XXII SemeAd
Seminários em Administração

novembro de 2019
ISSN 2177-3866

DEMAND VARIATION AND STOCK AVAILABILITY IN AN OMNICHANNEL GROCERY STRATEGY

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Agradecimento à orgão de fomento:
This work was conducted during a scholarship supported by CAPES – Brazilian Federal Agency for Support and Evaluation of Graduate Education within the Ministry of Education of Brazil, at the University Federal de Santa Catarina. My warmest thanks go to CAPES for that.

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1. INTRODUCTION

In the second half of the 90's, with the advent of the internet, online sales appeared through pure players, which only offered Web orders and deliveries where the customer would desire (AKSEN and ALTINKEMER, 2008). On the other hand, traditional retailers have continued to rely on customer perceived advantages when using the physical stores, such as being able to touch the product and interact face-to-face with sales people, not to mention that they can leave the store with their purchases in hands (CHOPRA, 2016). However, the growth of electronic market has driven traditional retailers to add online sales to their business, even though, for operational issues, they wished to maintain those channels operating separately (MARCHET et al, 2018). In its turn, pure online players also felt the need to diversify their business, establishing physical stores to expand their service offerings (HUBNER et al, 2016b). From beginning of the 21st century on, mixed channel structures emerged, combining physical stores, telephone orders and printed catalogs with the online environment. This strategy was known as "clicks-and-bricks" (AKSEN and ALTINKEMER, 2008). According to Marchet et al (2018), previous studies have evidenced that a physical and online channel integration in an appropriate way leads to a competitive advantage due to the synergy of channels. With this in mind, Chopra (2016, p.136) stated that "a combination of the two is more effective than either channel by itself". From then on, the omnichannel revolution was triggered mainly by the bricks-and-mortar retailers, in so far as they saw in online sales a new business opportunity (HUBNER et al, 2016b). In the omnichannel, retailers interact with their customer through a variety of channels (CHOPRA, 2016). However, omnichannel must not be confused with multichannel, where two or more marketing channels are used to reach one or more market segments and managing each channel separately. Omnichannel is "an advanced version of multichannel providing customers with an integrated shopping experience and enabling customers to move freely between the online (PC), mobile devices, brick-and-mortar stores, all within a single transaction process." (KIM and CHUN, 2018, p.9). In doing so, the omnichannel strategy allows the retailers to reach more consumers and expand their market (ABDULKADER et al, 2018). According to Abdulkader et al (2018), operating with a separate online structure of the physical store structure incurs additional costs for the retailers and they are also subject to an interruption of product availability between both systems. In other words, a product may be available in the online structure and not available in the physical store and vice versa. Therefore, integration across channels is no longer a decision issue about whether or not to do it, but how to do it in the most effective and efficient way (GALLINO & MORENO, 2014; HÜBNER et al, 2016b). As a consequence, the omnichannel movement put the logistics in evidence. Previously, a supply chain made a logistical effort to make its product available on the physical stores. In the omnichannel, the distribution system is on the front line and is the responsible to offer a variety of options for finding, buying and returning goods through the physical and online stores (HÜBNER et al, 2016b). The challenge for retailers today is to cope with new customer shopping behavior, however, without sacrificing their results due to the logistical complexity (HÜBNER et al, 2015). As a result of this, logistics customer service has been placed as a driving force behind logistics strategies, and due to the increasing transfer of power from retailers to consumers, time-based delivery has been used as an important strategy (DAUGHERTY et al, 2019). Due to the ease with which the online customer accesses the logistics service information, he/she becomes more informed and therefore, different from the customer of the brick-and-mortar. For this reason, issues such as availability of product, time and cost of delivery, and guarantees covering damaged products are so relevant (DAUGHERTY et al, 2019). For store-based retailers, aggregating online sales means redefining their distribution channels. Consequently, they need to reorganize their internal technology, organizational, and managerial processes for competitive advantage, making their migration to the omnichannel a complex process (ISHFAQ et al, 2016). With this complexity in mind, uncertainty regarding distribution risks related to product availability in response to customer demand variation become a problem for retailers. In order to respond to this problem, this study simulates a set of logistic variables for a grocery company. To accomplish its goal, this paper is organized into seven topics. The first topic introduces the theme and purpose of this study. The second topic present the used methodology. The thrid topic brings a brief presentation of the literature review, and some related studies of the theme. In the fourth topic, the simulation model assumptions are presented, followed by the distribution flow structure and the dynamic system model in the topic five. In its turn, the sixth topic presents the model test parameters, its results and analyzes in the different scenarios. Finally, in the topic seven, the conclusions and some final considerations are presented.

2. METHODOLOGY

In order to respond to this problem, this study present a literature review about logistics in an omnichannel strategy. As a result, a structure of omnichannel logistics distribution was developed based on the distribution typology and the archetypes of dispatching locations developed by Hubner et al (2016a). At last, the operation of this previously developed structure was simulated using the modeling in dynamic systems with two scenarios, omnichannel and multichannel, which subsequently had their results compared. The model was calibrated and subsequently submitted to a demand variation of 50% and 100%, with pulse variations and sine wave variations.

