ISSN 2237-8960 (Online)

RESEARCH PAPER

Ship-from-store omnichannel using a 4pl digital platform

Nicollas Luiz Schweitzer de Souza[1], Marcos Tadeu Arante[2], Ícaro Romolo Sousa Agostino[1], Lynceo Falavigna Braghirolli[1], Marina Meireles Pereira Mafia[3], Enzo Morosini Frazzon[1]

[1]Federal University of Santa Catarina (UFSC), Florianópolis, SC, Brazil.
[2]Equilibrium tecnologia, Brazil.
[3]University of Southern Denmark (SDU), Sønderborg, Denmark.

How to cite: Souza et al. (2024), "Ship-from-store omnichannel using a 4pl digital platform", *Brazilian Journal of Operations and Production Management*, Vol. 21, No. 2, e20241856. https://doi.org/10.14488/BJOPM.1856.2024

ABSTRACT

Goal: This research aimed to simulate a ship-from-store operation process from an omnichannel retailer. Based on this we proposed a conceptual model orchestrated through a 4PL. Through the results evaluated by performance indicators in the simulation, computational results of using the approach in a real case can be added to decision-making and the literature.

Design / Methodology / Approach: This paper comprises the collection of sales and logistics data from a retailer for developing a computer simulation using R programming language, so that the ship-from-store strategy is evaluated. Data from an omnichannel retailer supported the development of two scenarios: the first represent retailer's current praxis; in the second, the logistics orchestration model is applied. The analysis considers two performance indicators: freight price and freight time.

Results: The results demonstrate that after adopting the ship-from-store strategy the omnichannel retailer can reduce the freight price by up to 60%. Regarding the delivery time, a reduction of up to 8 days is envisioned. These reductions positively impact the customer experience in the online channel, increasing its attractiveness.

Limitations of the investigation: The limitations of the research are based on a logistics orchestration model for a retailer that is omnichannel and has several stores within its national territory with stock. This stock is sufficient to implement a ship-from-store process in this retailer.

Practical implications: This retailer, by applying the method, is able to achieve better customer rewards. In the same way, it manages to make the online channel more attractive at the lowest cost and in the shortest time. This retailer is also able to use new technological resources through a 4PL. This serves as a technological tool for the logistics orchestration operation.

Originality / Value: An original computer simulation for a 4PL digital platform orchestrating the ship-from-store strategy in omnichannel retailing is presented.

Keywords: Omnichannel; 4PL; Digital Logistics; Ship-from-store; Last Mile.

1 INTRODUCTION

Omnichannel retailers are using the present technologies resulting from globalization to be able to grow in terms of sales and optimize their operations (Jones et al., 2021; Kembro and Norrman, 2021). These technologies mature the omnichannel process, which means the

Financial support: None.
Conflict of interest: The authors have no conflict of interest to declare.
Corresponding author: nicollas_schweitzer@hotmail.com
Received: 09 May 2023.
Accepted: 15 May 2024.
Editor: Osvaldo Luiz Gonsalves Quelhas.

integration of different sales channels for the consumer to have the best shopping experience (Cai and Lo, 2020; Jin et al., 2020; Yang and Zhang, 2020).

Customers today want products to be available anywhere, anytime, and at the lowest possible price (Gao and Su, 2017; Lu et al., 2020). They evaluate all the potential pros and cons of each shopping channel to get the best deals ever, which increases the competitiveness among retailers, making them think of better strategies (Bayram and Cesaret, 2020; Stradioto Neto et al., 2020).

The retailers need to ship their products from the closest stores of customers for cost reduction (Aktas et al., 2020). Thus, adding the integration of offline and online processes, the concept of ship-from-store emerges, with the need to also improve the customer experience in the last mile process (Li, 2020; Pereira et al., 2020).

Through the adoption of ship-from-store, Xiaomi increased sales in the year 2017 in the first quarter by 70% and a Chinese snack retailer delivered an order in just 11 minutes (He et al., 2021). Zara was able to perform the delivery in two hours (Yang and Zhang, 2020). Thus, it is essential to have an information system integrated with these inventories to constantly forecast online purchases, estimate cost parameters, and monitor available store levels to be able to realize delivery (Souza, 2022). However, in Bayram and Cesaret (2020), the ship-from-store can damage the retailer's profit when its implementation is done in an imprudent way, which means without using technologies available today to better integrate the resources, that is, digital resources are a must.

Optimization of resources in the last mile becomes a strategic factor (Buldeo Rai et al., 2019). Considering that the logistic experience of an online consumer is directly related to this (Chen et al., 2021; Salvietti et al., 2022). In addition, online sales are currently increasing significantly (Brandao et al., 2021; Mrutzek-Hartmann et al., 2022). Therefore, new technologies, as well as express delivery strategies are required by online customers, as better price freight and delivery time are a differential in the shopping decision (Lu et al., 2020; Eriksson et al., 2022). Thus, retailers join the use of ship-from-store to positively impact the last mile (Seghezzi et al., 2021).

In this way, the customer strategically evaluates and chooses a purchase channel that optimizes its rewards; therefore, the ship-from-store can help when it comes to delivery time and freight price for the consumer, making the online sales channels more attractive and more economical for the company (Gencer and Akkucuk, 2020; Mishra et al., 2022).

Strategically to achieve logistics orchestration of omnichannel processes in the ship-from-store context modern supply chains are moving towards using 4PL (fourth-party logistics) services on platforms (Gao and Su, 2017; Souza et al., 2019). A 4PL combine innovative technology, resource and optimization solutions to perform the logistics orchestration of a retailer (Cezanne and Saglietto, 2015; Souza et al., 2020). A 4PL when integrated with other logistics operators can offer the retailer different transport possibilities, such as express delivery strategies to the customers, adding value to the last mile process and reducing delivery times and freight prices (Huang et al., 2021).

In this context, this research addresses the gap in the lack of research that assesses the benefits of logistics orchestration through a solution in 4PL platform in omnichannel retail with a ship-from-store strategy. The research question of this paper is to evaluate the gains of ship-from-store adoption in an omnichannel retailer through two key performance indicators, as well as the benefits of a logistical orchestration. The use of simulations can anticipate scenarios before a decision is made, thus we seek to add to the literature by using simulation in the context of omnichannel retailing. The retailers present in this context can obtain more data and indicators for their decision-making when adopting the ship-from-store process. This makes great use of this paper, as it seeks to address the concept of ship-from-store. The results obtained in this paper, are fundamental in helping the practical decision-making process and adding knowledge to the literature.

This research is organized by section. In this section, we introduce the topic and present the research question of this paper. In the next section, we look at related research and its contributions to this research. In section 3 we have the proposed approach, which describes the structure and the computer simulation applied. In section 4, we present the results and discuss them. Finally, section 5 concludes the paper.

2 RELATED WORK AND CONTRIBUTION

Omnichannel is defined as the integration of customer touchpoints during a sales process (Bayram and Cesaret, 2020; Pereira and Frazzon, 2019; Rai et al., 2019). An omnichannel has a plenty of data that, if treated, can be used to better personalize the customer experiences (Arslan et al., 2020; Yang and Zhang, 2020). Although omnichannel increases the sales of retailers, it also creates huge logistical and technological difficulties that they often can't solve (Weber and

Badenhorst-Weiss, 2018). Therefore, the necessity of an actor in this chain to perform the logistics orchestration is essential, allowing only the strategic decisions to be made by the retailer (Lim et al., 2018). This actor could be nominated as a 4PL, offering technological resources for logistical orchestration, thus managing to be integrated with all the actors of the chain (Fu et al., 2018). There is a trend in the omnichannel retail process that is the outsourcing of the logistics process to a 4PL, bringing competitive advantage to the retailer and adding value in the process to the consumer, being one of the attributes real-time tracking during the whole process (Çağlar Kalkan and Aydın, 2020; Lim et al., 2018; Lim and Srai, 2018).

A 4PL is a supply chain actor that brings together its own and other actors' resources, capabilities, and technologies to design, build, and execute logistics solutions (Fu et al., 2018; Mikl et al., 2020; Prashar, 2020; Premkumar et al., 2020). New logistics providers present as solvers for these new businesses can positively impact the value chain (Mikl et al., 2020). The 4PL uses technological resources and is the most prepared to fill the gaps that online sales can bring to the logistics process (Levina and Razumova, 2019).

