LOGISTICS 4.0: A SYSTEMATIC REVIEW  
Gabrielle Angeli Poli, Taila Nayara Saviani, Irapuan Glória Júnior  
Instituto Federal de São Paulo (IFSP)

Abstract
The term Logistics 4.0 corresponds to the evolution of logistics, resulting from the developments that Industry 4.0, with intensive use of technology, exempt the use of humans in the clear majority of actions and making the companies fully automated. This article intends to explore the various researches on Logistics 4.0 studied in recent years. The research has a qualitative nature, the use of systematic research to identify the relevant articles to present a panorama of the studies in the academy in recent years. The result of the research presents 9 focuses that are being studied. The contribution to the practice is to present possible gaps to the researchers that can be filled with new works. The contribution to the practice is to assist the managers in making and using the concepts of Logistics 4.0.

Keywords
Logistics 4.0; Industry 4.0; Technology; Systematic review.

1. Introduction
Companies are increasingly competitive and the search for improvements covering the global scenario (1), at the same time that the customers want the ever better products and in small time periods (2). The technological revolution brought the concepts of Industry 4.0 (3) and Logistics 4.0 (4).

Globalization affects society in a number of areas, especially in the growing flow of information and leads to greater competition and volatility in markets, culminating in the multiplication of challenges to companies in order to guarantee their existence (5).

The charge for quick results and a possible mass customization produced a survey that was the basis for the fourth industrial revolution, named Industry 4.0 (Ind4), which encompasses systems and concepts of integrated and intelligent industrial automation, production chains and globally
integrated logistics, supply of raw materials and energy combining concepts ranging from the most varied areas of Engineering to Information Technology (3).

In the deployment of industry 4.0, the concepts discussed in this step are consumed from design templates that can use different frameworks that are currently available in the business (6–8) with the close attention of project managers to risks (6; 9; 10) due to their technological dependence (11; 12), innovation level (13) and the development of new skills (14).

The modern consumer who is more informed and requires more immediate market results, such as the development of a new business structure that involves the production system concepts based on the intensive use of available information systems and automation (15).

As the industry evolves, logistics also needed to evolve, culminating in the so-called Logistics 4.0 (Log4), which assists professionals in this segment to reduce asset loss, generate fuel cost savings, ensure temperature stability, manage inventory, have a user view and create fleet efficiency (3).

Thus, with Log4 growing as Ind4 evolves, the restlessness to determine what the academy is researching is the starting point of this work, which has the following research question: "What are the search directions for Logistics 4.0 in the academy in recent years?". It aims to present the articles that are available in the state of the art regarding Logistics 4.0 and the identification of the directions of the selected articles.

2. Theoretical Framework

2.1. Industry 4.0

The world industry has undergone several changes throughout the centuries, with each change the history denominated Industrial Revolution. The evolution, according to Figure 1, began with the first industrial revolution, dated in the 19th century, where the mechanical force, characterized by the steam engine, made history, made possible the growth of the productive capacity and transport (16; 17).

In the early 1900's, due to the mass production of the previous revolution, models to develop the production were developed, highlighting the model made for the automotive sector, with Ford's "T" model, marked the second Industrial Revolution (18).

In the 20th century, another great transformation takes place, the introduction of digital technologies in the midst of the production process, paving the way for a new world. The
development of automated solutions has increased operational capacity and brought more efficiencies to production processes (19; 20).

The evolutions have not ceased and the fourth industrial revolution is currently being presented, which is characterized by the intensive use of information technology and the concept of "Intelligent Factory", which corresponds to real-time integration from manufacturing to the human resources department (15).

![Timeline Industrial Revolution based in MacDougall (2014).](image)

It was in Germany that the term Industry 4.0 was first established and are at the forefront of this industrial revolution since the term was established several companies have projects in the area of intelligent factories (21; 22). It is also possible to find as intelligent industry (23; 24).

The Ind4 is evolving and still receives other features such as the idea that human-machine interaction will drastically decrease, in situations in which machines and raw materials will be able to organize in real time through the internet, so the industries will not need human interaction in the production process (4). It is foreseen to use of the Internet of Things (IoT) and the Cyber-Physical System (25–27).