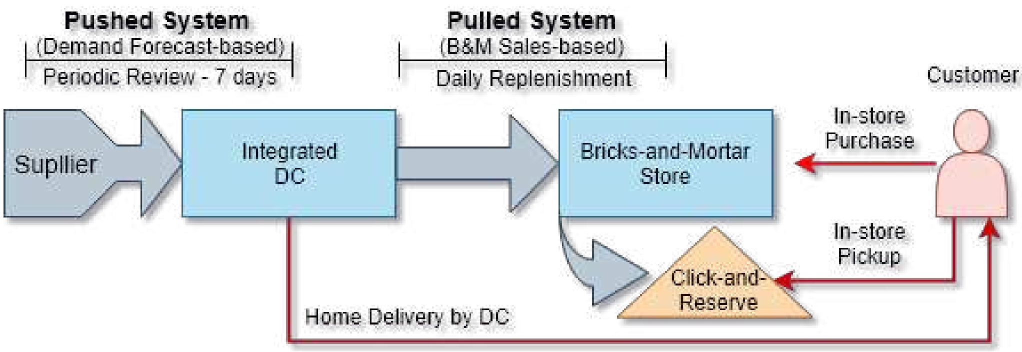
3. LITERATURE REVIEW

A channel is the means by which a retailer uses to access a customer, whether for sale or delivery (LEVY and WEITZ, 2012). According to Chopra (2016), in the omnichannel, retailers interact with their customer through a variety of channels, and this interaction occurs in terms of three flows: information, product, and funds. Information involves the retailer communication to the customer and the placing of customer orders. On the other hand, the product can move forward and return in the supply chain. Finally, the funds represent the payment for the product transferred from the customer to the retailer. However, this study focused basically on the product and information flow, not considering financial amounts involved, such as costs and revenues. In recent years, several studies have focused on omnichannel. However, studies that established a direct relationship between stockout behavior and inventory levels in response to customer demand variations were not found. Bendoly (2004), for exemplo, studied the impact of online order fulfillment using physical store inventory, testing substitute sources in different scenarios involving transshipment between stores. His conclusion was that, given the low inventory levels, the physical store receives priority and the online service is impaired. In addition, the author states that the optimal use of substitute sources varies according to the cost of replacement (transfer) and the cost of the stock reserves. In a similar study, Chiang and Monahan (2005) used two different channels for customer fulfil: direct supplier delivery for online sales and in-store inventory for self-service. However, when there was a stockout on one of the two channels, customers could search and change channels with a known probability. The authors concluded that the "dual-channel" strategy (integrated, albeit to a limited extent) outperformed the other two channels strategies in reducing operating costs in most cases. In another study, Bendoly et al (2007) provide insight to the inventory management strategies for "Clicks-and-Mortar" firms, considering the implications of the total costs in different inventory allocation strategies in maintaining service levels expected by consumer. The authors concluded that there is a cut in the level of online demand in relation to the total sale of the integrated channels, for which to locate inventories centrally or decentralized became the best alternative. At last, they alert that their model represents a limited view of the operational strategies of "Clicks-and-Mortar". In their turn, Aksen and Altinkemer (2008) proposed a routing system that decided between delivering the product in the customer's home or making it available in a physical store, according to the location of the stores and the allocation of customers. Similarly, Mahar and Wright (2009) examined two aspects of the decision to assign the place of fulfil of the online orders, proposing the postponement of the delivery orders for the analysis of possible consolidation. For this purpose, the authors considered the expected inventory, shipping, and customer wait costs, concluding that this postponement can reduce costs up to 23% in the fulfillment locations. The critical factors raised by the authors were the number of allocations made in each period and the fraction of total sales from the online channel. Up next, Bretthauer et al (2010) proposed a model that considered where and how much inventory should be kept at each fulfillment location so that a company operate both online and physical store sales in an integrated system. As a result, some specific sites were enabled to handle online sales, considering total costs. The authors concluded that when all costs (holding, backorder, fixed operating, transportation, and handling costs) are considered in the analysis, the percentage of online sales in relation to the total sales of the company becomes a factor critical decision maker. If only holding and backorder costs are considered, where the customer pays for shipping, the decision is more influenced by the standard deviation of demand. More recently, Modak (2017) developed a mathematical model to analyze the uncertainty of demand, price and delivery time in a two echelons omnichannel supply chain. According to the author, the model also allowed the study of the interaction between the retailer and the manufacturer, as well as the study of equilibrium solutions in decentralized channels. He concludes that the demand of the product in the channels depend on salling price and delivery lead time and faces some uncertainty. However, the most of recently studies in omnichannel focuses on distribution design (for exemplo, HÜBNER et al, 2016a; HÜBNER et al, 2016b; CHOPRA, 2016; MELACINI et al, 2018; WOLLENBURG et al, 2018).

4. MODEL ASSUMPTIONS

In order to demonstrate the distribution concept omnichannel adopted in this work, it was used the distribution typology and the archetypes of dispatching locations developed by Hubner et al (2016a), which is presented in Figure 4.1.

Figure 4.1 – Distribution typology of the model



Source: adapted by Hubner et al (2016a)

Regarding distribution typology, the authors presented three different categories. The first category defines the existence of the customers buying in-store, which characterizes the bricks-and-mortar (B&M) concept. The second category, defines the home delivery (HD) concept, for which we adopted the shipment by the DC. The last category refers to the type of store pickup by customers. The concept adopted here was the click-and-reserve (C&R), in which the "pickup" orders are served directly from the store stock. With regard to the archetypes of dispatching locations, there are also three types and we used all of them. To replenish the store and ship the home delivery we have established the retailer's DC. While, to provide stock for retailer's DC, we have defined the supplier's DC. Finally, as previously stated, the customers "pickup" in the store is served from the store stock. Meanwhile, the stocks reviewing operate differently depending on the requester. The stock reviewing of the store operates by pulled system (Figure 3.1), in which the store is replenished by the retailer's DC according to the previous day's sale. Therefore, store sales pull stock from DC. On the other hand, the stock reviewing of the retailer's DC operates by pushed system, in which the request to the supplier is based on the customer's demand forecast. In other words, retailer's DC purchases its stock from the supplier in the belief that the customer will buy what is planned and therefore the retailer will offer (will push) these stocks at its points of sale. Even though both product availability and delivery capacity are important service components in the online sales fulfillment (AGATZ et al, 2008), since our objective is to analyze the trade-off between product availability and inventory level, we establish that the firm will always have available order delivery capacity.

5. DYNAMIC SYSTEM MODELING

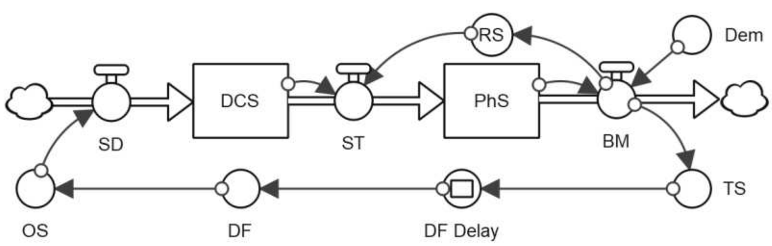
From distribution structure on, it was developed a dynamic model to simulate a specific omnichannel environment. This model is based on Sterman (2000) and Gonçalves et al (2005) and proposes to simulate a retail supply chain with a single supplier and only one product, not replaceable in face of a stockout.

5.1. Multichannel Structure

In the multichannel structure, there are two substructures operating simultaneously by the firm: online and physical store. However, for a better understanding, they are presented here separately.

Physical Store: the physical store structure in the multichannel scenario consists basically of two stock points: distribution center stock (DCS) and physical store stock (PhS). See Figure 5.1.

