Improvement Proposal to Achieve Shrinkage Reduction in Home Dispatch Process in Retail Company

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Abstract

In this research the problem is the generation of wastage in the home dispatch (HD) process and in the reverse logistics of a retail sector company, so its main objective will be to reduce them. The DMAIC methodology was used for process improvement. The engineering tools used correspond to Lean Six Sigma such as process standardization and Poka Yoke. After simulating the improvement proposal with the Arena software, the main results obtained were, at 95% confidence, the reduction in the number of reentries, wastage, and absenteeism, as evidenced by the decrease in the confidence interval limits. For the quantity of reentries indicator, the simulated improvement yields a confidence interval of [43.7081 ; 49.8239] units of product re-entered, resulting in values lower than those obtained in the current situation, according to its confidence interval [99.7428 ; 111.3172] units of product re-entered. For the quantity of wastage indicator, the simulated improvement yields an approximate confidence interval of [6.3968 ; 8.8032] units of product wasted, resulting in lower values than those obtained in the current situation, according to its confidence interval [21.4576 ; 25.8744] units of product wasted. For the number of absent customers indicator, the simulated improvement yields an approximate confidence interval of [2.5717 ; 4.0949] absent customers, resulting in values lower than those obtained in the current situation, according to its confidence interval [31.1758 ; 37.1562] absent customers.

Keyword
Shrinkage, reverse logistics, dispatch, DC, and Lean Six Sigma.

1. Introduction
Shrinkage in the home dispatch process represents a loss for any company, not only because it represents lost sales, but also because the customer goes through a bad experience and, if it cannot be declared an expense, it would also become an economic loss (Donderis et al., 2019). Nowadays, all consumers live in an omnichannel environment, using both online and offline channels to shop. The result is an increase in shipments to customers' homes, driving companies to improve their freight systems, making them more efficient and sustainable (Buldeo et al., 2019). Due to the recent omnichannel boom, the current freight systems of companies that ship products directly to the customer's home are still in the process of optimization. This generates customer dissatisfaction due to failures of the system itself, causing a high number of product returns to the DC's inventory. These returns imply a greater handling of the product, which increases the probability that it will be damaged, generating losses when it turns into shrinkage. Considering that most processes generate shrinkage or defective products, it is of great importance for companies to look for ways to reduce these losses, thus improving their productivity (Donderis et al., 2019).

In the same way, the processes involved in home dispatch consume resources such as processing time (H-H), the material that was used in packaging and shipping, etc. If to this is added the wastage generated, it results in a significant cost. In addition, waste contributes to environmental pollution, as it is part of the company's solid waste. Currently, a major problem of concern to society is pollution, which, in turn, is one of the various causes of climate change. The latter has negative effects such as global warming, rising sea levels, adverse effects on various resources, among others (Condori, J. et al., 2022, p. 1). Given that pollution is the beginning of several environmental problems, it is important to mitigate its causes, such as the generation and inadequate management of solid waste. The lack of knowledge about the care of the ecosystem and the effects of its deterioration have aggravated this problem, since people tend to prioritize their own economic benefit before environmental welfare (Delgado et al., 2021, p. 614).

1.1. Objectives
The general objective of the research is to reduce the waste generated in the HD process in a retail sector company. The specific objectives are as follows:

- Define the process of the company belonging to the retail sector in which the greatest amount of waste is generated.
- Identify the main causes of shrinkage generation in the HD process in the company belonging to the retail sector.
- Propose specific improvements for the main causes of shrinkage generation.
- Validate the effectiveness of improvement proposals.

