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Logistics 4.0 in Brazil: Critical Analysis and Relationships with SDG 9 Targets

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Abstract: The logistics sector is characterised as an important pillar of the Brazilian economy, significant regarding revenue and job creation. This study aims to critically analyse the logistical operations developed by Brazilian companies in the context of Logistics 4.0 and to structure a SWOT (strengths, weaknesses, opportunities and threats) matrix from the information gathered. In addition, relationships were established between the structured SWOT matrix and the targets of Sustainable Development Goal 9 (SDG 9). The methodological approach taken by the study consisted of semi-structured interviews with ten experts and data were analysed through content analysis. Once structured the SWOT matrix, the results were related with the targets of the SDG 9. The study presented the weaknesses and threats stand out in relation to the strengths and opportunities. When compared with the targets of SDG 9, it is possible to observe that many weaknesses are related to infrastructure and innovation. The main contributions of the study are the following: it is one of the few studies which holistically examined the sector in Brazil from a Logistics 4.0 perspective and the study points out some essential needs which should be addressed. The information presented here can broaden the debates on this topic and assist companies and government in the transition to digital transformation.

Keywords: Logistics 4.0; brazilian context; critical analysis; SWOT

1. Introduction

In the scenario of industrial transformations, the world is currently, experiencing the so-called Fourth Industrial Revolution (or Industry 4.0), characterised by process digitization [1,2]. The main pillar of Industry 4.0 is the integration among manufacturing operations and information flows throughout the entire production chain and digital systems, allowing greater control of actions with a minimum level of human interference [3] and a higher decentralisation of the value chain [4]. In general, advancements of Industry 4.0 have been favoured by four factors: increased data, computational power and connectivity; the need for analytical resources; increased human–machine interaction; and improvements in digital implementations combined with robotics advancements [5]. As a consequence, the development of this phenomenon will be responsible for major innovations in several fields in the next decades throughout the entire production network [6–9],

including design, sales, manufacturing, supplies, etc. Considering this last area, Ghobakhloo [1] and Sung [5] highlight significant changes in business logistics.

Logistics operations will be impacted by digital transformation, thus emerging the concept of 'Logistics 4.0'. It refers to the combination of traditional logistics with Industry 4.0 related technologies [10]. There are several technologies related to Industry 4.0 context that directly impact the logistics field, such as block chain, big data and the Internet of Things (IoT), among others [11–13]. Barreto et al. [10] highlight the relevance of these technologies for system improvement activities in logistics. The establishment of intelligent logistics will enable a real-time tracking of material flows, an efficient handling of transport and an efficient risk management, thereby enabling production system improvements; materials will be delivered at the right time, in the right quantity and in the right place [14].

Consequently, the use of Logistics 4.0 operations will allow greater flexibility and adjustments to market requirements. It will also provide optimisation in production networks, with lower production and storage costs, generating a better level of customer service [15,16]. According to Barreto et al. [10], the implementation of Logistics 4.0 by companies will be successful when considering the following points: (a) resource planning; (b) management and storage systems; (c) transportation management systems; (d) intelligent transport systems; and (e) information security.

The improvements provided by the Technologies related to Industry 4.0, if properly linked with public policies related to the targets of SDG 9 [17], could largely contribute to advancing countries' infrastructure, in especial in the emerging countries. Considering the Brazilian context, the logistics sector is of great importance due to its magnitude regarding job positions and financial movement [18]. Despite its importance, the Brazilian logistics sector is still underrepresented in the literature when considering the transition from traditional logistics to Logistics 4.0. Better understanding of the characteristics of this transition is important to enhance the debates on this subject. This indicates a research gap to be explored, which can be represented by the following research question: What are the strengths, weaknesses, opportunities and threats to the logistics operations developed by Brazilian companies in the context of Logistics 4.0?

To answer this research question, interviews were conducted with experts on the subject and based on the information collected, a SWOT matrix was structured. In addition, relationships were established between the structured SWOT matrix and the targets of Sustainable Development Goal 9 (SDG 9). The results will greatly contribute to the expansion of the debates associated with the theme.

In addition to this introduction, this article is structured in four more sections. Section 2 is dedicated to the theoretical foundation that underlies the study. Section 3 presents the methodological procedures developed to achieve the results. Section 4 shows the results and associated debates, followed by Section 5, which establishes the main conclusions of the work and final considerations. Finally, the references used are listed.

2. Theoretical Background

2.1. The Digital Transformation in Logistics Activities

The advancement of the digital age introduces new challenges to traditional logistics; the main challenge is related to the development of customer-oriented operations, capable of operating in a flexible way and adjusting to the needs of each consumer [19,20]. To a large extent, this is due to the new context of mass customisation demanded by customers and the need to integrate the entire production network so that it can be enhanced by digital transformation [10,14,16]. In Çınar et al. [21], the authors argue that Logistics 4.0 is one of the four dimensions that should be considered in maturity models related to Industry 4.0 (besides Factory 4.0, Operator 4.0 and Management 4.0), considering the activities of logistics and the management of supply chain.

Several definitions are presented in the literature for the term Logistics 4.0. Two of them are presented here, which in general summarise the others. Barreto et al. [10] define it as the combination of classic logistics with the innovations and applications provided by cyber-physical systems in order to carry out activities conventionally performed by people. This allows employees to work on tasks that are more cognitively demanding. For Winkelhaus and Grosse [16], Logistics 4.0 is a system that supports the development of industry and commerce using digital technologies and sustainably meets customers' individual demands.