In many cases the retailer does not have the know-how to integrate with different logistics operators or evolve in terms of technology to absorb new needs that the omnichannel context requires (Buldeo Rai et al., 2019, 2021; Rai et al., 2018, 2019). For an omnichannel process to work, it requires an offline integration with the online, automatically requiring a redesign of the supply chain (Brandao et al., 2021; Jones et al., 2021). These solutions are being developed as a platform since they can be accessed online from anywhere, having more convenience for management (Qian et al., 2018). Solutions like these in the platform range from the cargo routing process, such as integration with retailers and logistics operators, to the collection of consumer feedback after the order is delivered (Prashar, 2020; Premkumar et al., 2020; Souza et al., 2022).

Research from Rai et al. (2018) shows that 45% of consumers abandon their shopping carts due to poor delivery options, and 87% of them would buy again if they had a positive shopping experience. Thus, strategies that aim to reduce freight prices are necessary, such as ship-from-store. In the past, stores were the end of the supply process. Now, these stores also need to ship products to other stores or to customers, this process is called ship-from-store (Arslan et al., 2020; Bayram and Cesaret, 2020; Cordón et al., 2017; Weber and Badenhorst-Weiss, 2018). This allows a product to be shipped from more than one store to the consumer's address, reducing the shipping price and the shipping time to the customer (Buldeo Rai et al., 2019; Li, 2020; Rai et al., 2019).

By considering the inventory available in stores, orders start to arrive faster at the customer's home, providing an attractiveness to the digital channel and positively impacting the retailer's financial margins (Bayram and Cesaret, 2020). This process is extremely important in the omnichannel context because customers are increasingly attentive to the delivery time and freight price, i.e., they increasingly seek the best possible experience compared to other retailers for their purchase (Cordón et al., 2017). For Bayram and Cesaret (2020) when a ship-from-store process is implemented in an imprudent way without performing scenario simulations considering several variables, it may harm the retailer's profit. For this, it is necessary to have an orchestrator in the process that directs the orders and considers the inventory in an online and dynamic way (Arslan et al., 2020; Bayram and Cesaret, 2020; Cordón et al., 2017).

The implementation of a ship-from-store process without establishing a rigorous technological integration with the stores' stocks is imprudent (Cordón et al., 2017). Therefore, it can negatively impact the customer, since there may be a lack of stock to fulfill his order, not fulfilling the initial delivery time established, as well as having the damage of having to ship the product from another store to the customer (Rai et al., 2019). Thus, not adding value to the customer experience. The ship-from-store acts to add value to the consumer's experience, in a way that new delivery strategies can be established, such as express deliveries, for example (Arslan et al., 2020). Once the ship-from-store is implemented, last mile strategies can be created and implemented (Lim and Winkenbach, 2019). In addition, new carriers can be contracted for service (Castillo et al., 2018). Thus, new scenarios of ship-from-store implementation for different types of retailers should be studied (Lim et al., 2018). The use of computer simulation strengthens these studies, since it anticipates the application of a new scenario to validate the thesis (Souza, 2022).

Last mile logistics is the most expensive step in a business-to-consumer (B2C) logistics process (Weber and Badenhorst-Weiss, 2018). With the increase of online shopping, the last mile process grows every day (Lim and Srai, 2018; Lim and Winkenbach, 2019; Rai et al., 2019). Shipping the product from a location far away from the consumer can increase the cost to the retailer by 5 to 23 times (Buldeo Rai et al., 2019). Thus, the match of ship-from-store strategies with platform solutions integrated with logistics operators can be a positive point for retailers (Yang and Zhang, 2020).

The Brazilian last mile scenario is complex (Assis et al., 2022; Sa et al., 2022; Zeimpekis et al.,

2022) because there are long distances to be traveled between Brazilian states when only one distribution center is used (Mesquita et al., 2022). Thus, a retailer that does not have stores in each Brazilian state and the ship-from-store strategy implemented, needs to use other transportation strategies to try to promote express delivery to the customer. Often these alternatives may be beyond the retailer's control and costly to the business (Silva et al., 2022). Very few studies are present in the literature regarding the possible gains from the application of ship-from-store in the Brazilian scenario with real cases. Measuring these gains through a computer simulation resource favors decision making and makes potential gains tangible (Souza, 2022).

In the last mile, new concepts are being used such as independent drivers to make the deliveries and therefore gets a lower cost and a fast time to deliver orders to the consumer (Castillo et al., 2018). The use of vehicle sharing in the last mile process can reduce the distribution cost up to 44%, as well as 22% of the delivery distance traveled. With optimized routes and 63% of the annual routes are reduced (Aktas et al., 2020). Impacting not only costs but environmental issues and improving the consumer experience, with ever-faster delivery strategies (Aktas et al., 2020; Souza et al., 2023; Castillo et al., 2018).

In this section we may consider some factors as contributing to the research. Such as: targeting the 4PL as the potential logistics orchestrator that unites technology and the resources needed to orchestrate the logistics process in omnichannel retail. Also, the use of ship-from-store when possible for the retailer becomes totally recommendable and needs to be studied. The customer wants products with the lowest delivery costs and the shortest delivery times. Another important factor highlighted here in the literature is the use of computer simulation so that we can evaluate these gains and this impact on the retailer. These points are being studied here in the literature and these correlations favor the direction of this research.

3 PROPOSED APPROACH

3.1 Structure of a conceptual model for the 4PL platform operation

This research aimed to simulate a ship-from-store operation process from an omnichannel retailer based in Souza et al. (2023). Based on this we proposed a conceptual model orchestrated through a 4PL. The orchestration will be done through a platform solution for the retailer's logistics processes.

Initially the retailer's customer will make the purchase through the retailer's online channel, that is, with one of the omnichannel sales possibilities. At the moment the customer is having his buying experience, or rather, making freight quotes in one of these channels, the 4PL, which is connected to the logistics operators as well as to the retailer's sales channels, will present to the customer the best freight offers, whether faster or cheaper, according to the retailer's strategy decision to present in the sales process.

Thus, we consider that the 4PL is performing the connection with the carriers, as well as with the retailer, and tied to the ship-from-store process, it can perform the quotation of the closest store to the customer with a large number of carriers, resulting in different freight options for delivery of the order to the customer of this retailer. This personalizes the consumer's experience, in terms of the process of choosing the best transport.

When the customer selects the best choice for the order in the purchasing process, the connection between the retailer and the carriers is still via the 4PL. That is, via integration it triggers the carriers selected for the order so that they can perform the pickup at the given origins and delivery to the customer. This with real time location control, by the customer as well as by the retailer. Once there is a customer support team handling the failures and successes of deliveries.

Considering also the delivery completion process, every customer feedback collection is important. Since this can be translated into a better customer experience. 4PL is then in charge of this management as well. Additionally, this operation is described in Figure 1. This operational description is based on the contributions of the literature presented in this paper, as well as on the evidence of the use of the ship-from-store process.

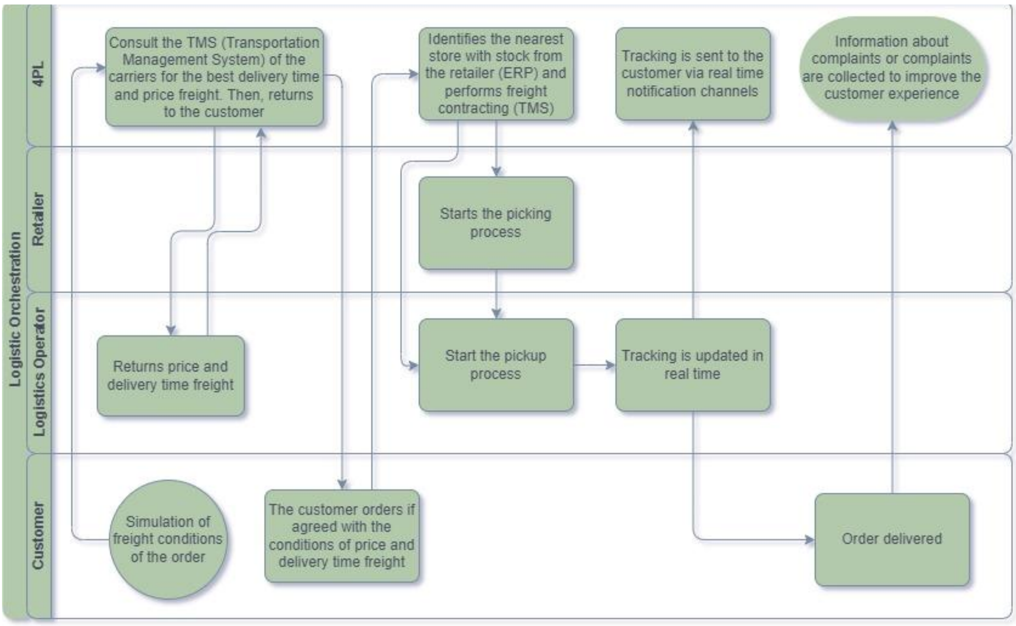

Figure 1 - Structure of a conceptual model for operation through a 4PL platform (self-elaboration)

With a solution in an online platform and connected to all the players in this logistics process, strategic decisions can be made in a faster and more dynamic way, such as enabling or disabling a carrier that does not meet its deadlines, generating discounts or promotions, blocking deliveries, or any other need to attribute value to the consumer's experience.