2. Literature Review

Peruvian tax regulations define "shrinkage" as a physical loss of inventories, which is generated by causes inherent to their nature or to the production process (Ferrer, 2010). The research by Donderis et al. (2019) recognizes as a problem the economic losses because of the generation of shrinkage in the processes, making use of the DMAIC methodology and finds the relationship between the variables that explain the identified shrinkage. These losses are generated in various sectors, including the retail sector. Problems such as high return rates and low efficiency in the management of returns contribute to the generation of these shrinkages. This increase in product returns occurs due to one of the biggest challenges for omnichannel retailing, which is its inability to provide customers with the opportunity to touch and feel a product before purchasing it (Mandal et al., 2021). Also, due to the convenience and no cost to cancel the order, omnichannel retailing with an online reservation, pickup, and payment option in-store can hurt the retailer by increasing the rate of order cancellations by the consumer (Zhang et al., 2018). Cancellations are, for retailers in the industry, as much of a concern as returns. With respect to high return rates, other strategies such as Buy Online and Return in Store (BORS) are sought to be adopted (Huang and Jin, 2020). Similarly, with the BORS strategy and other mechanisms such as the use of return insurance and offering a virtual proof to the consumer, the aim is to increase efficiency in the management of these returns (Yang and Ji, 2022).

On the other hand, in the case of logistics service, it is important to include the customer's perspective in order to achieve customer satisfaction and promote their intention to repurchase, as proposed by Frieska and Hsu (2022). A related problem that affects both the level of service and its costs is "missed deliveries", i.e., those that were not carried out due to the absence of customers at their homes (Seghezzi and Mangiaracina, 2023). This is due to planning problems, so it is important to analyze the omnichannel retail context and all the channels it encompasses in order to identify such problems in planning (Hübner et al., 2022). It is also necessary to focus on satisfying customer needs, achieving a high level of service by generating a positive customer experience, which is crucial for the success of any business (Vrhovac et al., 2023).

From another perspective, it is important to be aware that omnichannel logistics is undergoing significant changes in retail (Eriksson et al., 2022). Such changes in the macro environment affect and bring with them multiple opportunities and threats for the retail sector (Chen et al., 2017). One such change is that logistics service providers, who generally used to be invisible to consumers, are becoming the main point of contact in this omnichannel environment (Buldeo et al., 2019). This is why one should analyze the business context and look for a good implementation of omnichannel strategies to maximize the retailer's expected profits and, in turn, meet the demand for home dispatch and pickup (Yang et al., 2022)

In order to face the various challenges and changes mentioned above, it is necessary for companies to make improvements in their related processes. Regarding the search for process improvements, one of the tools used for this purpose is Poka-Yoke, used by several authors to ensure the effectiveness of the processes studied in their respective research. An example of this is Cubas et al. (2022), who use an alarm sound to control the correct cooling of their product, in addition to preserving worker safety when operating the cooling machine, and a pick to light indicator in the warehouse to visually indicate the number of products on each shelf and their maximum capacity. Likewise, Quiroz et al. (2022) use a Poka-Yoke that consists of placing a barcode on each product to register orders at a higher speed and reduce errors in their tracking, traceability, and storage, resulting in a 57.77% reduction in order documentation times. Continuing with process improvements using Lean tools, Canales et al. (2022) propose an integral model, validated with a simulation in Arena software, based on the combination of tools such as raw material ordering using the 5S under the multi-criteria approach ABC, FIFO, MRP, Forecasting and BPM, which achieved a reduction in dispatch time and frequency of extra purchases by 7.2% and 50%, respectively.

3. Methods

The methodology used in this research is DMAIC, which has been plotted in Figure 1, because it provides a comprehensive framework that helps to understand and identify the root cause of problems before taking corrective action to resolve them. In addition, this methodology can help to clearly define and measure objectives and to correctly track the performance of the improvements implemented based on numerical data analysis. The inputs are the total number of claims originated in the DC, the proportion of returned products that become shrinkage and the economic losses due to such shrinkage. The expected outputs are a reduction in customer claims due to "damaged product" originating in the DC, a 25% reduction in shrinkage in the home delivery process identified during returns due to "damaged product" and "customer absent", and a reduction in economic losses due to shrinkage reduction. The first step consists mainly in defining the process in which the problem was identified, the root causes of the problem and the objectives of the research. The second step consists of measuring the current value of the indicators to know the situation of the company. The third step consists of analyzing the values obtained and identifying opportunities for improvement. The fourth step is to propose improvements that attack the root causes of greatest impact and, finally, the fifth step is to control the implementation of the improvements.

