in: digitalization; Internet of Things (IoT) (describes the network of physical objects embedded in sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. These devices range from ordinary household objects to sophisticated industrial tools); use of Big Data (Allows companies to access various types of data. For example, this information collected enables professionals to recognize the behavior of their consumers, distinguish their needs and how the market is able to react to the proposals); quick and effective decisions; greater operational effectiveness; customer experience; and cutting-edge technologies.

The current trends for Logistics Management are linked to the evolutions of society, technology, Industry 4.0 and the corporate world. For this, the professionals who work with Logistics will need to improve the integration of critical organizational processes, from the end user to the

[1] ALMEIDA, Bruno Guerra. FABRO, Elton. *Indústria 4.0 como ferramenta na engenharia de manutenção com base na metodologia TPM*. SCIENTIA CUM INDUSTRIA, V. 7, N. 2, PP. 23 — 39, 2019. Disponível em < https://core.ac.uk/download/pdf/236126152.pdf > Acesso em: 08 jul. 2023.

original suppliers, so that they provide products and services of excellence, highlighting the information that adds value to customers, to other partners and that will change the ways of doing Logistics.

The innovations of Logistics 4.0 are achieved with the implementation of characteristics that put the company ahead of competitors, through services that may have something practical or that simply have some item that identify them as a growing trend in Logistics for the coming years.

Logistics 4.0 is therefore an advanced and technologically integrated approach to supply chain management and Logistics Operations. It combines the power of automation, digitalization, connectivity and data analytics to create highly efficient, agile and intelligent logistics systems.

Logistics 4.0 is based on the concept of Industry 4.0, which refers to the integration of advanced technologies into industrial operations. Similarly, Logistics 4.0 seeks to apply digital technologies and innovations throughout the supply chain, from production to final delivery. Some of the key elements of Logistics 4.0 includes:

- **Internet of Things (IoT):** The IoT allows the connection of physical objects to the internet, allowing the monitoring and control in real time of items, equipment, vehicles and logistics infrastructure. Sensors and connected devices collect data that can be used to optimize logistics processes, improve visibility and traceability, and make control decisions on data.
- **Big Data and Analytics:** Logistics 4.0 uses advanced data analytics to extract valuable insights and make decisive decisions. Data collected from various sources, such as sensors, warehouse management systems, and tracking systems, is processed and analyzed to identify patterns, trends, and bottlenecks in the supply chain. This helps improve demand forecasting, optimize inventory, reduce lead times, and improve overall efficiency.
- **Automation and Robotics:** Automation plays a key role in Logistics 4.0. Robots and automated systems are used in tasks such as picking, packaging, storage and transportation. This increases the speed, accuracy and efficiency of logistics operations, freeing up human errors and freeing up employees for more complex tasks.
- **3D Printing: 3D** printing technology is being increasingly adopted in Logistics, allowing the fast and customized production of parts and products. This reduces reliance on inventory and minimizes transportation costs, as well as opening up possibilities for mass customization.
- **Blockchain: Blockchain** technology offers an immutable and transparent record of transactions, which can improve the visibility and security of logistics operations. It

enables product tracking along the supply chain, verifies the trust and provenance of products, and simplifies payment and document processes.

- **Artificial Intelligence (AI): AI** is applied in Logistics 4.0 to predict demand, optimize transportation routes, perform predictive equipment maintenance, and automate decision-making processes.

Thus, as a facilitator, Logistics 4.0 is collaborative, giving agility of communication between the agents of the supply chain and sharing of information.[2]

It also achieves greater control of operations, with lower risks and greater synchronization, as well as less waste of time, fuel and other productive resources. In addition, it provides greater responses of operations to adverse conditions, with greater speed of information flows and greater speed in the transmission of instructions.

The main emphasis of Logistics 4.0 is to update the entire operation from strategic planning to inventories, through the use of technologies that optimize the supply flow of raw materials, semi-finished and finished products, in order to meet customer needs.