Figure 5.1 – Physical Store Structure in the multichannel scenario.

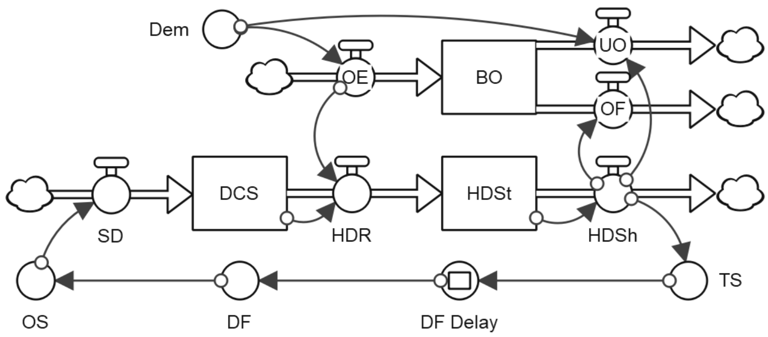


Source: by authors.

In this model the multichannel structure offers in its physical store only self-service.

Online Store: in online store, in place of the customer to buy and carry (BM), he/she buys and receives his/her purchases at home (HD). Therefore, it arises the need of a backlog orders stock (BO). In this model, it is assumed that the customer is not able to see the stock availability at the purchase time. This way, all customer demand (Dem) becomes an order entered (OE), feeding the backlog orders stock (BO) and demanding a product reservation (HDR). The BO is depleted by orders fulfillment (OF), when there is stock enough to do it properly reserved (HDSt).

Figure 5.2 – Online Store Structure in the multichannel scenario.



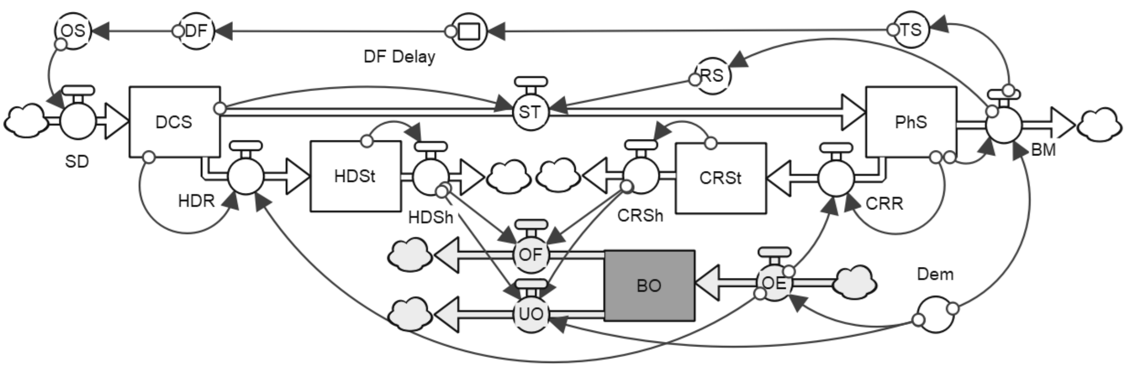
Source: by authors.

Otherwise, i.e., when there is not enough stock, the BO is depleted by the order cancellation (UO). In doing so, it was admitted that, or the orders are fulfillment in their term, or are canceled in the system and the customers informed. See the Figure 5.2.

5.2. Omnichannel Structure

With the concept of omnichannel in mind, i.e., the all channels integration, two important changes arise. The first one, is the possibility of a new way of the customer purchase delivery, “click&reserve” (CR), which is adopted in this model, and influence the physical store inventory management. See the Figure 5.3.

Figure 5.3 –Omnichannel scenario structure.



Source: by authors.

The second one, and not least, is the DC operation integration for both to transfer products to the physical stores, and to shipment HD orders of the online store.

6. MODEL RESULTS AND ANALYSIS

Despite the grocery stores operates mainly with basic products for people's daily lives, they experience strong periods of seasonality, that can be annual, monthly, weekly or even daily. “In a traditional retail store these fluctuations affect decisions on order quantities, shelf space allocation, markdown pricing and sales force levels” (AGATZ et al, 2008, p.350). In e-fulfillment, this demand fluctuation also occurs, which requires an alignment of delivery capacity and order picking, even though the delivery process is the greater challenge (AGATZ et al, 2008). In order to represent this seasonality, the sales volume behavior of the Brazilian retail trade, provided by the Brazilian Institute of Geography and Statistics (IBGE), was used, through the Monthly Trade Survey report. Likewise, for the weekly seasonality, the American Time Use Survey (ATUS) of the Time Use Institute was used. They interviewed more than 36,000 adults in the US during 2011, 2012 and 2013 (GOODMAN, 2008). The seasonal fluctuation is a problem, but it is predictable. On the other hand, the demand variation is when this demand forecast varies. The annual demand fluctuations of online stores and physical stores tend to be similar during the year, but may differ during the week (KEMBRO et al, 2018), however, we established in this model the same fluctuation behavior for both. In order to run the model, it was necessary to establish some initial parameters (Table 6.1), which were adjusted so that there were no stockout in its starting point, here named equilibrium state (ES). The first parameter defined was customer demand. The chosen value represents a not so small number that presents only a fraction of an integer in its variation, but not so large that it results in numbers with many decimal places in their sums. Whereas a year is presumed to have 365 days, it was established a daily demand about 143 units per day.

Table 6.1 – Base case parameters

Parameter	Definition	Value	Units
D	Customer demand for product A	52,200	units per year
DP_{OL}	Online Demand participation	6	% of D
CRP	C&R participation in the online sales	20	% of DP_{OL}
SL	Costumer Service Level	95	%
SCovPh	Stock Coverage – Physical Store	0.3	days
SCovDC	Stock Coverage – Distribution Center	2	days
SLT	Supplier Lead Time	1	day
DCRI	DC Stocks Review interval	7	days

Source: by authors

Another important parameter is the online demand participation (DP_{OL}) within firm total demand, since it is associated with the part of customer demand that will be attended by specific structures of that channel. The omnichannel model structure of this work predicts that part of the online sales (CRP) is attended by the physical store, i.e., both the order picking and the delivery to the customer occur in the store. The online demand participation used (DPOL) corresponds to digital grocery sales average in UK, the country with the most developed digital market in Europe (GARCIA, 2018). Hübner et al (2016a) have stated that click-and-collect delivery accounted for a little less than 20% of online grocery purchases. Therefore, 20% was the used value for the PCR in this model. In turn, the stock coverage of DC (SCovDC) and physical store (SCovPh) have been calibrated in the model so that the nuances of seasonal variations did not cause any stockout in the period under analysis.