Richey et al. [22] believe that the adoption of Logistics 4.0 concepts will enhance the efficiency in operations developed by companies worldwide. Strandhagen et al. [15] argue that the new technologies related to Industry 4.0 will considerably impact the logistical activities of transportation, material handling, inventory management and information flow, integrating the entire supply chain. The same authors cite five examples of impacts that will be observed as a result of the adoption of these technologies: (1) data analysis in real-time to better define the transport route; (2) reduction of storage-related needs due to rapid manufacturing and on-demand production; (3) stock control through robots and autonomous vehicles; (4) exchange of information between companies in a network in real time, allowing greater visibility of supply chain needs; in this way, distortions such as the bullwhip effect (in which a small variation in consumer orders can generate a major disruption in the supply chain) are avoided; (5) more precise and integrated control of information due to intelligent products and cloud data storage.

As seen, there are many plausible gains to be achieved as a result of adopting the concepts of Logistics 4.0. However, it is necessary to have focus, dedication and investments. Szymańska et al. [23] mention that the transition to Logistics 4.0 will require investments and costs can be a major barrier in several places. In addition, for these authors, the robustness of communication systems can also be a barrier to Logistics 4.0.

Barreto et al. [10] claim that there are 5 essential points for the correct development of Logistics 4.0: '(1) Resource Planning, (2) Warehouse Management Systems, (3) Transportation Management Systems, (4) Intelligent Transportation Systems and (5) Information Security'. However, only through the constant evolution of these five points can the benefits of Logistics 4.0 be obtained.

With the use of new technologies, it will be possible to better visualize information and consequently, better estimate the real needs of resources, such as equipment, materials and collaborators. Better resource planning will enable increased productivity and flexibility in supply chains [24]. The incorporation of concepts and intelligent systems linked to Logistics 4.0 will impact different fields of logistics operations, such as handling, storage, distribution and transportation [25].

The greater insertion of technologies in warehouse management will allow for a constant exchange of information among the members of a production chain, thus enabling better coordination of activities. As an example, the adoption of identification sensors based on radio frequency technology (RFID) is mentioned; these allow item tracking and almost instantaneous update of stock positions [10]. This information can be shared among all links in the supply chain and thus provide better quality of customer service [26,27].

The new technologies will also allow transport systems to be more efficient, as there will be greater integration among order management systems, distribution centres and suppliers. According to Timm and Lorig [28], technologies development associated with Logistics 4.0 will provide great integration among the different systems, generating an increasingly intense exchange of information and consequently, more precise decision making. In this way, it will be possible to monitor in real time the movement of products during logistical activities and evaluate mode performance through embedded sensors. Consequently, this will enable better definition of routes, traffic conditions analysis, instantaneous assessment of weight transported by freight vehicles, reduced fuel consumption and minimisation of environmental impacts. The new technologies mentioned are

associated with the concept of intelligent transport systems (ITS), which will enable greater confidence and reliability in transport operations, reducing risks and accidents [10].

Regarding human-machine integration, the implementation of new technologies associated with Logistics 4.0 will allow for greater cooperation or even the replacement of simple activities [29]. Basic, simple and repetitive activities should be replaced by technology, focusing human functions on those of greater intellectual demand, with critical and innovative development [23].

In this context, some punctual examples are presented in the literature. In Silva et al. [13], the authors show a manner for implementing big data in warehouses and emphasizing the benefit possibilities and the challenges of Logistics 4.0 in a specific activity. Focusing on transport digitalization, Pernestål et al. [30] analyse the impact of it on road freight; among the predictions of their research, according to their recycling flows will increase, as well as the "vehicle kilometers travelled" and the level of uncertainties. In addition, considering digitalization in transports, the research of Chen et al. [31] proposes a method to use IoT and the big data created through IoT to minimizing problems related to vehicle routing.

In addition to the application possibilities, it should be highlighted the relevance of companies to invest in information security, known as cyber security. In this context, Tang and Veelenturf [32] present the development of security systems to protect against cyber-attacks as one of the main investment critical points. Furthermore, these authors cite the need for companies' investments and government regulations to ensure the privacy of data collected from people, in order to guarantee public security. The development of solutions linked to the internet and information sharing throughout the entire network via cloud technology will require systems that preserve strategic information of companies and minimise vulnerabilities [10].

In addition, it is interesting to present the research conducted by Deloitte Insights [33] with 1600 executives from 19 countries. The results of this survey indicated that 73% of interviewees were developing some initiative related to Industry 4.0, focusing on improvements in processes and operations. A negative point, however, is that only 6% of them indicated logistics as one of the three main areas that receive technological innovations. Thus, great potential still exists in companies regarding Logistics 4.0 concepts.

2.2. The Logistics Sector in Brazil

The Brazilian logistics sector is an important pillar for the country's economy, employing around 2.5 million people and comprising roughly 195,000 active companies [18]. Activities related to this sector are characterised by the transportation of inputs, machinery, equipment and products consumed by families, representing about 12% of the companies' costs [34].