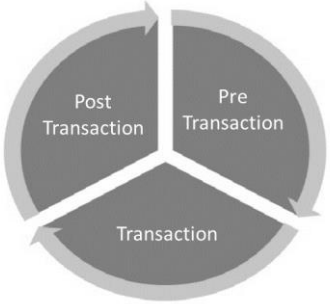
With this, it has objectives that are always directed to improve and modernize management, eliminating (or minimizing) bottlenecks and waste, reducing time (lead time) and reducing costs, without compromising quality. This is what happens with Logistics 4.0, which aims to optimize the operation and logistics processes, within the organizational strategy.

The following will be exposed trends that accompany Logistics 4.0.

3 LEVEL OF LOGISTICS SERVICE

The logistics service level (NSL) is the process of fulfilling the orders and needs of customers, with goods and services. This process employs management indicators to measure the logistics service in relation to the disposition of the right products, in the right quantities, in the right places, at the right time and at the best cost. The elements of the logistics service level can be found in the pre-transaction, during the transaction and in the post-transaction.

Figure 1-Elements of the Logistics Service Level



[2] ALMEIDA and FABRO, 2019.

In the pre-transaction, the logistics service level (NSL) needs a good environment to achieve an effective level. For example, they are presented as elements that provide a good performance in the level of logistics service: the definition of the delivery time of the goods, after the placing of an order; exchange and return procedures; procedures in case of lack of any product; dispatch methodologies; and establishment of contingency plans that meet strikes, natural disasters and product recalls.

During the business transaction, NSL is responsible for the results obtained from the delivery of the product to the customer. For example, the following can be cited as performance indicators at the logistics service level: inventory level; ability to deal with delay; delivery time of the finished product; and quality of care.

Post-transaction, NSLs are responsible for the services needed to support products already delivered to customers. For example, the following stand out: installation and warranties; return of packaging; handling of customer complaints; and handling customer returns.

The logistics service, in this way, is provided before, during and after the act of purchasing, constituting itself as an important factor of differentiation. That is why the logistics service level (NSL) is related to several indicators that are formed by the sum of several elements, as customers react to this total set.

The Logistics Service Level (NSL), for example, can be expressed by the following management indicators: order cycle (time between order and receipt); percentage of orders delivered complete; stock availability; reliability in delivery; frequency of delivery; punctuality; flexibility; information on the progress of the order; and restrictions on order size.

The NSL is, therefore, the Quality with which the flows of goods and services are managed and is the performance offered by suppliers to their customers, constituting this net result of all the firm's logistics efforts3.

4 E-COMMERCE AND LOGISTICS

The Internet is a powerful and efficient channel for commerce, considering the absence of geographical barriers and the convenience and speed. In this way, e-commerce is growing and becoming a revolutionary market in Brazil and other parts of the world.

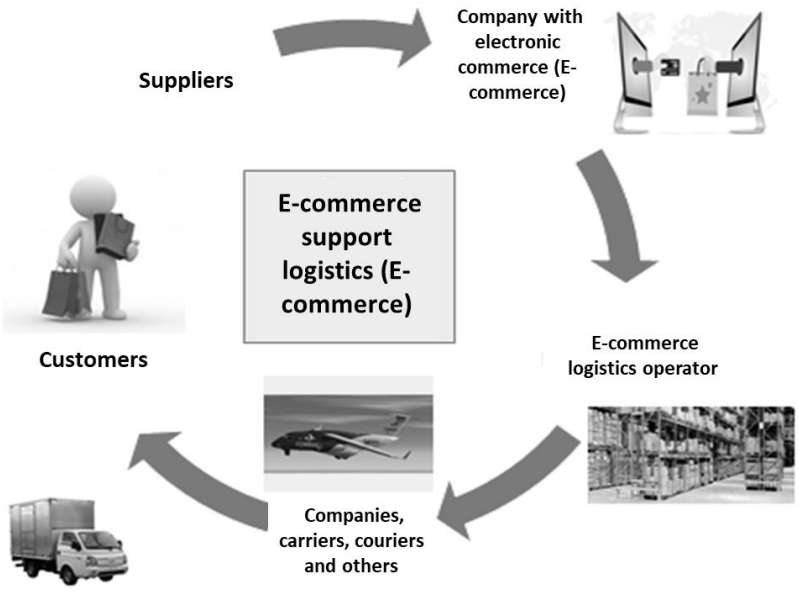
This e-commerce has been occurring because the Internet has become a powerful and efficient channel for commerce, through a structured model to break paradigms, giving rise to a New Economy by reducing the old economy and changing consumer habits.