In this way, Ind4 causes impacts on logistics, culminating in the modification of its processes and inserting more automation to meet the new way of organizing the industries, culminating in the so-called Logistics 4.0.

### 2.2. Logistics 4.0

Logistics aspects are essential to be possible to meet customers' requirements (28; 29). The origin of the word "logistics" is used in the military sphere, when deciding to advance with its troops,
the generals needed that under their orders a team that would arrange the displacement, at the right
time of ammunition, equipment and medical assistance to the sick in the battlefield (30; 31).

Over time it has been associated with a larger field, in addition to military, in which many
processes have been used to designate logistics, such as physical distribution, materials
management, marketing logistics, and supply chain management (32), modifying the essence of
the logistics that started to contemplate to the obtaining, movement and storage of materials and
products involving all the physical flow (33).

The evolution of logistics, as presented in Figure 2, has determinant aspects in the different periods (28), as
in the 1940s when military logistics during World War II took the concept of logistics into the
business world, and with the invention of container transport in 1956, the flow of international
goods took a big leap. The integration of operational logistic functions between the 1970s and
1980s, was based on the use of Kanban and Just-in-Time concepts that had been developed. In the
1990s it was marked by intense integration, with the use in companies of the concepts of Quick
Response and Efficient Consumer Response. Currently, companies have a major focus on supply
chain management seen as one of the key processes' groups from a provider to the end user.

Figure 2 – Evolutionary Cycle of Logistics based in Arbache et al. (2006)

It is possible to identify generations of logistics development (28):

- **Logistics 1.0.** Characterized by product transport operations;
- **Logistics 2.0.** There are various forms of collaboration, new partners and new means of transport;
• **Logistics 3.0.** It follows the same classic transportation activities, with more attention to the supply of products and services to the end customer. Incorporating communication technologies, facilitating quick access to information; and

• **Logistics 4.0.** Corresponds to a platform in which logistics is associated with Ind4 technologies, to aggregate values throughout the supply chain process.

Log4 will further facilitate the flow of the product, being the most tangible part of the supply network, the processes produced by it help to optimize results, create competitive advantages, thus eliminating gaps between production and demand (34).

![Figure 3 – Evolution of Logistics based in Petrache (2015)](image)

3. **Methodology**

This research has qualitative nature (35), with the use of the methodology of systematic review (36) with the aim of identifying the available research on logistics 4.0. The methodological procedures for this research, according to Figure 3, were:

- **Step 1: Define Selection Criteria.** The criteria for the selection of articles were defined in order to determine higher quality of the findings;

- **Step 2: Define Search Terms.** From the definitions found in the literature, the terms to be searched were established and the creation of the search string for the Google Scholar Engine, IEEE Xplore, ACM Digital Library and Web of Science;

- **Step 3: Select Articles.** The results of the search returned candidate articles that possibly will
be used, but only after the application of the selection criteria, in which will result in the items to be considered in the research;

- **Step 4: Results Analysis.** The most used areas and the number of articles about Log4 will be identified; and

- **Step 5: Show Results.** Results presentation of the evolution of research in Log4 and is directions in the academy.

![Methodological Process Diagram](image)

**Figure 4 – Methodological Process**

### 3.1 Selection Criteria

The systematic review considered the following criteria (C):

(C01) The period from 2014 to 2018;

(C02) It will use only published scientific articles, excluding monograph, dissertation, thesis, books and any other artifact;

(C03) Documents in pdf format;

(C04) Present in your texts concepts about logistics 4.0; and

(C05) They have in their abstracts terms relevant to the research question.