3.2 Computational Simulation

3.2.1 Use case description (scenario 1)

This paper studies a large Brazilian retailer that has more than 150 stores throughout Brazil and does not use the ship-from-store concept. The data used in the test case is from a Brazilian company that operates in omnichannel retail and has several stores throughout the country. Currently, this retailer uses the omnichannel strategy, but does not consider its stores as shipping points, in other words, the retailer does not adopt ship-from-store. In other words, the shipping of its products departs from only one shipping point, which is presented in Figure 2 as a Distribution Center located in the south of Brazil.

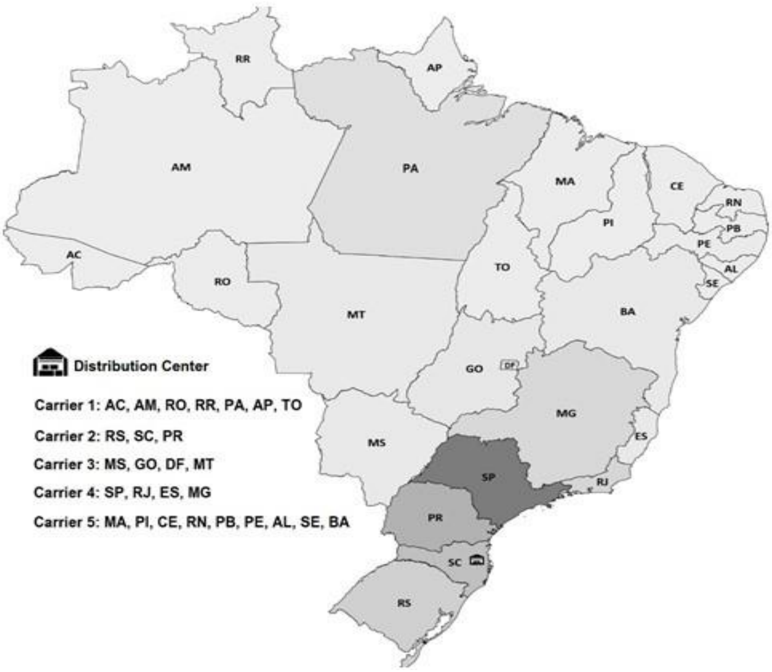

Figure 2 - Scenario 1 (self-elaboration)

This retailer currently has contracts with 5 carriers, each of which delivers to a specific region in Brazil. These carriers are presented in Figure 2 according to their UF of service. Thus, the freight price and delivery time are already established and standardized with each carrier, and there is no freight quotation process with other carriers that may be attending the order for a lower price freight or delivery time.

Additional retailer information for understanding the scenario was collected, such as the products sold by this retailer is non-perishable and most of the products weigh up to 30 kilograms. In Figure 2, it is also indicated from the darkest to the lightest color, where most of the orders are currently being sold by this retailer. The UFs (federative units) where the retailer has more orders allocated are in the South (PR, SC and RS) and Southeast (SP, RJ, ES and MG).

Information about how the picking and shipping operation runs:

a) This retailer currently has a daily shipping limitation of 3,000 orders (with a variation of 5%);

b) Orders are always picked by FIFO (First In, First Out);

c) The orders that are shipped on the same day are only the orders that were finalized their purchase until 2 o'clock in the afternoon;

d) The carriers have a contract with this retailer and are informed by e-mail at 2 pm about the number of orders that they must pick up to plan the size and quantity of trucks that must be available for shipment;

e) The carriers collect the orders and forwards them until they deliver to the customer.

There is no technological resource that connects the retailer with the logistics operators, just as there is no single process of communication with the final customer regarding the real-time tracking of his order or to collect feedback regarding the delivery.

The customer experience related to freight price and delivery time currently at this retailer is based on a fixed value already set with the carriers in each state. Thus, there is no competition or simulation of better values to be added to the customer experience. The retailer in this scenario does not adopt express delivery strategies.

3.2.2 Simulation description

The proposed simulation methodology of Chwif et al. (2013), which is presented in Figure 3, was adapted, and performed in this study. This method is executed in 4 phases: conception (conceptual model in Figure 1), programming, analysis, and project conclusion. These phases are described in Figure 3.

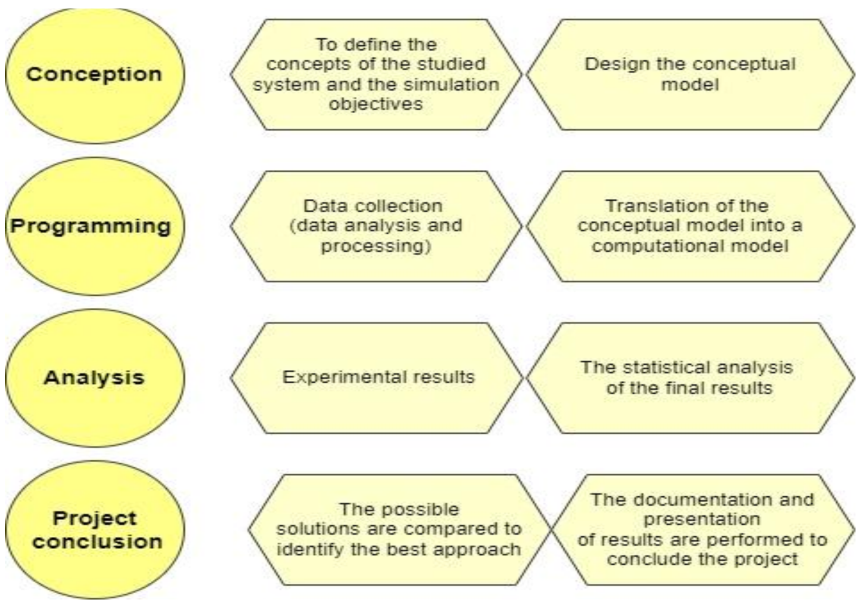

Figure 3 - Proposed simulation methodology (self-elaboration)

In the conception phase, it was decided that two simulations would be performed (two scenarios). The use case description (Figure 2) is scenario 1 and, based on the conceptual model in Figure 1, scenario 2 specifically with the use of the ship-from-store. Two KPIs (Key Performances Indicators) will also be evaluated between the simulation scenarios: freight price and delivery time. In Arslan et al. (2020) and Yang and Zhang (2020) these KPIs are the ones that base the buying decision for a customer in online retail. Additionally, in the computational model, the difference between scenario 1 and 2 is based on considering the same carriers that the retailer currently has, but altering the shipping point and considering all its stores as shipping points.

In the programming phase, we collected from the retailer order data for a period of 6 months, which was equivalent to 381674 orders. Thus, we have origin and destination data for each order, as well as freight price and delivery time tables from the carriers. Our conceptual model predicts the use of several carriers, but we only have tables for simulating of the 5 current carriers of the retailer. Therefore, we defined that we will consider only these carriers, but with the price freight and delivery time from the store closest to the customer. Simulating then a ship-from-store scenario with the current carriers.