Possessing excellent value proposition for consumers, e-commerce completes product offering, home delivery, accurate and objective content and reduced prices. However, e-commerce has a

[3] NOVAES, Antônio Galvão. *Logística e gerenciamento da cadeia de distribuição.* 10. reimpr. Rio de Janeiro: Elsevier, 2007, p. 189-207.

bottleneck due to the current Logistics structure that is still similar to the old one of the large distributors and wholesalers that is very expensive and complex.

Figure 2- E-commerce Support Logistics



E-commerce presents a business model with superior profitability in the long term, but it needs to achieve: scale in advertising and personnel; inventory investments; and investment in real estate. However, many times, after purchasing a desired product over the internet on an e-commerce site, this merchandise takes time to be delivered by the seller or is simply not delivered.

These logistical problems are very common in the e-commerce operations of companies, generating customer dissatisfaction, compromising the credibility of some sites, which can even culminate in the closure of operations. Therefore, the Logistics operation to support e-commerce must be adequate and effective.

The growth of e-commerce has led to the need for larger logistics operations to deliver an increasing volume of orders. Therefore, the need for outsourcing logistics activities in e-commerce has been growing.

In the area of Information Technology (IT), one of the first measures for the outsourcing of logistics activities of e-commerce is that the company has a management interface of the Logistics platform, allowing each order made on the site to be taken into account. After the order is shipped, the company and the customer will be able to track the order, and the store can manage the inventory of its products.

In support of e-commerce, Logistics will be able to do the reception, control and inventory of products, as well as picking, packaging and sending orders to customers. Also, you need to do reverse logistics for the best management of returned orders. Each returned product can be reinstated to stock or discarded if it is in poor condition.

E-commerce logistics needs to provide customers with various types of delivery, for example, express or economic. These logistics operators have, in many cases, partnerships with carriers, to get better prices for e-commerce.

Thus, Logistics is fundamental in e-commerce to reduce business costs in these operations. Thus, having a good e-Logistics, either internal or with the help of a good external platform, becomes a real strategic advantage for companies that perform e-commerce4.

5 TECHNOLOGIES IN LOGISTICS

The technology applied to Logistics is fundamental to meet the necessary evolutions, especially in the functions of transport and storage for the areas of industry, service and commerce, which need to be defined from the analysis of the work process of these segments and considering the realities of Brazil, as will be exposed below.

The technology applied to transportation is one of the most important activities of Logistics, because transportation represents most of the logistics costs in most organizations, having a fundamental role in the performance of several dimensions of Customer Service. In this context, technologies such as: Integrated Management System (Enterprise Resource Plannig – ERP) stand out; Radio Frequency – RF; transport management system; satellite tracker system; TAG toll system; GPS which are global positioning systems; and variable message boards. The container and pallets are technologies that stand out and that are revolutionizing transportation in all modes.

The technology applied to storage follows in second place of importance in Logistics for the reduction of logistics costs. In the warehouses, the following technologies stand out: conveyors; shelves for the verticalization of the warehouses (medium storage); Forklifts; stacker cranes; Automatic Guided Vehicles (AGV); picking systems; Pallets; information technology (IT) applied to storage; automatic stock identifications (e.g., barcode and RFID - radio frequency).

6 INFORMATION TECHNOLOGY (IT) APPLIED TO LOGISTICS 4.0

Information Technology (IT) applied to Logistics 4.0 needs to present a user-friendly interface, so that the company's employees can improve all their activities. Companies need to use or update their IT systems with capability, for example, to: make sales by mobile; NFC-e issuance; make product registration; and track results in real time.