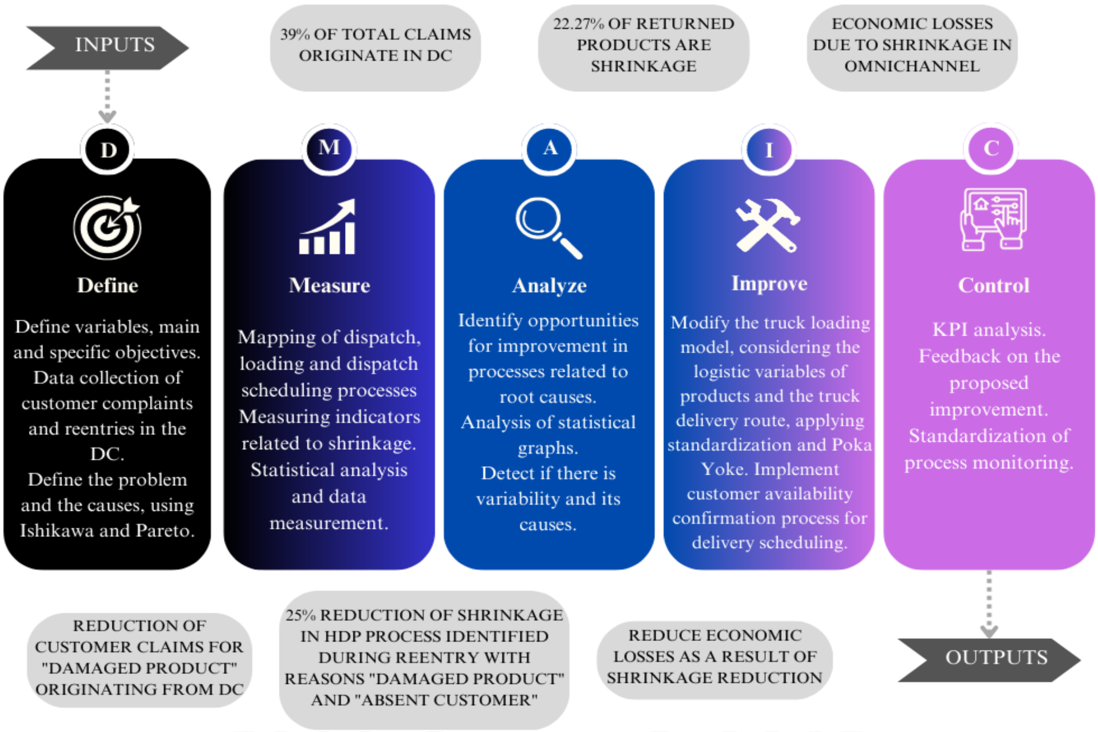

Figure 1. Improvement model to achieve shrinkage reduction.

Likewise, the main variables to be analyzed in the research were defined, as well as their respective indicators, which can be seen in Table 1.

Table 1. Main variables under analysis and respective indicators

Variable	Indicators	Unit of measure
Independent: Omnichannel reentries	Proportion of claims originating in DC among total claims	Percentage (%)
	Proportion of reinstatements due to claims for damaged product or incorrect product among total reinstatements	Percentage (%)
Dependent: Omnichannel shrinkage	Total omnichannel shrinkage in the DC	Units of Shrink products
	Percentage of omnichannel shrinkage out of total omnichannel reentries in the DC	Percentage (%)