Figure 6.1 - Demand x Stock (OC PhSt in ES)

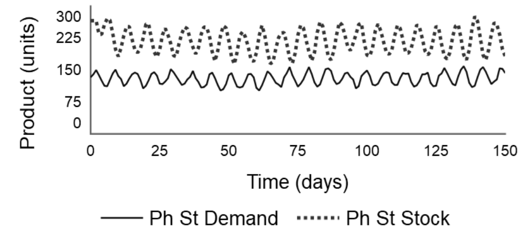
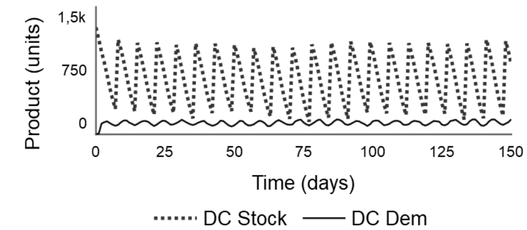


Figure 6.2 - Demand x Stock (OC DC in ES)



Source: by authors

Considering the pre-established demand and the parameters above mentioned in equilibrium state, the behavior of the stocks and demand of the physical store and DC within the omnichannel structure in the first 150 days of the year is shown in Figures 6.1 and 6.2, respectively. It is important to recall that the physical store stock feeds the self-service, here designated Brick&Mortar (BM), and also a part of online sales that the customer decides to pick up in the physical store, here designated Click&Reserve (CR). On the other hand, the DC stock feeds the other part of the online sales, in which customers decide to receive their purchases at home, here designated Home Delivery (HD), and the stock of the physical store by transfer. Observe in the Figure 6.1 that, in this time range (150 days), in some moments, the product quantity demanded of the physical store comes close to its stock quantity (e.g., 72nd period, when the difference between them is 9 units). Inasmuch the sales happen, the stock of the physical store is depleted. On the other hand, these sales are replaced in stock by DC. In other words, stock of the physical store is the result of balance between its sales and the DC transfers. The same goes for the DC, however, its stock is depleted by two outflows, the transfer to the physical store and the home delivery of the online store, and fed by the suppliers. Likewise, in some moments in the physical store, the DC stock and DC demand come close one each other (e.g., in the 77th and 133rd periods, where the difference between the stock and demand are 41 and 66 respectively). Notice that, despite the stock and demand are close, in the equilibrium state there are no stockout either in the physical store or in the DC, within the analyzed period. The same test was applied in the multichannel scenario, to ensure the feasibility of scenario comparison. It is important to understand that a demand only become a sale if there is stock available. Therefore, in this model, the demand and sale will have the same value, unless there is no stock enough to cover the demand. The part of model time range chosen to insert the demand variation had to present some ease to observe its consequences, i.e., with relatively low stock levels. This way, the period selected for the occurrence of the demand disturbance of the test case was around the 100th day, at which time the difference between stock and demand in the physical store is 25 product units. Conversely, the DC's stock in this moment is 949 product units, high enough to allow the coverage of the physical store sales without much interference. First test (T1) was the introduction, from equilibrium state (ES), a demand pulse by increasing customer demand by 50% and then 100% (Figure 6.3). The second test (T2) is similar to the first one, however in place of a pulse, a sine wave of demand with the amplitude of 50% and then of 100% was introduced (Figure 6.4).

Figure 6.3 - Demand Pulse Variation (OC)

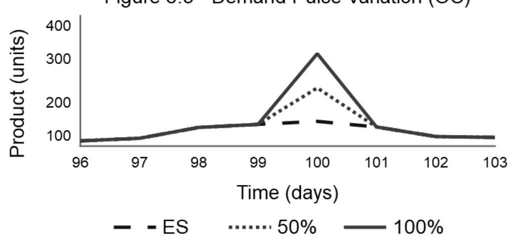
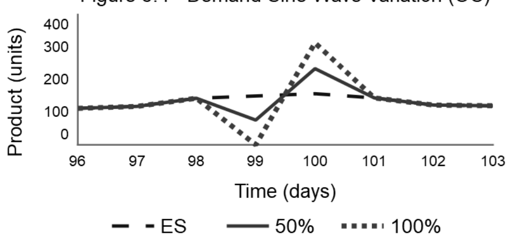


Figure 6.4 - Demand Sine Wave Variation (OC)



Source: by authors

The objective of the second test was to simulate a situation where part or all of the product demand does not occur on a given day, but accumulate with the next day demand. Situations like this occur in the face of external events, therefore exogenous, such as bad weather, public service strikes, or even randomly for no apparent reason. Even though that the tests objective is observing the stockout and variation of average stock in the face of demand variation, some intermediate results was also examined, but only in order to assist in their explanation. As seen previously, if on the one hand the stockout is the non-service rate of the customer demand, on the other hand, availability is the attendance rate of this demand. Once both omnichannel and multichannel structure have at least two stock points (physical store and DC) and both have their clients (demand), the analysis sometimes refers to one of the two stock points or the sum of both stock points. In these cases, in order to simplify the preview, the variations analysis was made using the comparison between the equilibrium state (ES) and 100% of the demand variation.

6.1. Omnichannel Scenario

Different from multichannel, the omnichannel has only one structure composed by two stock points: physical store and DC. Therefore, any actions applied to one of the parts of the system, can affect the whole system or part of it. Since the physical store supports both self-service (BM) and delivery of the pickup online sales (CR), we have established that CR has priority over BM, i.e., the pick of the CR orders products up in the shelves is executed on the day following the orders, before the store opening. The same occurs on the DC, where the home delivery sales (HD) have priority over the products transfer from the DC to the physical store. As above mentioned, in the first test (T1) was introduced, from equilibrium state (ES), a demand pulse (PV) by increasing customer demand by 50% and then 100%. Even though the physical store operates through a pulled system, in which it is prepared to respond a demand variation, there is a delay at least one day in make it. In doing so, the stockout is generated in the same day that the demand variation occurs. Both variation, 50% and 100%, decrease the product availability for customer throughout the omnichannel system, to 79.1% and 60.1% respectively (Figure 6.5). In response to demand variation, the demand forecast (DF) increase in the smoothed way, but immediately signal a swell of 2,86% when the demand variation is 100% in a single day. From the following day, when demand normalizes, the effect of the demand variation on demand forecast decreases smoothly over time. (Figure 6.7).