Companies that bet on IT as solutions for Logistics and usually achieve an increase in revenue. Therefore, integrated management systems are used as the examples that will be exposed below.

[4] NOVAES, 2007, p. 73-101.

WMS (Warehouse Management System) are automation and management systems for warehouses, warehouses and production lines. WMS is vital to the supply chain, providing targeted inventory rotation, intelligent picking, automatic consolidation, and cross-docking to maximize warehouse space usage.

TMS (Transportation Management System) are systems for improving the quality and productivity of the entire distribution process. TMS makes it possible to control all operations and management in transport in an integrated way.

Com a TI, a empresa encontra soluções como, por exemplo, o ERP, Enterprise Resource Planning ou SIGE (Sistemas Integrados de Gestão Empresarial, no Brasil) que são sistemas de informação que integram todos os dados e processos de uma organização em um único sistema. ERP is a solution for complex processes, such as the registration of items, greatly reducing the time required for the operation.

This ERP integration can be seen in management functions (e.g., finance, accounting, human resources, production, marketing, sales, and purchasing) and in organizational systems such as planning, managerial information, and decision support.

MRP (Manufacturing Resource Planning) are management systems that deal especially with inventories in which the demands depend on a certain final product. These types of systems also re-plan material requirements with each change in production scheduling, inventory records, or product composition5.

7 OUTSOURCING IN LOGISTICS 4.0

Outsourcing in Logistics 4.0 is a trend that seeks to transfer logistics activities to third parties, because they are not part of the main business of companies in many cases. This is due to these companies currently concentrating their efforts on their core activities, delegating complementary activities to third parties. Therefore, a partnership relationship with outsourced logistics operators is sought, with the company remaining focused only on tasks essentially linked to the business in which it operates. Outsourcing in Logistics 4.0 is therefore a process used by a company in which logistics operators are hired to develop this area of the company.

However, in choosing the logistics operator that will offer the services it is necessary to analyze the market options. There are many operators who do not comply with their legal and labor obligations. As advantages of the logistics outsourcing process, for example, one can achieve: the reduction of logistics costs; taking advantage of the knowledge and experience of the logistics operator; use of

[5] ABRACHE, Fernando Saba et al. *Gestão de Logística, distribuição e trade marketing*. 3. ed. 4. reimpr. Rio de Janeiro: Editora FGV, 2006, p. 61-112.

information technology (IT); concentration of the company on its core competencies; increased quality; simplification of the company's logistics processes;

Thus, the effectiveness of the logistics outsourcing process focuses on the choices of partnerships with logistics operators that excel in quality, to offer added value to their customers6.

8 LOGISTICS COST MANAGEMENT 4.0

Cost management is one of the main trends for Logistics 4.0, because these logistics costs are the ones that are in second place in the company, right after the costs of the finished product itself.

There are few studies and discussions about logistics costs, which "are the costs of planning, deploying and controlling all inbound, in-process and outbound inventory, from the point of origin to the point of consumption".7 Stand out in these logistics costs 4.0: inventory costs (inventory maintenance); costs arising from batches or service level; storage and handling costs; packaging costs; order processing costs (information technology); order processing costs; tax costs; and transportation costs[8].

In the management of logistics chain costs, for example, the following suggestions can be made for their reduction. In purchasing activities: reduction of the order cycle, delivery times and get discounts for quantity purchased.

In transport activities: use of EDI, bar code, route planners, unitization of loads and smart label. In storage activities: bar code, vertical space, horizontal conveyors, automatic picking, stacker cranes and layout sizing.

In inventory activities: inventory reduction, elimination of obsolete materials, standardization of raw materials, application of Just in Time (JIT).

In other logistics activities: use of ERP, simulators, route planners, management and operational training, TMS, reengineering of products, raw materials, production processes and packaging, agility in the processing of orders and billing, standardization and ideal mix of products, minimum prices for special products.