Brazilian logistics are mostly concentrated in the mode of road transportation, representing 61.1% of total flow, followed by the rail system (20.7%—in developed countries, this number reaches an average of 50%), the waterway network (only 13.6%, despite Brazil having the largest waterway extension in the world), pipeline routes (4.2%) and air transportation (0.4%) [35]. Considering this data, it is evident that there is a great disparity among the modes, largely caused by political investment decisions made in the second half of the twentieth century, which valued road freight transportation mode at the expense of the other modes.

Another point to be mentioned is related to infrastructural deficiencies. A study presented by the National Confederation of Industries [36] shows that Brazil invests only about 2% of GDP in infrastructure, while in other emerging countries this percentage is close to 4%. Moreover, the Global Competitiveness Index, reported by the World Economic Forum [37], shows Brazil in 78th position in the infrastructure pillar, showing great opportunities for improvements. In addition, as emphasized by Yüksel [38], developing countries faces greater challenges to transform their companies towards Industry 4.0.

These deficiencies were even more accentuated due to the COVID-19 pandemic. A study performed by CNT [39] showed that 74.6% of the companies indicate that they had a decrease in their demand, with 69.2% of them claiming difficulties in fulfilling their financial obligations.

3. Methodological Procedures

This study was conducted through six well-defined stages. These stages are presented in Figure 1 and are detailed below.

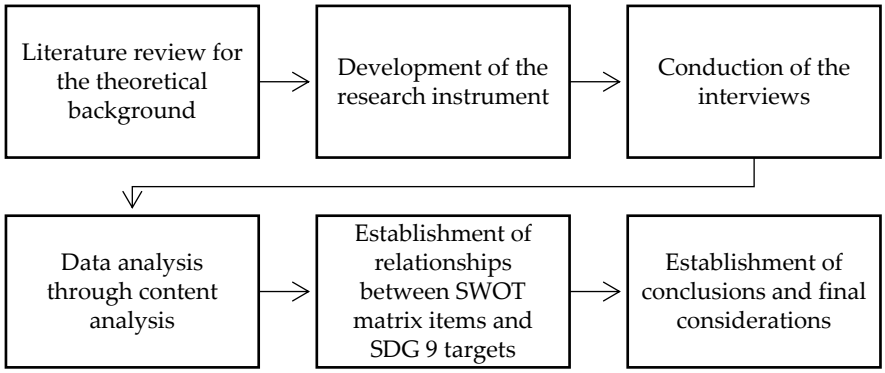

Figure 1. Stages developed to conduct this research (Source: The authors).

The theoretical foundation of the study was established through a literature review conducted in the following scientific bases: Science Direct, Emerald Insight, Springer and Taylor and Francis. In order to better understand the concepts associated with this research, the following key search terms were combined: 'logistics', 'Logistics 4.0', 'logistics operations', 'Industry 4.0', 'challenges' and 'SWOT'. Different studies were identified and subsequently analysed, enabling the establishment of the conceptual basis.

Information about the SWOT matrix was also searched. This matrix was chosen by the authors of this article as a structure for the critical analysis, allowing for better visualisation of the information and easier comparisons among the findings. Furthermore, as it is aimed at generating results for both researchers and market professionals, its use enables greater understanding by different types of readers. Examples of authors who used the SWOT matrix for their research can be mentioned, such as in Rauch et al. [40], Solangi et al. [41], Li et al. [42] and Tavana et al. [43].

The SWOT matrix was developed in the 1960s at Harvard Business School and proved to be an efficient tool for strategic planning processes, allowing for the identification of aspects in the constructs' strengths, weaknesses, opportunities and threats. This tool allows for the recognition of internal qualities and problems, as well as the possible mapping of future situations of opportunities and threats [44]. Silva et al. [45] corroborate with this perspective and reinforce the importance of the SWOT matrix to elaborate more assertive strategies. Table 1 presents a brief definition for each construct of the SWOT matrix.

Table 1. Constructs that compose the SWOT matrix (Source: See table).

Construct	Definition	References
Strengths	Available resources and skills that can be used to explore opportunities and minimise threats.	[46]
Weaknesses	Negative points that can prevent good performance throughout project development. These points must be critically analysed and considered in the planning structure.	[45]
Opportunities	Trends or devices that can contribute, in the present or in the future, to realizing the analysed planning or process. They are able to enhance project success.	[47]
Threats	Situations or phenomena that may hinder the objectives' implementation. They are characterised as events that cannot be controlled, but must be evaluated during planning development.	[45,47]

Based on the theoretical foundation, key issues related to the theme were identified, which allowed for the structuring of a research instrument to be used in interviews with specialists. Seven open questions were developed to create semi-structured interviews. During these interviews, the specialists were able to better explore each subject. The research instrument used in these interviews is shown in Table 2. It should be noted that both the project of this study and the research instrument mentioned were submitted and approved by a research ethics committee, as demanded by Brazilian legislation (Certificate of Ethical Appreciation Presentation (CAAE) number 18829419.1.0000.5405).

Table 2. Research instrument used in the interviews.