Figure 6.5 - Product Availability (OC in PV)

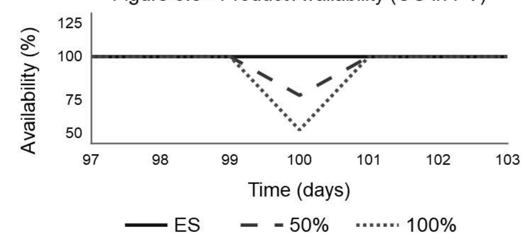


Figure 6.6 - Closing Stock (OC BM in PV)

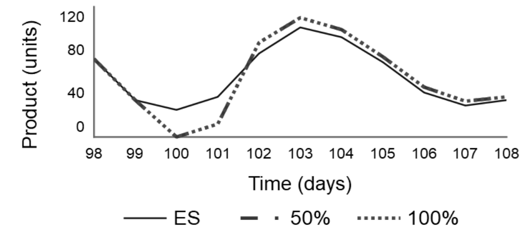


Figure 6.7 - Total Demand Forecast (OC)

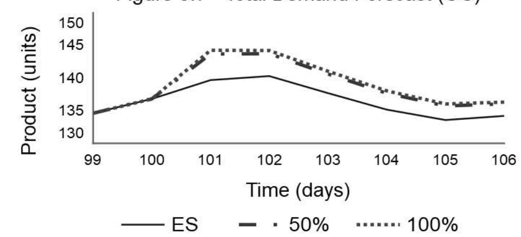
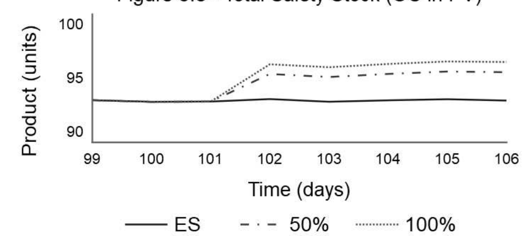


Figure 6.8 - Total Safety Stock (OC in PV)



Source: by authors

For this reason, the average stock of the physical store also increases, if compared the equilibrium state (ES) with the100% of demand variation. But this response is not immediate. In the 100th period the closing stock of the physical store empties completely (Figure 6.6), decreasing the average stock by 12.56% in the 100th period and 24.06% in the 101st period, when comparing ES and 100% demand variation (Figure 6.9). However, influenced by the safety stock and demand forecast, the average stock is increased quickly.

Figure 6.9 - Average Stock (OC BM in PV)

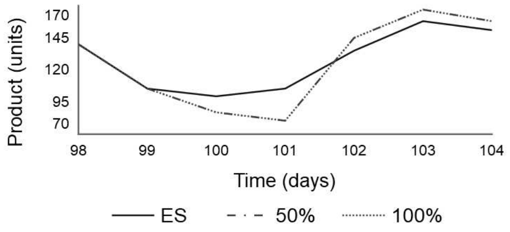
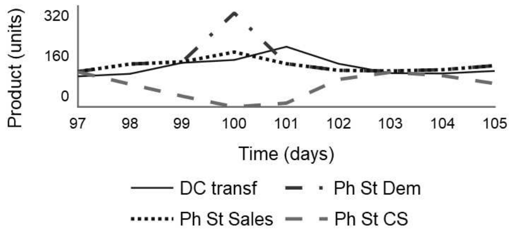


Figure 6.10 - Stock Flow (OC BM in PV)



Source: by authors

Notice in Figure 6.10 that although demand was 298 units in the 100th period, the sale was 174 units and that is the information that the DC receive. In doing so, the DC transfer of the following day was the volume sold added to the physical store stock adjustment, i.e., 191 units. That is why the closing stock in the 101st period was 67.57% lower, when compared the 100% pulse demand variation with the ES (Figure 6.6). At this period, the adjustment was positive (17 units), since both the demand forecasting and the safety stock were positively influenced by the demand variation (Figures 6.7 and 6.8). In test 2, instead of a pulse in a single moment, one sine wave of demand is introduced, striking two moments, 99^{th} and 100^{th} periods, the first negative and the second positive wave, both with the same amplitude. The variations used were the same as in Test 1, i.e., 50% and 100% demand variation, from the equilibrium state (Figure 6.4). Since in Test 2, first a reduction in demand is caused, stock accumulates in the physical store on the 99th day (e.g. 177 units of closing stock with 100% demand variation versus 34 units in ES - Figure 6.11).

Figure 6.11 - Closing Stock (OC BM in SW)

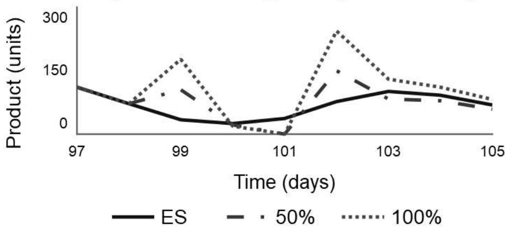
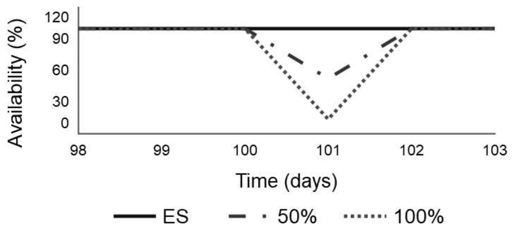


Figure 6.12 - Product Availability (Ph St in SW)



Source: by authors

Although on the next day, 100th day, the equilibrium state demand has been increased in the same intensity that it was reduced the previous day, the store received the DC transfer, requested on the 98th day. So, there was stock enough to cover the demand of the 100th day (e.g. 19 units still remain in stock with 100% DV - Figure 6.11). However, as on the 99th day the demand was reduced by 100%, on the 101st day the store did not receive this product from the DC. So that, the stockout occurred on the 101st day (e.g. 118 units of stockout with 100% DV) in the physical store, once that the demand normalized (e.g. 137 units) but the stock was scant (19 units – Figure 6.11). In doing so, the stock availability in the physical store was 13.9% in this day (Figure 6.12). As a result of the higher sales volume of the 100th day, the stock transfer by DC to the physical store on the 102nd day generated an overstock (e.g. 244 units of closing stock - 100% DV - Figure 6.11). As on the 101st day the demand was higher than the available stock, sales completely depleted this stock (Figure 6.11) and failed to serve a percentage of the customers who searched for the product, which basically means the stockout. But, when the equilibrium state (Figure 6.13) is subjected to a demand variation with a sine wave of amplitude of the 100% of the demand (Figure 6.14), for example, the demand forecast responds to the negative sales wave in the 99^{th} period, reducing the demand forecast for the subsequent period (100^{th} day) by 15.38%.