[6] BERTAGLIA, Paulo R. *Logística e Gerenciamento da Cadeia de Abastecimento*. 1ªed. 5ª tiragem. São Paulo: Saraiva, 2008, p. 129-130.
[7] FARIA, Ana Cristina de; COSTA, Maria de Fátima Gameiro da. *Gestão de custos logísticos*. 1. ed. 6. reimpr. São Paulo: Atlas, 2010, p. 69.
[8] CHING, Hong Yuh. *Gestão de estoques na cadeia de logística integrada* – Supply chain. São Paulo, Atlas, 2010, p. 187-198.

Figure 3 - Michael Porter's Value Chain

Source: Porter (1990, apud, NOGUEIRA, 2012, p. 9)

Thus, these logistics costs are distributed along the production chain, from purchases, through the inbound transport process, in the inventory and movement of the company's raw material, in the production, inventory and movement of finished products, in the physical distribution by outbound transport, to the after-sales support. Michael Porter's value chain demonstrates very well the managerial cost of each process in order to obtain information for managerial decision-making.

9 REVERSE LOGISTICS

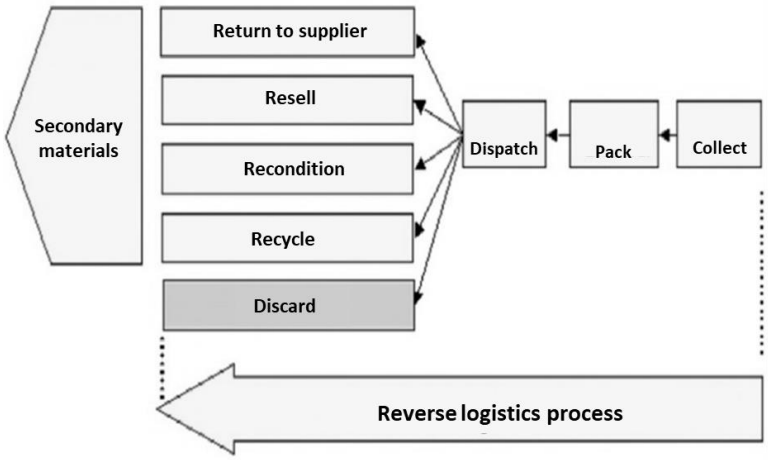
Reverse Logistics arose due to the service of a variety of social, environmental and governmental interests, aiming to ensure the business and profitability of the company over time, always meeting the socio-environmental responsibility of organizations. Thus, we sought to meet the socio-environmental role, for example, in the return of products, reduction at source, recycling, replacement of materials, reuse of materials, disposal of waste, reform, repair and remanufacturing.

The first studies on Reverse Logistics were carried out from the 1970s, having as main focus the return of goods to be processed in recycling of materials, denominated and analyzed as reverse distribution channels. After the 1990s, it was that the theme became more visible in the business scene.

Reverse Logistics is important to meet different needs of stakeholders such as shareholders, employees, customers, suppliers, local community and government who evaluate companies from different perspectives. In addition, Reverse Logistics has as main purposes: to return after-sales products, without interfering too much in the operations and profitability of the activities of the companies; decrease pollution by contamination or excess products; comply with environmental legislation that exempts governments and holds companies or their production chains accountable by equating the reverse flows of post-consumer products.

Avoid risks to the image of the company, its citizen reputation and show before the community its awareness of socio-environmental responsibility.

Figure 4 - Reverse Logistics Process



The reverse distribution channels of after-sales goods are those referring to the reverse flow of industrial goods that are marketed and processed, for example, for reasons of: expiration date; excess inventory; consignment; quality problems, defects; transport breakdowns; order errors; end of seasons; end of commercial life of the product; and obsolete stocks.

The reverse distribution channels of post-consumer goods are those that have different forms of processing and marketing of these post-consumer products or their constituent materials, from their collection to their reintegration into the production cycle as a secondary raw material.