#	Question
1	In your opinion, what will be the main impacts of Logistics 4.0 for companies and supply chains?
2	How do you evaluate the adoption of Logistics 4.0 concepts by Brazilian companies?
3	The adoption of Logistics 4.0 concepts requires technological applications of different types. Some of them are presented by Barreto et al. [10] and cited below: "(1) Resource Planning, (2) Warehouse Management Systems, (3) Transportation Management Systems, (4) Intelligent Transportation Systems and (5) Information Security". Based on your experience, evaluate how the Brazilian logistics sector is prepared for these technologies.
4	What will be the biggest difficulties experienced by Brazilian companies in the transition from traditional logistics to Logistics 4.0?
5	Do you believe that the implementation of Logistics 4.0 in Brazilian companies will cause problems related to jobs, due to the difficulty for many workers to qualify at the same pace of technological changes?
6	How will smaller companies operating in the logistics segments need to deal with the changes caused by Logistics 4.0?
7	Based on the information presented and the 4 constructs of a SWOT matrix, point out the Strengths, Weaknesses, Opportunities and Threats of the Brazilian logistics system, considering this new reality.

The third stage of this study was characterised by the interviews. Ten interviews were carried out with experts in the area, who knew the concepts and the technologies related to Logistics 4.0, as well as the current situation in Brazil. The interviews were conducted over the course of five months. Regarding the sample of experts, the high qualifications of these interviewees stand out. Seven of them are doctors, one is a PhD candidate

and one has a master's degree; their theses and dissertations were focused on production engineering, mechanical engineering and logistics and they work or coordinate study laboratories focused on logistics and supply chain, presenting a good knowledge about the logistics operations developed by Brazilian companies. It is also worth mentioning that some of the professionals worked in logistics operations management for large Brazilian companies before working as professors. Finally, it should be noted that one of the interviewees, despite not having a master or doctor degree, has extensive experience in the logistics area; this respondent worked for many years in this sector and has disseminated this experience by giving lectures and publishing books. Table 3 presents more details about the interviewees' profiles.

Table 3. Details about the interviewees' profiles.

#	Profile
R1	Professor at University of Campinas (Unicamp), coordinates a laboratory of research on the logistics area. This respondent presents a good experience in engineering, focusing on transport operations. This expert supervised several master, doctoral and post-doctoral researchers and has several articles published in journals and proceedings in national and international events.
R2	Manager in the logistics area, with great experience in planning, manufacturing and logistics fields. This respondent worked in multinational companies of several profiles, having knowledge about details of their logistics chains. This expert is specialized in Supply Chain Management and strategic management and works as post-graduation professor and lecturer in the logistics area, with published books and articles related to the theme.
R3	Professor at State University of Pará (UEPA), with experience in Logistics Systems, Quality Management and Sustainability. Currently, this expert performs research on sustainable logistics systems, has several articles published in national and international journals and events and a book on Supply Chain Management. Additionally, this expert works as a reviewer for international journals of great relevance.
R4	Professor at Federal University of Paraná (UFPR). This respondent has experience in themes related to Industry 4.0 technologies as applied to operations management, presenting several projects and articles developed on the indicated themes.
R5	Professor at Santa Catarina State University (UDESC). This respondent is currently a PhD candidate at Federal University of Santa Catarina. This expert has published articles relating to the impact of Industry 4.0 on logistics and has participated in several national logistics conventions.
R6	Professor at the Faculty of Technology (FATEC). This respondent has scientific articles published in several national and international journals. His line of research is Industry 4.0, its associated technologies and the consequences of these technologies on Logistics 4.0 and Health 4.0. Provides guidance, in addition to participation and organisation of events focused on logistics management.
R7	Professor at State University of Pará, with a line of research linked to the production and management of supply chains, with projects related to companies in the northern region of Brazil and participation in several national events on logistics.
R8	Professor at Federal University of Itajubá (UNIFEI). This respondent has good professional experience in operations management, developing research related to Industry 4.0. Additionally, this respondent has articles published in important international journals.

R9	Professor at State University of Pará. This respondent has good professional experience, including a history of acting as a consultant in large companies with complex supply networks.
R10	Professor at Federal Rural University of the Amazon (UFRA), studies focused on production, transport and logistics areas. This respondent has several projects focused on logistics developed with companies in the northern region of Brazil.

Once data were collected, they were tabulated for the fourth stage of this research. In this stage, content analysis of the information collected was carried out following the guidelines presented by Elo and Kyngäs [48].

According to Elo and Kyngäs [48], content analysis can be conducted through three phases, namely: (a) preparation phase; (b) organisation phase; (c) analysis process and results reporting. In the 'preparation phase', the mentioned authors (citing Polit and Beck, 2004) argue that the unit of analysis must be defined and that it can be described by a specific word or theme. In this research, the unit of analysis was the theme: 'SWOT analysis of logistics operations developed by Brazilian companies in the context of Logistics 4.0'. As recommended by Elo and Kyngäs [48], during the preparation phase the authors of this article expanded their theoretical knowledge on the subject.

Continuing, Elo and Kyngäs [48] argue that, in the organisation phase, researchers must choose the analysis approach, whether inductive or deductive. The inductive approach is proposed when there are no previous studies on the subject or when existing knowledge is very fragmented. In contrast, deductive analysis is used when proposing an initial knowledge-based analysis structure to test something. Despite understanding that the theme 'Logistics 4.0 in the Brazilian context' is still a subject little explored by academic research, the authors of this article opted for the deductive approach, since a script was structured for better conducting the interviews. Furthermore, the interviewees also evaluated Brazilian logistics operations in relation to the emerging concepts of digital transformation.