Figure 6.13 - Demand vs DF (OC in ES)

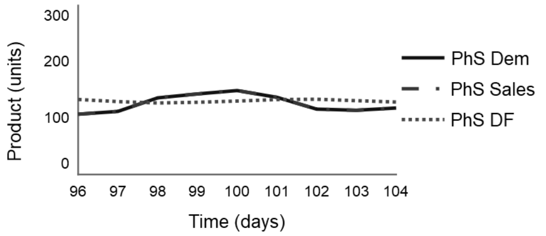
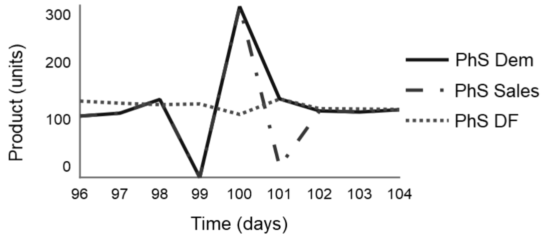


Figure 6.14 - Demand vs DF (OC in 100% SW)



Source: by authors

This is because the influence of the sales variation on demand forecasting is smoothed over a seven-day adjustment period. However, because on the 100th day the positive wave of the sine wave demand variation occurs, once again the demand forecast responds, but this time increasing by 3% for the subsequent period, 101st day. By contrast, the safety stock is calculated using the error standard deviation between the demand forecast and sales (Figure 6.16), in addition to the service level and the lead time. Therefore, if the demand varies, the error standard deviation also varies. Once the sales variation occurs, the error standard deviation is quickly revised. Note in Figure 6.16 that, after the three error consecutive peaks (127, -186 and 118), the error standard deviation is revised from 13.9 units of the product in the 100th period to 22.5 units in the 103rd period. This is because, regardless of the signal, the error variation is accumulated and considered in the standard deviation calculation. With this in mind, since the error standard deviation has a direct relation with the safety stock, when the former increases, the latter also. As time goes by, if new demand variations do not occur, the error standard deviation and, consequently, the safety stock, tend to normalize.

Figure 6.15 - Demand Forecast (OC in SW)

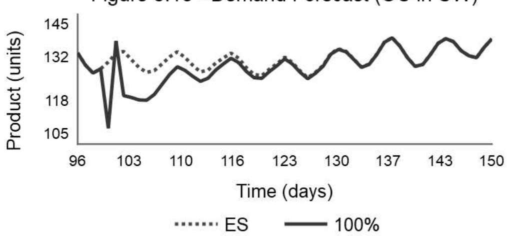


Figure 6.16 - Error Standard Deviation (OC in SW)

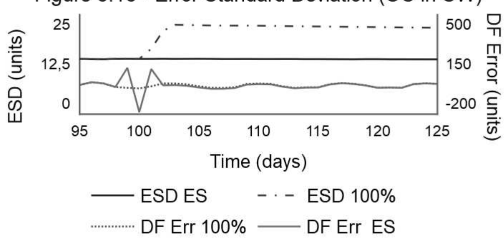
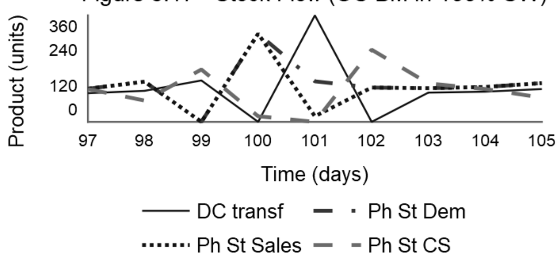


Figure 6.17 - Stock Flow (OC BM in 100% SW)



Source: by authors

As long as there is enough stock to fulfill demand, sales and demand have the same value. Otherwise, the stockout occurs. Notice in Figure 6.17 that in the 100th period, the physical store had only 19 units of closing stock. Even though its demand was 137 units of product in the 101st period, since it did not receive transfer by DC, only 19 was able to be fulfilled. Therefore, there was a stockout of 118 units. In order to facilitate the Figure 6.19 understanding, it was established that the transfer always occurs at the beginning of the period, from where the sales are subtracted, resulting in the final stock balance. In doing so, even if in the 101st period the physical store received 360 units of product by DC transfer, this amount can only contribute to the sales of the following day.

6.2. Multichannel Scenario

Basically, what sets multichannel scenario apart from omnichannel is the fact that, in multichannel, there are two independents, online and store-based structures. Therefore, for a future comparison between both scenarios to be feasible, in some moments the both structures results were aggregated for analysis purposes. We also applied the same parameters in both scenarios. In general terms, the stock behavior face to the demand variation was similar in both MC and OC scenarios, once the parameters were maintained. Therefore, we have basically brought the main results here, i.e., related to availability and stock level. The further results follow in the scenarios comparative analysis topic. When we applied the pulse by 50% and then 100% over the demand equilibrium state (T1) in the multichannel scenario, the product availability for customers decreased in both structures, however in different moments. In the physical store structure, the stockout occurred on the same period in which occurred the demand variation (Figure 6.18), i.e., in the 100th period. This is because the DC replenish the physical store every day, resulting in a low stock coverage for it. In the online structure is different, for the sales are support directly by DC. Whereas the supplier replenishes the DC every seven days, depending of the moment, there is stock enough to cover the demand variation. However, as the days go by, the sale continues depleting the DC stock. With this, at some point next to the following delivery of the supplier, the stock becomes insufficient to cover the demand, resulting in stockout (Figure 6.19).