### 3.2 Search Terms

Regarding the terms used were considered the use of "Logistic 4.0" and "Logistics 4.0" (28; 30; 37), according to Table 1.
Table 1 – Search Terms

<table>
<thead>
<tr>
<th>Base</th>
<th>String</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scholar Google</td>
<td>(&quot;logistics 4.0&quot; OR &quot;logistic 4.0&quot;) filetype:pdf</td>
</tr>
<tr>
<td><a href="http://www.scholar.google.com">www.scholar.google.com</a></td>
<td></td>
</tr>
<tr>
<td>IEEE Xplore</td>
<td>(&quot;logistics 4.0&quot; OR &quot;logistic 4.0&quot;)</td>
</tr>
<tr>
<td>ieeexplore.ieee.org/</td>
<td></td>
</tr>
<tr>
<td>ACM</td>
<td>(&quot;logistics 4.0&quot; OR &quot;logistic 4.0&quot;)</td>
</tr>
<tr>
<td>Digital Library dl.acm.org/</td>
<td></td>
</tr>
<tr>
<td>Web of Science</td>
<td>(&quot;logistics 4.0&quot; OR &quot;logistic 4.0&quot;)</td>
</tr>
<tr>
<td><a href="http://www.webofknowledge.com/">www.webofknowledge.com/</a></td>
<td></td>
</tr>
</tbody>
</table>

3.3 Selected Articles

The research had as a preliminary result 44 articles, of which 17 were selected, as presented in Table 2. There was the case of an article that was returned to the bases of ACM, IEEE, and Web of Science but was only counted in the first.

Table 2 – Candidate and Selected Articles

<table>
<thead>
<tr>
<th>BASE</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scholar Google</td>
<td>04 / 00</td>
<td>01 / 01</td>
<td>08 / 02</td>
<td>21 / 08</td>
<td>05 / 01</td>
<td>39 / 12</td>
</tr>
<tr>
<td>IEEE Xplore</td>
<td>00 / 00</td>
<td>00 / 00</td>
<td>00 / 00</td>
<td>00 / 00</td>
<td>01 / 01</td>
<td>01 / 01</td>
</tr>
<tr>
<td>ACM Digital Library</td>
<td>00 / 00</td>
<td>01 / 01</td>
<td>00 / 00</td>
<td>00 / 00</td>
<td>00 / 00</td>
<td>01 / 01</td>
</tr>
<tr>
<td>Web of Science</td>
<td>00 / 00</td>
<td>00 / 00</td>
<td>01 / 01</td>
<td>02 / 02</td>
<td>00 / 00</td>
<td>03 / 03</td>
</tr>
<tr>
<td>TOTAL</td>
<td>04 / 00</td>
<td>02 / 02</td>
<td>09 / 03</td>
<td>23 / 10</td>
<td>06 / 02</td>
<td>44 / 17</td>
</tr>
</tbody>
</table>
4. Analysis and Interpretation of Results

4.1 Articles that are available in the state of the art regarding Logistics 4.0

The research resulted in the identification of growth in the study of concepts related to Log4. As shown in Figure 4, in 2014 no articles were found on the topic, starting in 2015 and reaching its apogee in 2017, in 2018 it was considered until July 2018. Articles are available in Appendix A.

![Figure 5 – Publications in the period from 2014 to 2018](image)

4.2 Identification of selected article directions

In the context of Logistics 4.0, the areas researched are shown in Figure 6. Since 2015, its application can be found in studies about the changes and challenges (18%) found in the implementation of Log4, new solutions, opportunities and potential technicians in this new scenario (38–40), in the understanding of its evolution (6%) through innovation presenting the development of this concept (28), social and economic factors and conditions that influenced, in sustainable business models (6%), relating logistics 4.0 and sustainability (41).
In manufacturing (12%), seeking to improve the manufacturing system, which is an important process in the market competitiveness (42; 43), can be found in freight transport (17%) with the intensive use of freight and freight cars control, allowing gains of efficiency in this sector (44–46), in the workflow (17%) aiming to integrate different processes, which aims to create value of products and services for the final customer (47–49), in the storage of products (12%), making the process more efficient and fast with monitoring and robotization technique, reducing costs and increasing customer satisfaction (37; 50).

In the development of applications (6%) implemented with elements characteristic of the fourth industrial revolution to help and improve the supply chain management (51), in the area of training using Serious Games (6%) and can provide learning processes in the new work environment(52).