The following elements were considered for the computer simulation of the scenario 1 (Figure 2):

a) Entity: Orders.

b) Resource: Five carriers (1 for each region of Brazil) with their due freight price and delivery time available in a spreadsheet; 15 shipping docks, in this single shipping point. We considered the limitations stated above in chapter 3.2 of the order cutting time range of 2 pm, shipping capacity of 3000 orders per day, with a 5% variation.

The following elements were considered for the computer simulation of the scenario 2 (Figure 4):

a) Entity: Orders.

b) Resource: Five carriers (1 for each region of Brazil) with their due freight price and delivery time available in a spreadsheet; All the stores that the retailer has throughout Brazil.

The computational simulation was implemented using Simmer: Discrete-Event Simulation package for R language (Ucar et al., 2019). The computer used to perform the experiments has the processor Intel i7-11390H. The validation technique of the computational model is Comparison to Other Models, which according to Sargent (2010), has the results of a simulation being compared with other scenarios, in addition to the retailer's current analytical scenario. In order to validate the research, the simulation was tested a few times to verify if the price and delivery time tables received from the retailer agreed. Two simulations were required to represent the correct value when checked against the sheets of data made available by the retailer.

In the scenario 2 (Figure 4), orders are shipped from the store closest to the customer. The retailer studied did not provide inventory cost data and available inventory in each store. The information obtained from the retailer is that all the commercialized items are present in all the stores, no store has an item more than in another, what differs from one store to another is only the amount of inventory available. In other words, all stores have the same number of items being commercialized, which for simulation purposes, we can consider all stores as shipping points. Thus, the store closest to the customer will be the one that will ship the order in the simulation. The daily shipping capacity was also not considered. For both scenarios, after validating the experimentation compared to the tables, each scenario was simulated only one time, no random variables are present in this simulation.

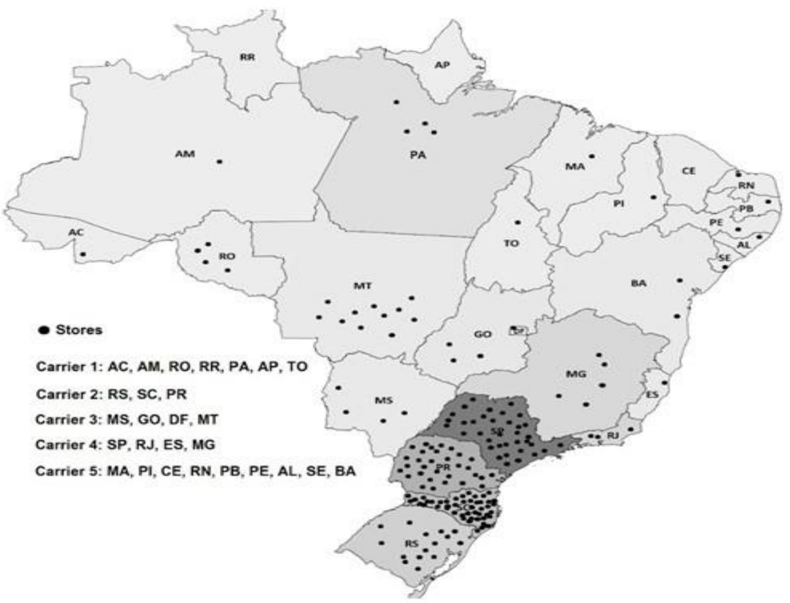

Figure 4 - Scenario 2 (self-elaboration)

The delivery time indicator will be evaluated in a daily basis for each federative unit of Brazil, while the freight price indicator will be evaluated in a monetary measurement unit, in real (Brazilian currency) and by Brazilian federative unit. Thus, these two indicators will be compared. The analysis is presented in the next section.

4 RESULTS AND DISCUSSION

The proposed approach was applied in order to make a comparison between the two scenarios in the performance indicators of delivery time and freight price. For the first performance indicator here treated as delivery time and being a key indicator regarding the consumer's experience in online shopping, the results of the scenario comparison are presented in Figure 5 The reduction in delivery time days by UF is presented. This figure shows the reduction in days per Brazilian federal unit (UF). The colors represent the two scenarios studied. The lighter one is scenario 2 and the darker one is scenario 1. The number is the result of the simulation compared to the scenarios. Scenario 2 being subtracted from scenario 1.

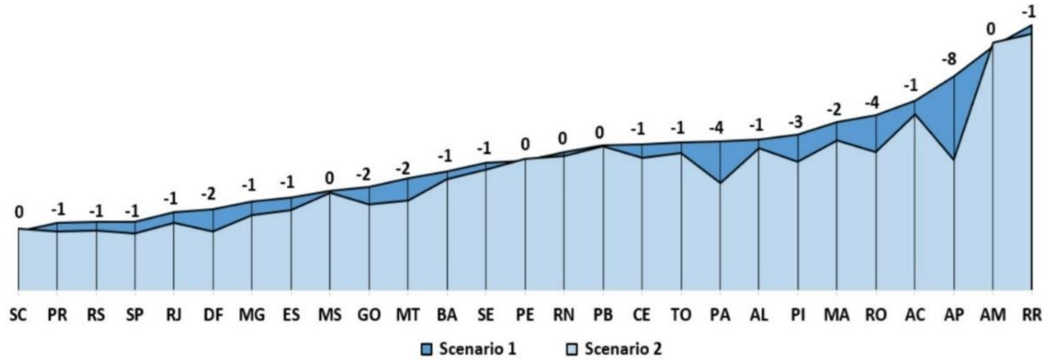

Figure 5 -Delivery time (self-elaboration)

The UFs with the most expressive reductions are AP, PA, RO, and PI, located farther from the central shipping point in scenario 1, which with the consideration of the retailer's stores in scenario 2, is attributed to this reduction. Potential customers in this region can be served with much shorter lead times than before and consequently have a better experience (Souza, 2022; Yang and Zhang, 2020). In other UFs, the reduction was not so expressive because they are already located near the initial distribution center, but even if the reduction occurs in one day, other strategies can be implemented, such as express delivery within one day e.g., in Castillo et al. (2018).

In Figure 6 below, we have on the left the map referring to the first scenario and, on the right, the second scenario. Darker colors are longer delivery time and lighter colors are shorter delivery time. One can notice a significant reduction between the scenarios in relation to deadlines. The UFs located in the Northern region of Brazil were not positively impacted. This may indicate an opportunity to investigate the market in the region to set up a store or in strategies to capture more customers in this region and offer a better service. Visibility of this market opportunity in omnichannel retailing is essential to increase sales (Li, 2020; Bayram and Cesaret, 2020).

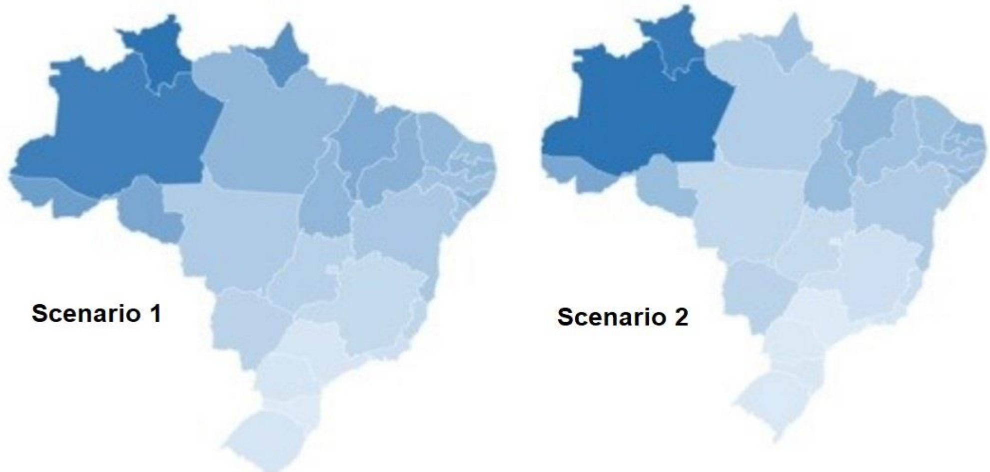

Figure 6 - Delivery time heatmap (self-elaboration)

Figure 7 represents the relationship of the distance of orders simulated in relation to the delivery time. based on the comparison of the results of scenario 2 with scenario 1. On the Y axis is the reduction in days for scenario 2. On the X axis there is the distance in kilometers (KM) of the orders. According to the increase of the distance from the expedition point there is a significant reduction in the delivery time. In the studies of He et al. (2021), Aktas et al. (2020) and as a result of this research it is extremely expressive of the reductions in kilometers that the use of ship-from-store can impact a large retailer.