Figure 6.18 - Demand vs Stock (MC BM in PV)

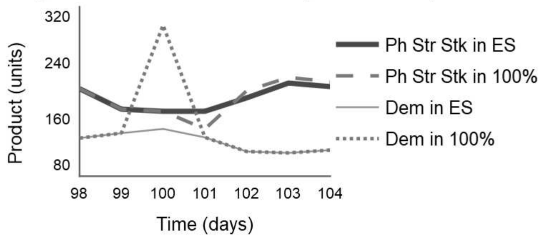


Figure 6.19 - Demand vs Stock (MC OL in PV)

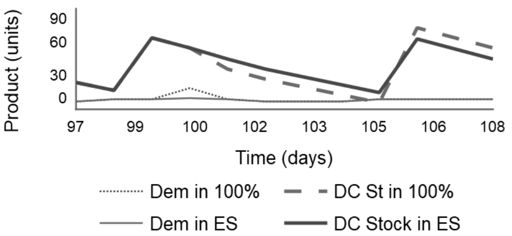
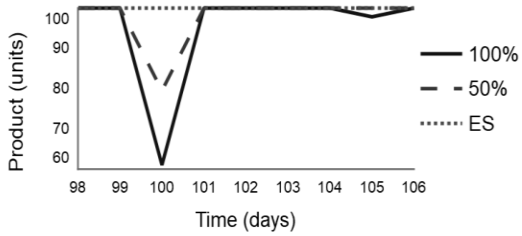


Figure 6.20 - Total Availability (MC System in PV)



Source: by authors

In doing so, the product availability in the physical store (BM) structure in the 100th period was 78.2% and 58.5% when applied the 50% and 100% demand variation, respectively. By contrast, in the online structure occurred a stockout only when applied the 100% demand variation, resulting in a decrease in the product availability to 66.7%, which only occurred in the 105th period. If we considered both structures, physical store and online, as a single structure, we would have two moments of stockout. First, in the 100th period when the product availability across the multichannel system decreases to 79.5% and 61% face to 50% and 100% demand variation, respectively. Second, when this availability decreases to 97.8% in the 105th period, face to 100% demand variation (Figure 6.20). Following the same reasoning, we also applied in the multichannel a sine wave of demand (T2), striking two moments, 99th and 100th periods, the first negative and the second positive wave, both with the same amplitude. Once again, we used two demand variation amplitude, 50% and then 100%. In the same way that in omnichannel, in the multichannel physical store, the demand variation with sine wave only result in stockout in the 101st period (Figure 6.21). In doing so, availability in the physical store structure was 52.6% and 14.1%, considering 50% and 100% demand variation, respectively.

Figure 6.21 - Demand vs Stock (MC BM in SW)

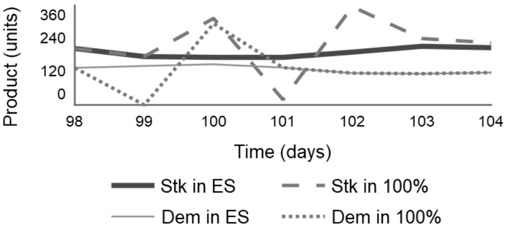


Figure 6.22 - Demand vs Stock (MC OL in SW)

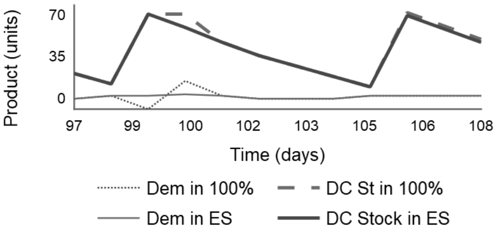
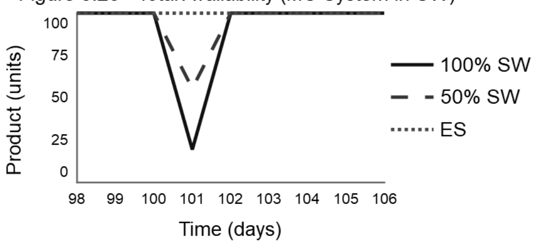


Figure 6.23 - Total Availability (MC System in SW)



Source: by authors

As we have shown previously, the high levels of the DC stock supported the demand variations for a time, until the stock levels become lower, close to the next supplier delivery. However, even though there was a demand increase in the 100th period, the remaining stock of the previous period (99th period) covered this variation. In doing so, the stock balanced and there was no stockout in the online channel of the multichannel (Figure 6.22). If we take into account both structures of the multichannel scenario, i.e., by unification of the online and physical store structures, the stock availability decreased only in one period, 101st (55.60% and 19.40%, considering 50% and 100% of the demand variation with sine wave, respectively). See Figure 6.23.

6.3. Scenarios Comparison

The first result we compared was the stockout. In this aspect, there was occurrence in both scenarios, however with different characteristics. We starting by comparing the total stockout of the scenarios in each of the tests (demand variation for pulse and sine wave). In the pulse demand variation, when we tested a 50% pulse, the stockout was 2.08% higher in the omnichannel scenario (OC). However, when we tested a 100% pulse or more, the multichannel scenario showed higher values than omnichannel scenario (MC). With 100% of demand pulse, the OC was 0.80% lower than MC. We experienced other even higher demand-variation pulses (150%, 200% e 500%), and in all of them, the stockout was lower too in the OC (2.46%, 1.80% and 4.13%, respectively). Actually, it was the stockout in the multichannel scenario that increased, not the stockout in the omnichannel scenario that decreased. This behavior was explained when we observed that the online demand in the multichannel scenario is fully supported by a parted DC. Since on the DC the stocks are replenished by suppliers every seven days, higher demand peaks deplete the DC stock balances more quickly, causing the stockout for the remainder of the period until the next delivery of the supplier. Unlike that in the multichannel, in the omnichannel scenario the online demand is supported by the same structure that support of the physical store demand, as a result, it is less exposed to ruptures. This is because, in the model used here, online sales have priority over the other outputs. HD sales, for example, are reserved prior to the physical store transfer order attempt. The same occurs in the physical store, where the reserve of the CR sales is attempted before replenishing shelves. Since, in OC the DC stock is planned to support all the demand of the company, and in this specific test the HD demand represents 4.8% of this total, hardly the DC stock to be so low as, to occur a stockout. In addition, the DC average stock is relatively higher than average stock of the physical store, due to the DCRI (DC Stocks Review interval). In doing so, the HD demand is more protected from stockouts than the CR demand, which is supported by the physical store. On the other hand, the MC online demand has its own DC stock and does not has priority over any other demand. When submitted to a sine wave variation of the demand, the stockout in the omnichannel scenario showed stockouts 1.56% and 1.72% higher than multichannel scenario, to 50% and 100% sine wave variation of the demand. Another way to analyze the stockout is to measure the exposure time to an imminent stockout. Gasnier (2002) states that when the closing stock reaches levels below the safety stock, it enters a critical zone of stockout risk. Basically, this indicator, the exposure to stockouts (ExpS) measures the number of days in a given period in which the closing stock was in the critical zone, offering a risk of stockout facing possible demand variations. However, even in the ES, we noticed a difference of this indicator between both scenarios. Observe in the Figure 6.26 that the behavior of the exposure to stockouts of the DC is equal in the omnichannel scenario and in the structure of the physical part of the multichannel scenario, but different in the structure of the online part of the multichannel scenario. This was because into the online structure circled only 6% of the total sales of the multichannel structure, i.e., relatively low values compared to the structure of the physical store. In the 35th period, for instance, safety stock and final stock of the DC in the physical store structure were 63 and 66 product units. Even though narrowly, it did not reach the stockout risk zone. Over the same period, in the online structure, safety stock and final stock were 4 and 2 product units, respectively. In doing so, by just 2 product units the final stock entered into the stockout risk zone. If we consider rounding rules theses values become even more susceptible.