The deductive approach is operationalised through three intermediate steps. The first step is the development of a matrix for analysing collected data. Then, these data must be classified according to defined categories and finally, tests and comparisons with previous studies must be carried out. With all the information collected, it was possible to conduct the critical analysis and to structure the SWOT matrix.

The items of SWOT matrix were related with the targets of SDG 9. For this, the targets were adapted to summarize its content and the items presented by the experts in the interviews. The content of these relationships is summarized in a figure.

Finally, in the last phase of the research, conclusions were established and final considerations were presented.

4. Results

This results presentation follows the interview script that was used and converges to the SWOT Matrix that was structured. Discussion accompanies the presentation of the results.

Considering the main impacts of Logistics 4.0 on companies and their supply chain, positive and negative impacts were pointed out. The development of Logistics 4.0 in the Brazilian context will be a huge disruptive transformation, according to most of the interviewed specialists. Technological advances will enable the entire supply chain to be connected and to exchange information in real time, providing greater control over information and improving decision-making. The interviewees also mentioned that it would be possible to provide extremely agile services, according to specific customer needs (customisation). Full traceability will also become significant, since the orders' real-time status will be available throughout the entire logistical flow.

In addition, the interviewees believe that the adoption of Logistics 4.0 will also enhance opportunities in identification and will provide better commercial demand forecasts, increasing companies' flexibility. Both views lead to actions that will provide an increase in activity efficiency, enabling the execution of more optimised processes, greater efficiency in storage operations. An example cited by the interviewees is a significant reduction in the 'bullwhip effect'. It will be possible to have greater cost control and a provision of services with more competitive prices. In short, these aspects will make it possible to improve the service levels provided to customers and offer a more enriching and captivating experience, directly focused on customers' specific requirements.

Nevertheless, the negative impacts were also cited. The first one to be mentioned is related to the great difficulty for companies to adapt the current process to the new technological processes necessary for Logistics 4.0, greatly due to associated costs with the change. The second negative impact is linked to the dependence that the logistics chain will have on technology, since any disturbance or failure that impacts its functioning may cause problems to the logistics flow. Finally, regarding additional demand for energy caused by new telecommunications infrastructure, the dependence on telecommunications may create interruptions within logistics network originated by blackouts.

Considering the scenario presented above, the interviewees in general believe that the adoption of the Logistics 4.0 concepts will be characterised as an arduous task by most Brazilian companies, since most of them are still taking their first steps in this transformation process. A significant number of the interviewees argued that large companies, which have greater financial capacity to apply these new technologies, lead in this process. However, the interviewee felt that, initially, the adopted technologies will not require significant changes to existing operations.

Considering the technological applications mentioned by Barreto et al. [10] as essential to the Logistics 4.0 applications, 'Resource Planning Systems' and 'Information Security Systems' stood out in the answers as being the most observed systems in Brazilian companies that develop logistics operations. This, however, does not mean that there are no opportunities for improvements. Most of the interviewees highlighted that Brazilian companies need to have robust information security systems, which enable safe and reliable information exchange in the Logistics 4.0 context, avoiding exposure of strategic or private information. Some of the interviewees mentioned that industry executives in general only start to value these systems after problems occurred.

Regarding 'Warehouse Management Systems', the interviewees in general envision a high potential for their use in the Logistics 4.0 context. Additionally, the fact that a significant portion of Brazilian companies use warehouse management systems when developing storage operations means that they are useful. Nevertheless, their use is still at a beginning level with regards to the existing functionalities of these systems. The high implementation cost and the difficulty in obtaining credit were also mentioned by some interviewees as obstacles to the further expansion of this technology.

Finally, 'Intelligent Transportation Systems' were mentioned as those that present the lowest degree of application in Brazilian companies, considering the mentioned systems. The used versions of these systems are simplistic and do not explore the systems' full potential. Transports Management Systems require great information exchange between the company and the modes in the external environment, causing the dependency of the telecommunications infrastructure. According to most interviewees, the Brazilian telecommunications infrastructure is not homogeneous in country regions and is one of the main barriers to the adoption of Transports Management Systems. In addition, they also believe that this concept is not well known by many logistics managers.

Evolving through data analysis, it was possible to synthesise the main difficulties that might be experienced by Brazilian companies in the transition from traditional logistics to Logistics 4.0. These difficulties were grouped into four main points, which are: High cost related to new technology implementation and existing process adaptation. The low

technological development in Brazil enhanced this aspect, since most of the equipment is imported, which generates additional costs when compared to national production.

Brazilian executive culture that, in general, does not understand logistics as a strategic area. In addition, there are managers who still fear the adoption of major structural changes and also present few planning strategies, focusing on short-term actions.

Infrastructure disparity in Brazilian territory. One of the main characteristics of Logistics 4.0 is related to the intense information exchange and the great integration among different components of the logistics chain. For this, as a starting point, a robust infrastructure is required to ensure great performance in different types of logistics modes, including robustness in terms of energy and telecommunications infrastructure. These aspects will enable continuity of operations and information integrity. As previously mentioned, Brazil still presents great disparity in terms of infrastructure, with regions showing serious deficiencies.

The low qualifications of the current Logistics workforce, when considering the tasks required for the adoption of new technologies. To make the transition to Logistics 4.0, companies will also have to make available technical training for their staff to ensure that their employees will be able to operate these new technologies.