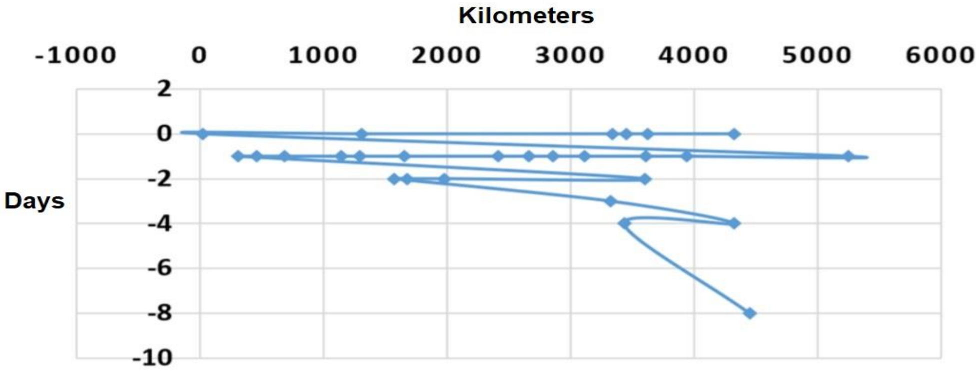

Figure 7 -Distance X Days (self-elaboration)

Analyzing the second freight price indicator, the comparison between the scenarios is presented in Figure 8. This figure presents the monetary value of reduction and the percentage of reduction of the freight price by UF. A MT client that in the current retailer scenario disburses an amount of around R$ 90.00, with the computational simulation applied here, can now disburse only an amount of around R$ 30.00, i.e., a reduction between 59% and 60%. This performance indicator was the most expressive and directly impacts the customer experience since the customer always looks for the best price (Buldeo Rai et al., 2019; 2021). For Assis et al. (2022) the reduction of the freight price potentially increases the attractiveness of the online sales channel, because it becomes a competitive element. In this research we achieved results that prove this evidence.

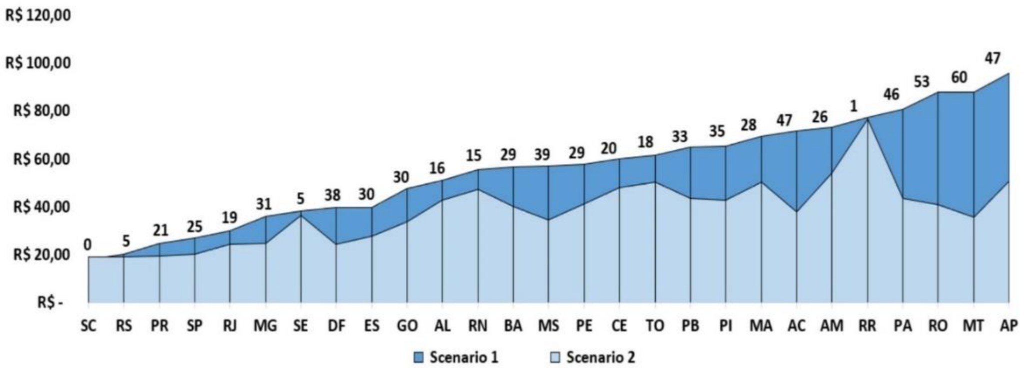

Figure 8 - Freight Price (self-elaboration)

In Figure 9, we have the comparison between scenario 1 (left) and scenario 2 (right) in color map, with darker ones being the most expensive freight value and lighter ones being the cheapest. We have a significant reduction in the UFs making it extremely attractive to the consumer at a cheaper freight price than before (in scenario 1).

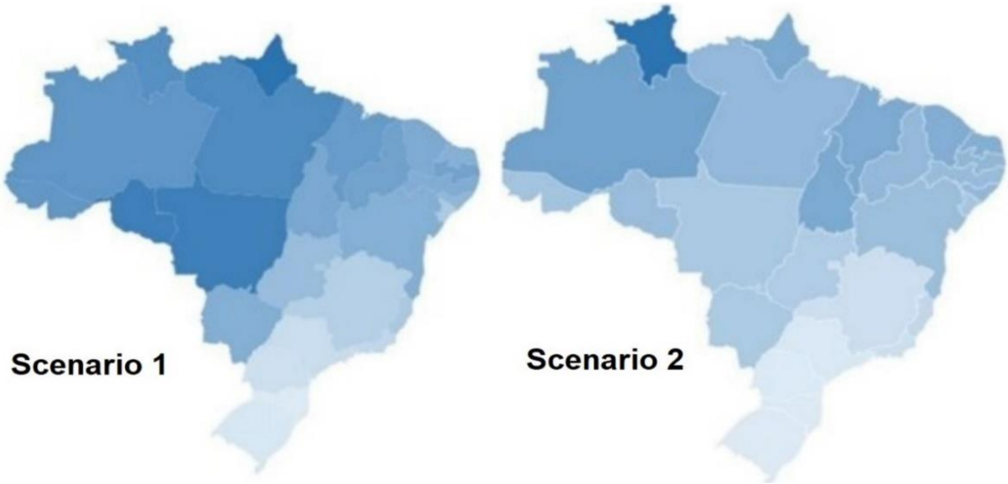

Figure 9 - Freight Price heatmap (self-elaboration)

In figure 10, the relationship between the distance of the orders (X axis) and the percentage reduction of the freight price (Y axis) is presented, based on the comparison of the results of scenario 2 with scenario 1. The most significant reductions in percent are located in the orders that are farthest from the point of origin of the orders. Freight prices are one of the main competitive elements in a customer's buying decision (Rai et al., 2018; Salvietti et al., 2022).

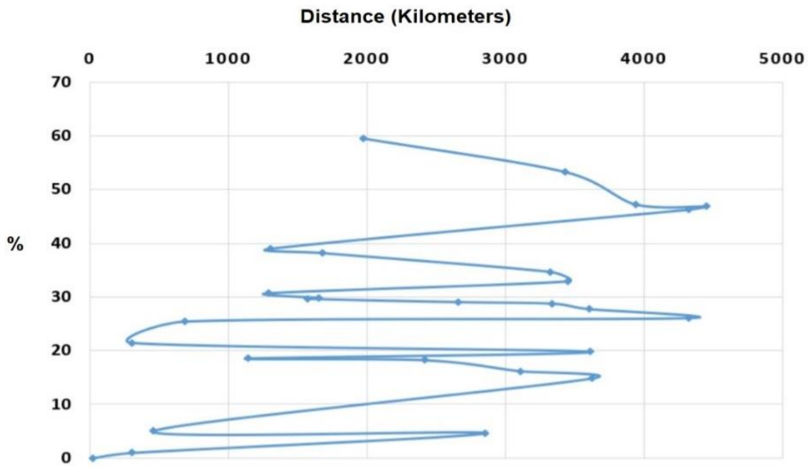

Figure 10 -Distance X Percentage freight value reduction (self-elaboration)

Figure 11 illustrates the volume of orders and their relation with the distance to be delivered in scenarios 1 and 2. The analysis of this figure presents one of the main results of this research. The relationship of the distance from scenario 1 to 2 when the ship-from-store strategy is implemented is remarkably expressive. This adds value to the retailer as there is a reduction in the delivery time for the customer, less distance to be transported, lower risks of loss or damage to the product being moved, shorter transit time for an order, lower transportation costs, reduced environmental impact, and greater customer satisfaction (Souza, 2022; Chen et al., 2021; Salvietti et al., 2022). Retailers that are located in Brazilian and foreign scenarios can evaluate this figure for decision making regarding the ship-from-store strategy, as this analysis focuses on distance traveled in the scenarios by the orders simulated here.