Omnichannel returns are basically products that have been purchased through a 100% online purchase and then returned by consumers to the company (Ahsan and Rahman, 2021). Product returns are considered as another dimension of logistics service quality (Cotarelo et al. cited by Frieska and Hsu, 2022). Unlike multichannel retailing, omnichannel blurs the existing boundaries between channels, which work synergistically (W. Gao et al. (2022) cited by Frieska and Hsu, 2022; Trenz et al. (2022) cited by Frieska and Hsu, 2022; Zhang et al. (2022) cited by Frieska and Hsu, 2022). In addition, omni-channel selling shows integrated activities across all chain channels and customer touch points (Verhoef et al. (2022). cited by Frieska and Hsu, 2022). In the case of companies in the retail sector, omnichannel reverse logistics consists of receiving products that were previously shipped but, for some reason, the customer does not accept it. Some of the reasons for reentry may be due to a cancellation of the purchase, a defect in the product, or because the customer was not at the dispatch address to receive the product, among others. The product goes through the whole process again before being shipped.

As for the dependent variable, shrinkage is defined as the losses generated throughout the supply chain. They affect the profitability of the industry, including the retail sector (América Retail, 2020). In most companies, shrinkage is generated, resulting in economic losses and a reduction in productivity. By identifying the main causes of shrinkage, it will be possible to efficiently focus improvement efforts (Donderis et al., 2019). Omnichannel reverse logistics brings with it a higher risk of shrinkage generation, due to the fact that there is greater handling of the goods, and therefore a higher probability of human error. These can be generated by the handling of the operators during the operational flow or by the carrier during the journey to the destination.

The sequence of activities that comprise the improvement process designed with their respective techniques and instruments are detailed in Table 2.

Table 2. Table of Materials, Techniques, and Instruments

Activity	Techniques	Instruments
Analysis of historical data extracted from the system and the cloud to identify probable causes	Quantitative data analysis	Excel
Obtain information from an expert on opportunities for improvement in the process under study to validate the root cause analysis	Interview	Structured questionnaire
Modeling and validation of the improvement scenario by statistical comparison between the current and improved scenarios	Simulation	Simulation software (Arena)

This is an applied research in which the subject of study is a company in the Peruvian retail sector, which, as stated by García et al. (2023), considers large departmental chains, supermarkets and commercial stores that sell various products to a large number of customers. During May 2020, due to the pandemic, sales in the sector fell by 49.87%, with the most affected businesses being clothing, footwear, appliances, and household goods. Despite all this, the pandemic generated a great opportunity in online sales at the end of 2020, which had an increase of 250% in the retail sector (Garcia et al., 2023).

4. Data Collection

The macro-process under analysis in this research is the omnichannel process, whose block diagram is presented below in Figure 2.