Considering human factors in the Logistics 4.0 context, interviewees envisioned two possibilities: first, a transitional stage, in which an operator is supported by a technological device to enable an increase in productivity and in a later phase, technological devices will replace employees in some tasks. The fact is that most interviewees believe that there will be a reduction in job opportunities, mainly for basic, simple and repetitive activities. Facing this reality, employees associated with the aforementioned tasks should be reallocated to more complex tasks linked to critical and innovative development, requiring personal and professional improvements. However, the interviewees believe that the training and development of employees will not always be at the same speed as technological changes. Furthermore, in general, Brazilian society considers the substitution of manual jobs by these new technologies to be a negative aspect.

Analysing the perspective of small companies that operate in logistics activities, two different viewpoints were presented by the interviewees regarding the transformation generated by Logistics 4.0. As already mentioned, a significant number of the interviewees argue that large companies will present a greater capacity to implement technologies and therefore smaller companies will experience problems in terms of competitiveness. In contrast, some interviewees mentioned that small yet innovative companies could take the lead in this transformation, due to their leaner and more flexible structure, which allows for the adoption of disruptive solutions in Logistics 4.0 context.

Questions 1 to 6 allowed for the collection of relevant information to critically analyse the logistical operations developed by Brazilian companies, as presented. Question 7, in turn, directly focused on the four constructs of the SWOT matrix. It should be noted that when asked about each field, interviewees presented some new information, in addition to reinforcing some points already presented in the previous questions. Thus, the SWOT matrix, presented in Table 3, includes information from the entire data collection process.

An example of new information mentioned was the highlight of logistical operations in relation to agribusiness. Given the level of experience in this segment in Brazil, the interviewees argue that this is a strong point and an opportunity for the country to become a leader in the development of technological solutions focused on this segment.

Another important fact mentioned by the interviewees and highlighted here refers to the fact that Brazil's geography enables the use and development of different logistical modalities. This creates the possibility of integrating different modes that can optimise logistics operations. Despite this possibility, the interviewees highlighted the low transport modes diversification that exists in Brazil, with a high concentration in road transportation and underutilization of modes such as waterway and rail.

The amount of bureaucracy that exists for companies operating in the country, the unstable regulation and the current political and economic instability were also mentioned. The union of these points creates uncertainties that preclude new investments. Regarding Brazil's industrial parks, the interviewees believe that they still present a low development level when compared to other countries and this is characterised as a weakness. Associated with intense foreign competition, these aspects generate a disadvantage for Brazilian logistics operations. Broadly speaking, technologies for Logistics 4.0 are better developed in other countries currently.

Finally, the interviewees mentioned that despite Logistics 4.0 being characterised as an arduous task, the transition from traditional to digital logistical is essential. In addition, providing greater agility in processes and allowing an easier definition of strategic directions, society increasingly seeks agile, specialised and customised services and this is an opportunity that cannot be missed.

Through all this information collected, the authors of this article were able to structure the SWOT matrix related to the logistics operations developed by Brazilian companies in the Logistics 4.0 context, as presented in Table 4.

Table 4. SWOT Matrix for logistics operations developed by Brazilian companies in the Logistics 4.0 context (Source: The authors).

Strengths
1. Highlight of logistical operations related to the agribusiness segment (S1).
2. Brazilian geography that allows the use of different transport modes (S2).
3. Information availability, even if not in electronic form, which allows critical analyses about logistics systems and agility in decision-making (S3).
Weaknesses
1. Brazilian executive culture that does not focus on planning, but on emergency short-term actions; and which is also averse to changes. In addition, logistics is often seen as a non-strategic area (W1).
2. Imbalance in the use of existing transport modes. Even though the Brazilian logistics system provides different options, most of the operations are concentrated in road transportation. Waterways have unexploited capacity (W2).
3. Low technological level applied in logistics operations; consequently, a high investment level will be demanded (W3).
4. Infrastructure heterogeneity due to different levels of technology adoption and territorial extension, which makes the integration in Brazilian logistics system more difficult. In addition, basic governmental infrastructure has ample possibilities for improvements, often preventing greater potentialisation in the use of different modes (W4).
5. Companies that operate in logistical activities have difficulty in obtaining credit for improvements and/or technologies implementation (W5).
6. When existing, low reliability of data transmission services and network security (W6).
7. Small number of companies dedicated to the development of technologies focused on Logistics 4.0 when compared to other countries (W7).
8. Low industrial development that, consequently, would make the adoption of Logistics 4.0 difficult (W8).
9. Low qualification of employees, considering the skills required for Logistics 4.0 (W9).
Opportunities
1. Increasing demands from society for agile and specialised services, including customisation and traceability, which can be enhanced by Logistics 4.0 (O1).

2. Using the advantage of the digitalisation of operations, companies will be able to increasingly integrate the entire production network and enhance their competitiveness through the identification of activities that do not increase value to the customer. Consequently, results can be improved (O2).
3. Potential to become a leader in technological solutions development for specific segments, e.g., in logistical activities of the agribusiness chain (O3).
Threats
1. Significant foreign competition, both with companies that develop technologies associated with Logistics 4.0 and with companies that develop logistics operations (T1).
2. Political, social and economic instability that can preclude long-term investments, which are necessary for Logistics 4.0 implementation (T2).
3. In general, Brazilian society considers the elimination of jobs due to new technology adoption as a negative aspect (T3).
4. Bureaucracy, a high tax burden and unstable government regulation, which can hinder the necessary changes for Logistics 4.0 implementation (T4).