Reverse Logistics is applied, therefore, in after-sales and post-consumption, through reverse distribution channels. For this, the reverse logistics flow must be implemented, from the point of consumption to the point of origin, which needs to be well managed to occur the disposal, recycling, reconditioning, resale or return to the supplier, when applicable. These logistics strategies have an economic and ecological vision, within the socio-environmental responsibility of the companies9.

10 FINAL CONSIDERATIONS

The Brazilian environment imposes difficulties on the growth of companies. Mainly in Logistics, therefore, an overview was drawn about the new trends in Logistics 4.0 that have highly important roles for the renewal of knowledge, boosting the renewal of organizations and, consequently, their productivity and profits.

It ends by emphasizing that the main emphasis of Logistics 4.0 is to update the entire operation from strategic planning to inventories, through the use of technologies that optimize the flow of supply of raw materials, semi-finished and finished products, in order to meet the needs of the customer.

Thus, some processes that are always directed to improve and modernize management were highlighted, eliminating (or minimizing) bottlenecks and waste, reducing time (lead time) and reducing

[9] BARSANO, Paulo R.; CAMPOS, Alexandre de. *Administração: guia prático*. 1. ed. São Paulo: Érica, 2013, p. 192-193.

costs, without compromising quality. This is what happens with Logistics 4.0, which aims to optimize the operation and logistics processes, within the organizational strategy.

It was finally concluded that it is necessary to seek an advanced and technologically integrated approach to the management of supply chains and Logistics Operations 4.0 is, as well as innovations, through the implementation of features that put the company ahead of competitors,

Nevertheless, it is worth deepening the work, discussing the developments of Logistics 4.0 so that it integrates services that may have something practical or that simply have some item that identifies them as a growing trend in Logistics for the coming years.

REFERENCES

ABRACHE, Fernando Saba et al. Gestão de Logística, distribuição e trade marketing. 3. ed. 4. reimpr. Rio de Janeiro: Editora FGV, 2006.

ALMEIDA, Bruno Guerra. FABRO, Elton. Indústria 4.0 como ferramenta na engenharia de manutenção com base na metodologia TPM. SCIENTIA CUM INDUSTRIA, V. 7, N. 2, PP. 23 — 39, 2019. Disponível em < https://core.ac.uk/download/pdf/236126152.pdf > Acesso em: 08 jul. 2023.

ALMEIDA, Paulo Samuel de. Indústria 4.0: Princípios básicos, aplicabilidade e implantação. São Paulo: Érica, 2019.

BALLOU, Ronald H. Gerenciamento da Cadeia de Suprimentos: Logística Empresarial. 5. ed. reimpressão. Porto Alegre: Bookman, 2009.

BARSANO, Paulo R.; CAMPOS, Alexandre de. Administração: guia prático. 1. ed. São Paulo: Érica, 2013.

BERTAGLIA, Paulo R. Logística e Gerenciamento da Cadeia de Abastecimento. 1ªed. 5ª tiragem. São Paulo: Saraiva, 2008.

CABRAL FILHO, Djalma Alves. Gestão logística e tendências da logística 4.0. Ponta Grossa - PR: Atena, 2023.

CHING, Hong Yuh. Gestão de estoques na cadeia de logística integrada – Supply chain. São Paulo, Atlas, 2010.

DIAS, Marco Aurélio P. Administração de materiais: uma abordagem logística. 19. reimpr. São Paulo: Atlas, 2009.

FARIA, Ana Cristina de; COSTA, Maria de Fátima Gameiro da. Gestão de custos logísticos. 1. ed. 6. reimpr. São Paulo: Atlas, 2010.

GLISTAU, E.; COELLO MACHADO, N. I. Industry 4.0, Logistics 4.0 and Materials - Chances and Solutions. Materials Science Forum, 2018.

NOGUEIRA, Amarildo de Souza. Logística empresarial: uma visão local com pensamento globalizado. São Paulo: Atlas, 2012.

NOVAES, Antônio Galvão. Logística e gerenciamento da cadeia de distribuição. 10. reimpr. Rio de Janeiro: Elsevier, 2007.