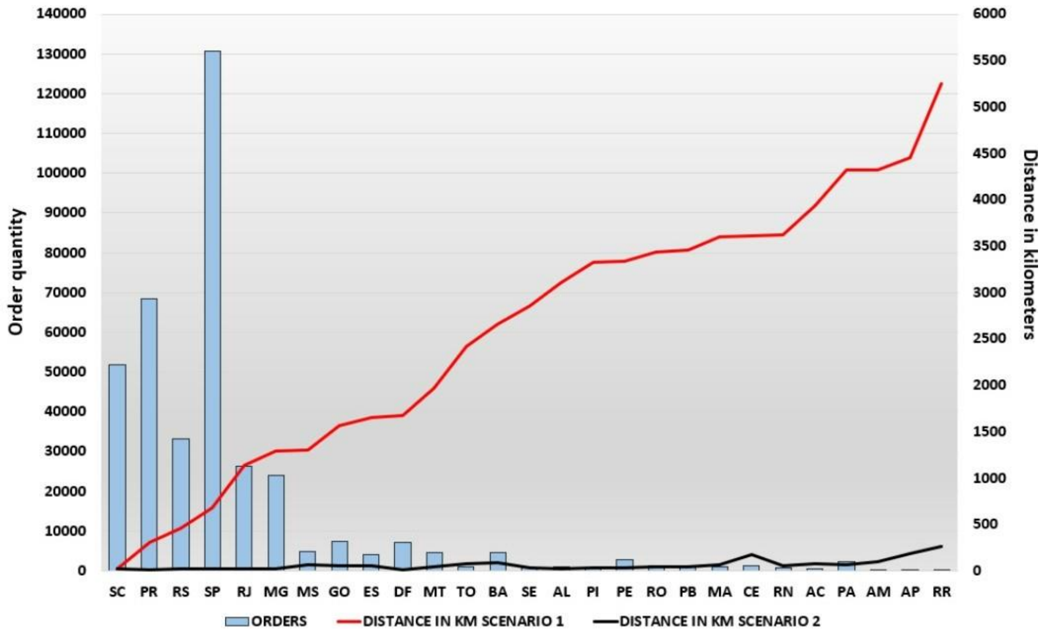

Figure 11 - Orders X Distance Scenario 1 X Distance Scenario 2 (self-elaboration)

The lack of data from other carriers to perform the simulation in scenario 2 was the reason it was not possible to demonstrate a freight quoting process with other carriers besides the 5 currently in operation. Being one of the main characteristics of our conceptual model from the logistics orchestration of a 4PL, the ability to be connected to several carriers.

However, aligning the conceptual model with the computer simulation, the simulation scenario sought to focus on the ship-from-store process, the entire process for this retailer is orchestrated through a 4PL. That is, in scenario 2, the 4PL being integrated with more logistics operators than the five currently present in the retailer, a possible reduction of these indicators is achieved, as well as an express delivery process, which can add value to the final consumer and attract them According to Cezanne and Saglietto (2015), Huang et al. (2021) Çağlar Kalkan and Aydın (2020), these are some of the main attributes and characteristics of a 4PL.

In accordance with Souza (2022) and using this element in this research, through a 4PL all communication with the carriers after the purchase of the product is done via integration, without the need to send an email, which makes the process more bureaucratic. The order tracking becomes online and dynamically updated, for the client as well as for the retailer's control tower, which monitors the orders and acts in case any action is required during or after the delivery of the product to the consumer (Prashar, 2020; Lu et al., 2020).

All the data transited during this orchestrated process through the 4PL is translated according to the retailer's needs, into the best experience for the consumer, being also an element of a 4PL e.g., in Souza, (2020). This means that customizations, as well as promotions, can be applied dynamically in real time (Buldeo Rai et al., 2021). Since the solution proposed here is a platform that can be accessed online by the retailer.

Therefore, given that the retailer needs to serve the customer at the lowest possible price and in the shortest possible time, the approach proposed here and orchestrated by a 4PL is able to meet this need. This 4PL, being a logistics service provider that concentrates technology and can manage all the other logistics service operators in the chain, seeks to optimize and achieve a level of service for the retailer that aims to make it more competitive. In this way, it meets the retailer's needs amid the competitive omnichannel scenario, attracting more customers and making its sales channel more profitable for the customer.

5 CONCLUSION

The A retailer needs experience and evidence to guide his decision making. This research was able to use real data from an omnichannel retailer in order to demonstrate through computer simulation its scenario, if it chose to use ship-from-store. Additionally, this operation was described as orchestrated by a 4PL, that is, this retailer adopting the ship-from-store process, has its logistic process, as well as the integrations with the logistic operators, orchestrated by a 4PL.

We obtained more significant reductions in the indicator of freight price and thus in the

Brazilian Journal of Operations and Production Management, Vol. 21, No. 2 e20241856 | https://doi.org/10.14488/BJOPM.1856.2024

delivery time. These two performance indicators treated here are key factors to contribute to the consumer's choice process when making a purchase and to always consider the best strategy that aims to optimize them is essential for omnichannel retailing. Thus, the path indicated and attested via simulation for this retailer is the ship-from-store process orchestrated via a 4PL.

These performance indicators compared between the scenarios, are relevant for a retailer. Through simulation, we obtained freight price reductions of up to 55%. Which for many retailers, becomes a highly complex challenge, reduce freight prices. This reduction is totally directed to the experience of the consumer who is shopping via one of the retailer's omnichannel channels.

This Brazilian retailer, which is in Brazil, where the distance between the regions is long, this reduction is highly converted into customer fidelity. Once the orders are being shipped closer to the customers. This means that the potential for increased sales and new transportation strategies through a logistics orchestrator is significant.

This retailer adopting a ship-from-store strategy in the future and using a solution orchestrated by a 4PL will have opportunities to relate to other carriers. Some of them with express delivery strategies. In other words, it will be able to reduce even more the time and price for the final client. Besides being able to further improve the consumer experience in their sales networks.

The omnichannel retailer studied in this study, through the adoption of the ship-from-store practice in addition to the use of a logistics orchestrator, according to the logistics orchestration structure presented above, manages to increase the logistics experience for its customers. This retailer is concerned with strategic decisions, while the 4PL presented in this research as an orchestrator act in integration with logistics operators and performs operational activities. As a result, the retailer focuses on strategies.

The ship-from-store factor is properly related to the distribution of inventory among stores, a reevaluation by the retailer of the location of their suppliers will be essential, since it will no longer be only one point being supplied by them.

The scientific implications of this study are that computer simulation is a strong resource for decision-making in retail logistics operations. In this way, it can be considered that the advent of technology reduces time and strengthens decision support. This has a social impact on decision-makers, who are now using technological resources. In other words, they are fed operational results measured by performance indicators. This makes the manager's role more assertive. Thinking about the theoretical implications, we have theoretically provided more practical studies that add to the scope of this research, inserting that a ship-from-store scenario for the retailer studied here and orchestrated by a 4PL, from the point of view of the performance indicators studied here, is more favorable. Further studies with other retailers need to be carried out in order to better demonstrate this and draw more theoretical implications. Mainly from a theoretical point of view, to strengthen the case that a 4PL really is the best orchestrator for this type of operation.

The first limitation of this research is that we do not have inventory data to consider the value of inventory in scenario 1 and 2, so then we consider that there is always inventory in the stores, and what would change for the scenarios would only be a greater number of times of supplying the stores. Thus, the cost of inventory could not be evaluated. Since this will have an impact on the retailer. The second limitation is that the freight cost for supplying the stores was not investigated, since in scenario 1 the suppliers delivered to only one location and for scenario 2 this would change several supply points. It is pointed then as future research directions, a better understanding of the market in this region through a market study that can serve as a basis for strategies for a new store in the region or other decisions of the retailer. Other types of retailers that sell different types of products are also a good direction for future research. Since further testing with practical data in other contexts is pertinent.

ACKNOWLEDGMENTS

This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

REFERENCES

Aktas, E., Bourlakis, M. and Zissis, D. (2020), “Collaboration in the last mile: evidence from grocery deliveries”, *International Journal of Logistics Research and Applications, Taylor & Francis*, Vol. 0 No. 0, pp. 1–15.

Arslan, A.N., Klibi, W. and Montreuil, B. (2020), “Distribution network deployment for omnichannel retailing", *European Journal of Operational Research*, Elsevier B.V., available at:https://doi.org/10.1016/j.ejor.2020.04.016

Assis, T. F. de, Abreu, V. H. S. de, Costa, M. G. da, & D'Agosto, M. de A. (2022). Methodology for Prioritizing Best Practices Applied to the Sustainable Last Mile— The Case of a Brazilian Parcel Delivery Service Company. *Sustainability*, Vol. 14, Page 3812, 14(7), 3812. https://doi.org/10.3390/SU14073812

Bayram, A. and Cesaret, B. (2020), "Order fulfillment policies for ship-from-store implementation in omni-channel retailing", *European Journal of Operational Research*, Elsevier B.V., No. xxxx, pp. 1–16.