5. Discussion

Analysing the literature, it is possible to verify several convergence points with the presented findings. First, it should be mentioned that there is a greater level of information exchange, emphasized by the specialists for Brazil in the context of Logistics 4.0. This great information exchange, as presented by Timm and Lorig [28] in their study about the impacts of new technologies on global logistics, will allow for quick and assertive decisions, thereby reducing logistics processing time. It is worth mentioning the considerations made by Richey et al. [22]; for these authors, data analysis and the information provided by logistics chains will increase efficiency in operations in several countries. In relation to the greater service level enabled by Logistics 4.0 related technologies, the experts highlighted it as an opportunity for Brazil. Richey et al. [22] argue that this will also occur globally.

Despite the beneficial possibilities provided by Logistics 4.0, there are several negative impacts to be considered. Among these impacts, the experts mentioned the costs associated with the transition towards this new reality. It is worth mentioning that the costs related to the transition to Logistics 4.0 is widely mentioned in the study of Szymańska et al. [23]. In addition, the greater need for a proper energy and telecommunications infrastructure is another focus of attention mentioned during the interviews. This need for greater robustness in communication systems for Logistics 4.0 is widely mentioned by Szymańska et al. [23].

Another relevant focus of attention is information security. The high level of information exchange in the Logistics 4.0 context will require that Brazilian companies improve their information security systems, as mentioned by the experts. However, it is important to mention that this is not an issue to be addressed only by organisations in Brazil. The importance of the robustness of information security systems for companies worldwide is referred to by Tang and Veelenturf [32].

For employees, the debates presented by the interviewees regarding the replacement of employees by technology are not restricted to the situation in Brazil. Cimini et al. [29] also address this issue in their study. The fact is that most interviewees believe that there will be a reduction in job opportunities, mainly for basic, simple and repetitive activities. Szymańska et al. [23] corroborates this fact in a broad manner. Facing this reality, employees associated with the aforementioned tasks should be reallocated to more complex tasks linked to critical and innovative development, requiring personal and professional improvements. However, the interviewees believe that the improvement, recycling and training of employees will not always be at the same speed as technological changes. Furthermore, in general, the substitution of manual jobs by these new technologies is considered a negative aspect by Brazilian society.

Considering the findings of this study, it is possible to verify similarities and differences that Brazil presents in relation to other contexts, which emphasises the relevance of regional studies to consider these specificities. The low qualification of the workforce and the deficiencies related to infrastructure can be mentioned as examples of challenges that will be singular for the situation in Brazil. The geography features and expertise in agribusiness are instead positive aspects specific to Brazil. In this sense, the contribution of a SWOT matrix to organise collected information and provide an overview of the current reality for Brazilian Logistics 4.0 may be useful for researchers and market professionals.

Relationships between SWOT Matrix and the Targets of SDG 9

When the items presented in the SWOT matrix are analysed, it is possible to establish several relationships between them and the targets of SDG 9. For this, the targets of SDG 9 were considered and adapted to be related with SWOT matrix items regarding the Brazilian reality for Logistics 4.0. These adapted targets are presented in Table 5.

Table 5. Adapted targets of SDG 9. Source: Adapted from [17].

Code	Description
AT_1	Develop a reliable, resilient and sustainable infrastructure, including regional aspects, that can support economic development and people's well-being (Adapted from Target 9.1)
AT_2	Promote an inclusive and sustainable industrialization, in line with increased employment and economic growth, including the encouragement of smaller companies through different mechanisms such as access to credit (Adapted from Target 9.2 and 9.3)
AT_3	Update and improve industrial infrastructure towards a resilient and sustainable infrastructure, providing for this financial, technical and technological support (Adapted from Target 9.4 and 9.a)
AT_4	Encourage scientific research for technological updating in different industrial sectors (Adapted from Target 9.5)
AT_5	Stimulate domestic technological development and the development of research and innovations in different industrial areas, including adding value to commodities (Adapted from Target 9.b)
AT_6	Increase the access to information and communication technologies, as well as universal access to the internet (Adapted from Target 9.c)

The strengths presented in the SWOT matrix can be used as drivers in the search for achieving some of these targets. The S1 highlights the role of logistical operations to the agribusiness sector in Brazil; in the scenario of Logistics 4.0, can contribute to the need of creating value for commodities (AT_5). The possibility of using different transport modes due to the Brazilian territory feature (S2), can positively contribute for achieving AT_1 and AT_2, since the technologies related to the Industry 4.0 combined with an adequate infrastructure can enable Brazil to have productive efficiency gains in several sectors; at the same time, it would contribute for jobs creation and economic growth.

When the weakness items are analysed, it is possible to observe that Brazil present important issues to be addressed. The short-term mentality of executives in Brazil (W1) can directly affect AT_1 and AT_3. Since companies are focusing on the short-term, they are not capable of requesting from the government long-term initiatives to improve country's infrastructure. The imbalance of transport modes (W2) is another weakness related to the same targets (AT_1 and AT_3); to minimize it, the Brazilian government must develop an adequate infrastructure and incentive companies to use alternative modes of transportation.