Figure 6.24 - Average Stock - from ES to 100% PV

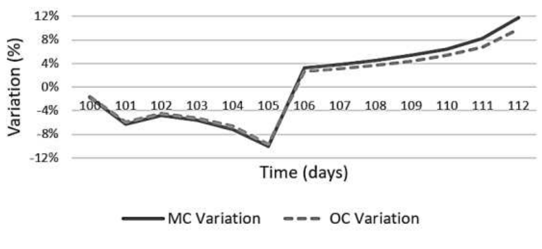


Figure 6.25 - Average Stock - from ES to 100% SW

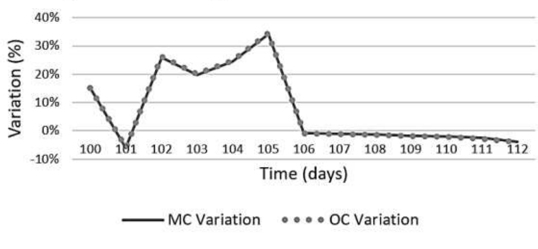


Figure 6.26 - Exposure to Stockouts (ExpS) of the DC in ES

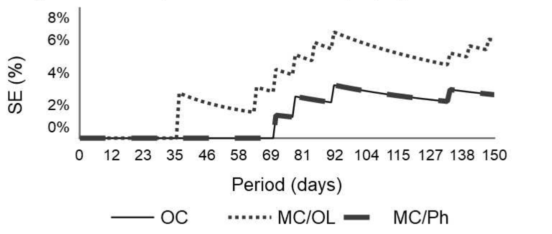
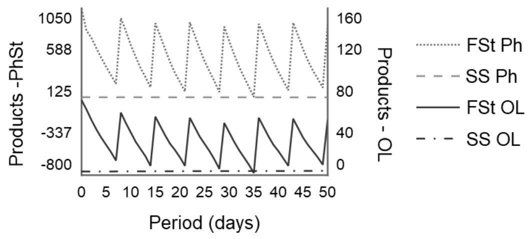


Figure 6.27 - Final Stock x Safety Stock - MC in ES



Source: by authors

When it comes to average stock, in equilibrium state, both scenarios showed very similar values. Even though the average stock value in the OC scenario in equilibrium state has been 0.43% higher than MC scenario into analysis period (150 days), this difference is not very representative, considering issues such as rounding by product packaging factor, established in the model. Even when we applied a 100% pulse variation of the demand, the behavior of the average stocks of both scenarios remained similar, with negative variation peaks between 100th and 105th period, and soon after with positive variation peaks from the 106th period, when it compared with the ES. However, the omnichannel scenario seems to recover faster than the multichannel scenario, towards the ES (Figure 6.24). In its turn, the sine wave variation applied in the scenarios showed similar behavior over the period analyzed in both scenarios, when compared to the 100% demand variation to the ES (Figure 6.25).

7. CONCLUSION AND FINAL CONSIDERATIONS

Even though that previous studies have evidenced that a physical and online channel integration in an appropriate way leads to a competitive advantage due to the synergy of channels (MARCHET et al, 2018), with regards to stockout generated, channels operating separately showed better results of stock availability than operating in an integrated way. Some specific evidences are discussed as follows. When it was simulated the situation in which part or all of the product demand did not occur on a given day, but accumulated with the next day demand, i.e., 50% and 100% sine wave variation of customer demand, all the results were worse than when there was a single demand positive peak, i.e., 50% and 100% pulse demand variation. The only exception was the online structure in the multichannel scenario when subjected to a 100% pulse demand variation, for reasons previously explained. At first, this seems illogical, since in the sine wave variation of the demand, the demand is only transferred from one day to the next day, whereas in the pulse variation, the increase of the demand is real. This is because, even if the demand variation of one day compensates the other, consecutive demand disturbance confuse the control systems more than just one real perturbation. In practice, this affects the demand forecasting system of the retailer and how the physical store stock is replenished by DC. Therefore, the less consecutive disturbance of the demand, the better the customer service level. Another observation was the stock availability for the online demand. There was no stockout to comply it, except, again, in the online structure of the multichannel scenario when subjected to a 100% pulse demand variation. This is because the online sales have priority over the others outflows. In doing so, they only experience lost sales when the stock volume of their stock points is less than their demand. However, since CR and HD have a low sales share, 0.95% and 4.05% respectively, this makes the occurrence lost sales difficult. Even though the results of stock levels and lost sales have been quite similar both in multichannel schenario, and in omnichannel scenario, the envolved costs in other logistic activities, such as warehousing, transportation, purchases and deliveries consolidated, resulting from a shift from multichannel to omnicanal, could more than justify the decision. The objective here is not to state that the omnichannel strategy impairs the level of service, but rather to point out that inventory levels should be adjusted so that inventory availability is not impaired. In other words, these results are considered a cautionary note to retailers who are planning to adopt an omnichannel strategy and are concerned about maintaining their level of service. With this in mind, it is suggested that future studies consider such costs in order to evaluate the feasibility of a transition from a multichannel to omnichannel strategy. A final comment is the demand, sales, and demand forecasting relationship. The demand forecasting considers the sales as a reference. However, when there is a stockout, even though demand had existed, its conversion into sales is what gets registered. Therefore, the final suggestion for future studies is to analyze the influence of the stockouts on the market share of the company.

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