![Figure 6 – Articles Direction](image)

### 4.3 Discussion

As well as market demands and changing consumer expectations, companies will tend to adapt to new technological realities and trends. Currently Ind4 presents an alternative as a new way of producing, much more efficient and less exhausting for humans. This context helps in the evolution of new ways to control the delivery flow of finished products and raw materials, boosting Log4.
It is possible to observe that most searches are in "Changes and Challenges", which may indicate that there is still a lot of uncertainty in Log4. The themes "Workflow" and "Transport" are indications that the researchers look for ways to make feasible the implantation of this type of concept in the companies of supply chain.

5. Conclusion

The evolution of logistics, since the 1940s, has undergone many transformations up to Industry 4.0 (Ind4). In Ind4 the use of humans is dispensed for the great majority of actions, making the companies fully automated.

The result of the research indicates a growth regarding the studies of Logistics 4.0, mainly in relation to the Changes and Challenges, Workflow and to the Transports.

The limits of this work are to use only articles in English and not to consider articles in proceedings due to the recommendation of the methodology used. The contribution to the practice is to present to the researchers the possible gaps that can be filled with new works. The contribution to the practice is to assist the managers in making and using the concepts of Logistics 4.0. Future work is in mapping the process relationships between Ind4 and Log4, the use of Industrial Internet of Things and the impacts on Supply Chain Management.

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### Appendix A

#### Table 3 - Candidate and Selected Articles

<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Logistics - Evolution Through Innovation</td>
<td>Evolution</td>
</tr>
<tr>
<td>2015</td>
<td>Logistics 4.0 – A Challenge for Simulation</td>
<td>Changes and Challenges</td>
</tr>
<tr>
<td>2016</td>
<td>Logistics 4.0 Solution New Challenges and Opportunities</td>
<td>Changes and Challenges</td>
</tr>
<tr>
<td>2016</td>
<td>Robot Selection for Warehouses</td>
<td>Storage</td>
</tr>
<tr>
<td>2016</td>
<td>Process Improvement Trends for Manufacturing Systems in industry 4.0</td>
<td>Fabrication</td>
</tr>
<tr>
<td>2017</td>
<td>How to Promote Self-regulated Learning Processes by Using Serious Games</td>
<td>Serious games</td>
</tr>
<tr>
<td>2017</td>
<td>Logistics 4.0 And Emerging Sustainable Business Models</td>
<td>Sustainability</td>
</tr>
<tr>
<td>2017</td>
<td>Applications within Logistics 4.0</td>
<td>Applications</td>
</tr>
<tr>
<td>2017</td>
<td>Towards inclusion of the freight rail system in the industrial internet of things - Wagon 4.0</td>
<td>Transport</td>
</tr>
<tr>
<td>2017</td>
<td>Securing of safety by monitoring of technical parameters in warehouse racks, in high-bay warehouses and high storage warehouses - Literature Review of the problem</td>
<td>Storage</td>
</tr>
<tr>
<td>2017</td>
<td>The connected wagon - a concept for the integration of vehicle side sensors and actors with cyber physical representation for condition-based maintenance</td>
<td>Transport</td>
</tr>
<tr>
<td>2017</td>
<td>Connected freight rail rolling stock: a modular approach integrating sensors, actors and cyber physical systems for operational advantages and condition-based maintenance</td>
<td>Transport</td>
</tr>
<tr>
<td>2017</td>
<td>Logistics of Knowledge 4.0 - Advances in the literature of a concept in application</td>
<td>Workflow</td>
</tr>
<tr>
<td>2017</td>
<td>Employees for new production systems</td>
<td>Fabrication</td>
</tr>
<tr>
<td>2017</td>
<td>The Predominant Role of IT as a Competitive Global SCM Strategy: The Case of Roland DG Japan, a Manufacturing Company</td>
<td>Workflow</td>
</tr>
<tr>
<td>2018</td>
<td>The Transition to Industry 4.0 in one of the Turkish logistics company</td>
<td>Workflow</td>
</tr>
<tr>
<td>2018</td>
<td>Technical Potentials and Challenges Within Internal Logistics 4.0</td>
<td>Changes and Challenges</td>
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</table>
Correspondência:

Gabrielle Angeli Poli. e-mail: gabrielleangeli@poli@gmail.com
Taila Nayara Saviani. e-mail: tailanayara@gmail.com
Irapuan Glória Júnior. e-mail: ijunior@ndsgn.com.br