Brandao, M.S., Godinho Filho, M. and da Silva, A.L. (2021), "Luxury supply chain management: a framework proposal based on a systematic literature review", *International Journal of Physical Distribution & Logistics Management,* Emerald Group Holdings Ltd., Vol. 51 No. 8, pp. 859–876.

Buldeo Rai, H., Verlinde, S. and Macharis, C. (2019), "The 'next day, free delivery' myth unravelled: Possibilities for sustainable last mile transport in an omnichannel environment", *International Journal of Retail and Distribution Management,* Emerald Group Publishing Ltd., Vol. 47 No. 1, pp. 39–54.

Buldeo Rai, H., Verlinde, S. and Macharis, C. (2021), "Who is interested in a crowdsourced last mile? A segmentation of attitudinal profiles", *Travel Behaviour and Society,* Elsevier Ltd, Vol. 22, pp. 22–31.

Buldeo Rai, H., Verlinde, S., Macharis, C., Schoutteet, P. and Vanhaverbeke, L. (2019), "Logistics outsourcing in omnichannel retail: State of practice and service recommendations", *International Journal of Physical Distribution & Logistics Management,* Emerald Group Publishing Ltd., Vol. 49 No. 3, pp. 267–286.

Çağlar Kalkan, M.B. and Aydın, K. (2020), "The role of 4PL provider as a mediation and supply chain agility", *Modern Supply Chain Research and Applications,* Emerald, Vol. 2 No. 2, pp. 99–111.

Cai, Y.J. and Lo, C.K.Y. (2020), "Omni-channel management in the new retailing era: A systematic review and future research agenda", *International Journal of Production Economics,* Elsevier B.V., Vol. 229, available at:https://doi.org/10.1016/j.ijpe.2020.107729.

Castillo, V.E., Bell, J.E., Rose, W.J. and Rodrigues, A.M. (2018), "Crowdsourcing Last Mile Delivery: Strategic Implications and Future Research Directions", *Journal of Business Logistics*, Wiley-Blackwell, Vol. 39 No. 1, pp. 7–25.

Cezanne, C. and Saglietto, L. (2015), "Redefining the boundaries of the firm: The role of 4PLs", *International Journal of Logistics Management,* Emerald Group Publishing Ltd., Vol. 26 No. 1, pp. 30–41.

Chen, R., Perry, P., Boardman, R., & McCormick, H. (2021), "Augmented reality in retail: a systematic review of research foci and future research agenda", *International Journal of Retail and Distribution Management*, Vol. 50, No. 4, pp. 498–518. https://doi.org/10.1108/IJRDM-11-2020-0472/FULL/XML

Chwif, L., Banks, J., de Moura Filho, J. P., & Santini, B. (2013), "A framework for specifying a discrete-event simulation conceptual model", *Journal of Simulation,* Vol. 7, No. 1, pp. 50–60. https://doi.org/10.1057/JOS.2012.18

Cordón, C., Leleux, B. and Lennox, B. (2017), "Adidas Russia/CIS and the Russian crisis: retrench or double down (Abridged case series)", *Supply Chain Forum, Taylor and Francis Ltd.*, Vol. 18 No. 4, pp. 231–239.

Eriksson, E., Norrman, A., & Kembro, J. (2022), "Understanding the transformation toward omnichannel logistics in grocery retail: a dynamic capabilities perspective", *International Journal of Retail and Distribution Management,* ahead-of-print(ahead-of-print). https://doi.org/10.1108/IJRDM-10-2021-0508/FULL/PDF

Fu, Y., Wang, H. and Huang, M. (2018), "Integrated scheduling for a distributed manufacturing system: a stochastic multi-objective model", Taylor & Francis, Vol. 13 No. 4, pp. 557–573.Https://Doi.Org/10.1080/17517575.2018.1545160

Gao, F. and Su, X. (2017), "Omnichannel Retail Operations with Buy-Online-and-Pick-up-in-Store", Management Science, Vol. 63, No. 8, pp. 2478–2492.

Gencer, Y.G. and Akkucuk, U. (2020), "Disruptive Logistics and Green Supply Chain Management", pp. 96–106.

He, Y., Xu, Q., & Shao, Z. (2021). "Ship-from-store" strategy in platform retailing. *Transportation*

Research Part E: Logistics and Transportation Review, 145(November 2020), 102153. https://doi.org/10.1016/j.tre.2020.102153

Huang, M., Dong, L., Kuang, H., Jiang, Z.Z., Lee, L.H. and Wang, X. (2021), "Supply chain network design considering customer psychological behavior-a 4PL perspective", *Computers and Industrial Engineering,* Elsevier Ltd, Vol. 159, available at:https://doi.org/10.1016/J.CIE.2021.107484.

Jin, D., Caliskan-Demirag, O., Chen, F. (Youhua) and Huang, M. (2020), "Omnichannel retailers' return policy strategies in the presence of competition", *International Journal of Production Economics,* Elsevier B.V., Vol. 225, available at:https://doi.org/10.1016/j.ijpe.2019.107595.

Jones, A.L., Miller, J.W., Griffis, S.E., Whipple, J.M. and Voorhees, C.M. (2021), "An examination of the effects of omni-channel service offerings on retailer performance", *International Journal of Physical Distribution & Logistics Management,* Vol. ahead-of-print No. ahead-of-print, available at: https://doi.org/10.1108/IJPDLM-06-2020-0175

Kembro, J.H. and Norrman, A. (2021), "Which future path to pick? A contingency approach to omnichannel warehouse configuration", *International Journal of Physical Distribution & Logistics Management,* Emerald Group Holdings Ltd., Vol. 51 No. 1, pp. 48–75.

Levina, E. and Razumova, Yu. (2019), "Digitalization of the transport and logistics market: integration of information systems. Russian experience in introducing digital technologies in the organization of logistics processes", *Revista Amazonía Investiga,* Vol. 8 No. 22, pp. 269–279.

Li, R. (2020), "Reinvent Retail Supply Chain: Ship-from-Store-to-Store", *Production and Operations Management,* Wiley-Blackwell, Vol. 29 No. 8, pp. 1825–1836.

Lim, S.F.W.T., Jin, X. and Srai, J.S. (2018), "Consumer-driven e-commerce: A literature review, design framework, and research agenda on last-mile logistics models", *International Journal of Physical Distribution & Logistics Management*, Vol. 48 No. 3, pp. 308–332.

Lim, S.F.W.T. and Srai, J.S. (2018), "Examining the anatomy of last-mile distribution in e-commerce omnichannel retailing: A supply network configuration approach", *International Journal of Operations and Production Management,* Emerald Group Publishing Ltd., Vol. 38 No. 9, pp. 1735–1764.

Lim, S.F.W.T. and Winkenbach, M. (2019), "Configuring the last-mile in businessto- consumer e-retailing", *California Management Review,* SAGE Publications Ltd, Vol. 61 No. 2, pp. 132–154.

Lu, F., Feng, W., Gao, M., Bi, H. and Wang, S. (2020), "The Fourth-Party Logistics Routing Problem Using Ant Colony System-Improved Grey Wolf Optimization", *Journal of Advanced Transportation,* Hindawi Limited, Vol. 2020, available at: https://doi.org/10.1155/2020/8831746

Luiz Schweitzer de Souza, N., Rossato, I.D.F. and Henkes, J.A. (2019), "Uma Análise Das Estratégias De Produção Mais Limpa E Eficiência Energética Em Uma Indústria De Equipamentos Odontológicos", *Revista Gestão & Sustentabilidade Ambiental,* Universidade do Sul de Santa Catarina - UNISUL, Vol. 8 No. 3, p. 639.