The weakness regarding the low application of technologies in logistics operations in Brazil and the consequent need of high levels of investments (W3) can be directly related to the adapted targets AT_4, AT_5 and AT_6. To address these targets, the Brazilian government must invest on technologies related to the digital transformation to develop the logistics system in the country. It should be highlighted that this kind of investment would be beneficial to the target AT_2, since it would create employment, economic growth and could be helpful for smaller companies.

Regarding the infrastructure heterogeneity that hinders logistics system integration (W4) and the data transmission services and network security low reliability (W6), both weakness are directly related to the targets AT_1, AT_3 and AT_6. Several regions of Brazil still need basic infrastructures to enable the mentioned integration, especially when the technologies related to Industry 4.0 are considered.

The lack of access to credit for technologies improvements and/or implementation by several companies that develop logistical activities (W5) is linked with AT_1, AT_2 and AT_3. In Brazil, the access of low-cost credit is scarce, despite its relevance to the economy.

The weakness related to the lack of companies developing Logistics 4.0 related technologies can be linked with the target AT_2, since, with smaller companies are stimulated, they can greatly contribute to job creation and economic growth. The low industrial development (W8) is also related with this target as well as the target AT_3 since when it is considered the current level of technologies adoption in logistics sector, the transition to Logistics 4.0 will not be fast. The low qualification of workers for Logistics 4.0 requirements is connected with AT_2 too. If the Brazilian government develop initiatives to qualify the workforce, the digital transformation can be a more inclusive process.

Considering the opportunities identified in this research, the targets AT_1, AT_2, AT_3 and AT_5 can be highlighted. AT_1 and AT_2 are in the same line of reasoning of the demands from society for logistics services improvements (O1). AT_2, AT_3 and AT_5 are aligned with the production network integration and competitiveness increase (O2). The target AT_5 is also related to the potential that the country has to lead specific segments such as logistical activities of the agribusiness chain (O3).

Regarding the threats, while the fear related to jobs elimination due to new technologies is related to AT_2, requesting that the government acts to minimize or eliminate this threat through workers qualification and policies focused on economic growth; the threats T2 and T3 are clearly connected with all the adapted targets presented because of their amplitude.

The Figure 2 summarizes all the presented relationships.

	SWOT Matrix Items																		
Adapted Targets (AT)	#	S1	S2	S3	W1	W2	W3	W4	W5	W6	W7	W8	W9	O1	O2	O3	T1	T2	T3	T4
	AT_1		+		-	-		-	-	-				+				-		-
	AT_2		+						-		-	-	-	+	+			-	-	-
	AT_3				-	-		-	-	-		-			+			-		-
	AT_4						-											-		-
	AT_5	+					-								+	+		-		-
	AT_6						-	-		-								-		-

Figure 2. Relationships between SWOT matrix items and the adapted targets from SDG 9. Note: The positive and negative signs represent positive and negative relationships between SWOT items and the adapted targets, respectively.

6. Conclusions and Final Considerations

Considering the relevance of the logistics sector in Brazil, the eminence of the Logistics 4.0 context and the lack of studies that investigate both themes in the literature, the main objective of this research was characterised by the critical analysis of logistics operations developed by Brazilian companies in the Logistics 4.0 context and the structuring of a SWOT Matrix. For this, ten experts in the field were interviewed and collected data were analysed using the content analysis technique, following the guidelines proposed by Elo and Kyngäs [48]. Based on the presented results, it is possible to state that the main objective has been achieved.

The conclusion that can be drawn from this study is that Brazilian companies, in general, will face significant barriers to achieving the benefits related to the adoption of Logistics 4.0, some with an economic/organisational character and others due to an uneven governmental infrastructure among Brazilian regions. The authors of the present article believe that the transition to the digital revolution will be inevitable and the sooner government and companies act in this direction, the consequences related to competitive loss for Brazilian companies will be more effectively mitigated. The information presented here can be useful for professionals of this area who are interested in the implementation of new technologies in logistics operations, for researchers interested in the subject and for government managers when defining industrial policies.

The study offers two main contributions to the literature. First, it is one of the few studies that holistically examined the sector in Brazil under a Logistics 4.0 perspective. Second, the study points to preconditions (e.g., qualification of personnel) that should be addressed for the implementation of Logistics 4.0. Furthermore, as the Brazilian logistics sector is suffering from the impacts of COVID-19, this study may provide useful insights related to the steps needed to support recovery efforts.

The main limitation of this study lies in the number of experts consulted, since a larger sample could provide greater robustness to the analysis. However, the interviewees' qualifications stand out, since they present solid academic training, participate or coordinate logistics research laboratories and have the required knowhow and industry track record to act as experts in the study. In addition, the focus on Logistics 4.0-related technologies in a general level should also be presented as a research limitation. Nevertheless, the current level of Logistics 4.0 in Brazil and the magnitude of difficulties that they face justifies the presented scope.

As a proposal for future studies, the authors recommend investigating aspects mentioned in this article with greater depth, such as the professional qualification and improvement process directed to the employees in the sector. Additionally, the development of a study that provide guidelines for companies in updating security information systems throughout their supply chain, due to the relevance of security threats highlighted in the findings presented in the paper, would be pertinent.

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