Mesquita, F. R., Mesquita, F. R., & Fernandes, R. F. (2022), "Projeções e desafios do dropshipping na era omnichannel / Dropshipping projections and challenges in the omnichannel era", *Brazilian Journal of Development,* Vol. 8, No. 1, pp. 314–338. https://doi.org/10.34117/BJDV8N1-021

Mikl, J., Herold, D.M., Ćwiklicki, M. and Kummer, S. (2020), "The impact of digital logistics start-ups on incumbent firms: a business model perspective", *International Journal of Logistics Management,* Emerald Group Holdings Ltd., available at: https://doi.org/10.1108/IJLM-04-2020-0155

Mishra, S., Malhotra, G., Arora, V., & Mukhopadhyay, S. (2022). Omnichannel retailing: does it empower consumers and influence patronage? *International Journal of Retail and Distribution Management,* Vol. 50, No. 2, pp. 229–250. https://doi.org/10.1108/IJRDM-04-2021-0199/FULL/XML

Mrutzek-Hartmann, B., Kotzab, H., Yumurtacı Hüseyinoğlu, I. Ö., & Kühling, S. (2022)", Omni-channel retailing resources and capabilities of SME specialty retailers – insights from Germany and Turkey", *International Journal of Retail &* Distribution Management, ahead-of-print(ahead-of-print). https://doi.org/10.1108/IJRDM-10-2021-0503

Pereira, M.L., Petroll, M.D.L.M., Ocke, M.A. de M. and Santos, W.S. (2020), "Proposição de Uma Agenda de Pesquisa a Partir de Uma Revisão Teórica Do Comportamento Do Consumidor Omnichannel", *CLAV* 2020, available at:

http://bibliotecadigital.fgv.br/ocs/index.php/clav/clav2020/paper/view/7530

Pereira, M.M. and Frazzon, E.M. (2019), "Towards a Predictive Approach for Omni-channel Retailing Supply Chains", *IFAC-PapersOnLine,* Elsevier B.V., Vol. 52 No. 13, pp. 844–850.

Prashar, A. (2020), "The Expansion Dilemma for Fourth-Party Logistics Services: Kodan Solutions Private Limited", *Vision*, Sage Publications India Pvt. Ltd, Vol. 24 No. 4, pp. 506–516.

Premkumar, P., Gopinath, S. and Mateen, A. (2020), "Trends in third party logistics–the past, the present & the future", *International Journal of Logistics Research and Applications,* Taylor and Francis Ltd., available at: https://doi.org/10.1080/13675567.2020.1782863

Qian, X., Huang, M., Zhang, Q., Yin, M. and Wang, X. (2018), "Mechanism design of incentive-based reverse auctions with loss-averse 3PLs under incomplete attributes", *PLoS ONE*, Public Library of Science, Vol. 13 No. 11, p. e0207937.

Rai, H.B., Mommens, K., Verlinde, S. and Macharis, C. (2019), "How does consumers' omnichannel shopping behaviour translate into travel and transport impacts? Case-study of a footwear retailer in Belgium", *Sustainability* (Switzerland), MDPI AG, Vol. 11 No. 9, available at: https://doi.org/10.3390/su11092534

Rai, H.B., Verlinde, S. and Macharis, C. (2018), "How Are Logistics Service Providers Adapting to Omnichannel retail?", *IFAC-PapersOnLine,* Elsevier B.V., Vol. 51 No. 11, pp. 588–593.

Sa, T. E. T. de, Júnior, O. S.S., & Bandeira, R. A. de M. (2022). Mobilidade urbana: uma análise sobre as políticas públicas de transporte da região metropolitana do Rio de Janeiro. *Revista Brasileira de Planejamento e Desenvolvimento,* Vol. 11, No. 2, pp. 458–475. https://doi.org/10.3895/RBPD.V11N2.13540

Salvietti, G., Ziliani, C., Teller, C., Ieva, M., & Ranfagni, S. (2022), "Omnichannel retailing and post-pandemic recovery: building a research agenda", *International Journal of Retail and Distribution Management,* ahead-of-print(ahead-of-print). https://doi.org/10.1108/IJRDM-10-2021-0485/FULL/PDF

Sargent, R. G. (2010), "Verification and validation of simulation models. Proceedings - Winter Simulation Conference", pp. 166–183. https://doi.org/10.1109/WSC.2010.5679166

Seghezzi, A., Winkenbach, M., Mangiaracina, R., (2021), "On-demand food delivery: a systematic literature review", *International Journal of Logistics Management, Emerald Group Holdings Ltd*., available at: https://doi.org/10.1108/IJLM-03-2020-0150

Silva, R. M., Bergmann, G., & Vieira, B. (2022), "O Nível de Serviço Logístico: uma pesquisa survey nas redes de varejo de material de construção localizadas no Litoral Norte do Estado do Rio Grande do Sul", *Produto & Produção,* Vol. 23, No. 1, pp. 49–65. https://doi.org/10.22456/1983-8026.117592

Souza, N.L.S. de, Stradioto Neto, L.A., Rossato, I.D.F., Silva, B.S. da and Henkes, J.A. (2020), "Aplicação De Ferramenta Da Indústria 4.0 Em Um Caso Com Alguns Cenários Nacionais E Internacionais", *Revista Gestão & Sustentabilidade Ambiental*, Universidade do Sul de Santa Catarina - UNISUL, Vol. 9 No. 2, p. 120.

Souza, N. L. S. de. (2022), "Proposta de modelo para orquestração logística com plataforma 4PL digital em uma operação ship-from-store no varejo omnichannel", [Master Thesis, Federal University of Santa Catarina]. https://tede.ufsc.br/teses/PEPS5835-D.pdf

Souza, N. L. S., Flores, M. R., Cauchick-Miguel, P. A., & Frazzon, E. M. (2023), "Analysis of product-service system logistics strategies in e-commerce: a literature review", *Brazilian Journal of Operations & Production Management,* Vol. 20, No. 4, pp. 1693-1693. https://doi.org/10.14488/BJOPM.1693.2023

Souza, N. L. S. de, Stradioto Neto, L. A., Fettermann, D. de C. and Frazzon, E. M. (2022) "Evaluation of the customer requirements for last mile delivery in Brazil", *Brazilian Journal of Operations & Production Management,* Vol. 19, No. 3, pp. 1–12. doi: https://doi.org/10.14488/BJOPM.2022.1360

Souza, N. L. S. D., Arante, M. T., Braghirolli, L. F., Mafia, M. M. P., & Frazzon, E. M. (2023), "Orchestrating a ship-from-store omnichannel operation using 4PL digital platform", *International Journal of Business Forecasting and Marketing Intelligence*, Vol. 8, No. 1, pp. 52-72. https://doi.org/10.1504/IJBFMI.2023.127704

Stradioto Neto, L.A., Souza, N.L.S. de, Rossato, I.D.F., Henkes, J.A. and Keine, S. (2020), "Avaliação Dos Metodos Para Aplicação Da Análise Do Inventário Do Ciclo De Vida Na Indústria Moveleira", *Revista Gestão & Sustentabilidade Ambiental,* Universidade do Sul de Santa Catarina - UNISUL, Vol. 9, No. 4, p. 126.

Ucar, I., Smeets, B. and Azcorra, A. (2019), “simmer: Discrete-Event Simulation for R”, *Journal of Statistical Software,* American Statistical Association, Vol. 90, pp. 1–30.

Weber, A.N. and Badenhorst-Weiss, J.A. (2018), “The last-mile logistical challenges of an omnichannel grocery retailer: A South African perspective”, *Journal of Transport and Supply Chain Management,* AOSIS, Vol. 12, available at: https://doi.org/10.4102/jtscm.v12i0.398

Yang, D. and Zhang, X. (2020), “Omnichannel operations with ship-from-store”, *Operations Research Letters*, Elsevier B.V., Vol. 48, No. 3, pp. 257–261.

Zeimpekis, V., Abreu, A., Alves De Araújo, F., Mendes Dos Reis, J. G., Silva, M. T., & Aktas, E. (2022), “A Fuzzy Analytic Hierarchy Process Model to Evaluate Logistics Service Expectations and Delivery Methods in Last-Mile Delivery in Brazil”, *Sustainability*, Vol. 14, pp. 5753, Vol. 14, No. 10, pp. 5753. https://doi.org/10.3390/SU14105753

Author contributions: NLSS: conceptualization, software, validation, analysis, investigation, data collection, draft preparation, manuscript editing, visualization; MTA, IRSA, LFB, MMPM and EMF: draft preparation, supervision.