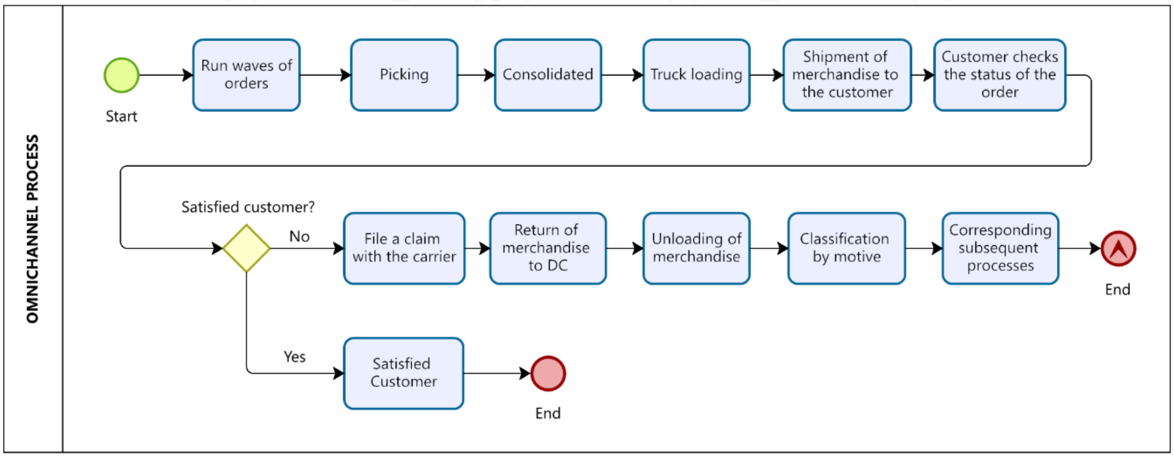

Figure 2. Block diagram of the omnichannel process

According to the diagram presented, the process currently starts with the "wave" of orders. Subsequently, the various orders are picked and then sent to the consolidated warehouse, where the orders are grouped by customer for subsequent loading onto the truck. After loading, the orders are sent to the dispatch point established by the customers. Once the order has arrived at the dispatch point and the customer has checked the product, two situations can occur: the order is in conformity and is accepted by the customer, or the order is not in conformity and the customer complains to the carrier. In the latter case, the order is returned to the DC either because it is damaged, incomplete, incorrect, etc. When the truck arrives at the DC, the goods are unloaded, and their condition is checked. If the product is damaged, it is classified as shrinkage and is separated, communicating to the stock area to make the inventory adjustment. The product in good condition can be stored or loaded in a mobile for later reshipment.

In this research, emphasis will be placed on the analysis of two micro processes related to the macro process presented previously. The first of these micro processes is the omnichannel dispatch process, whose operational flow is shown in Figure 3. The second of these is the scheduling process, whose flow is shown in Figure 4.

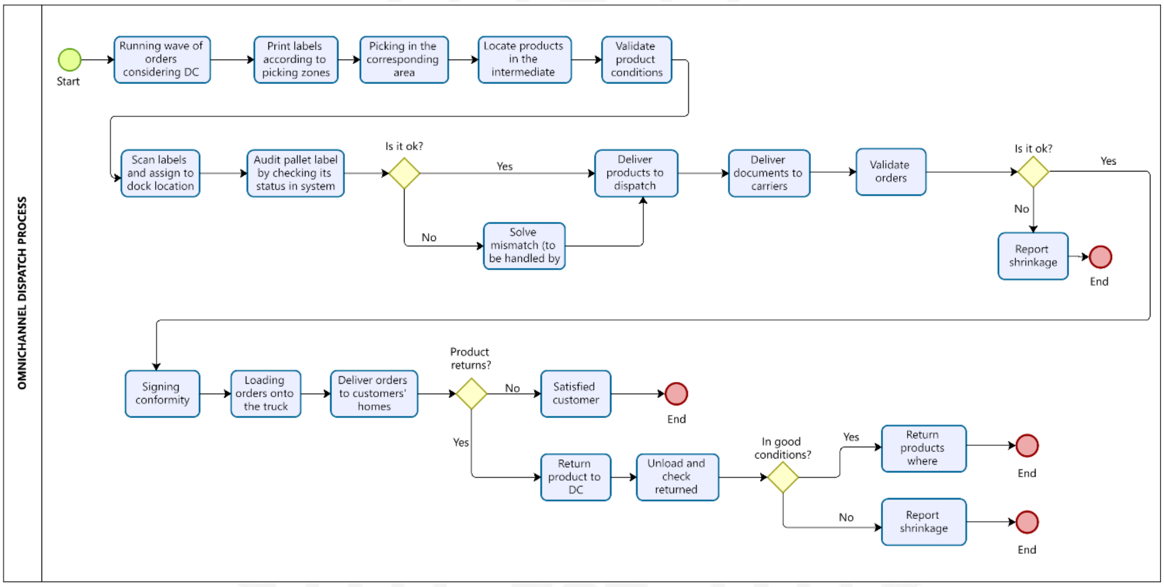

Figure 3. Block diagram of the omnichannel dispatch process

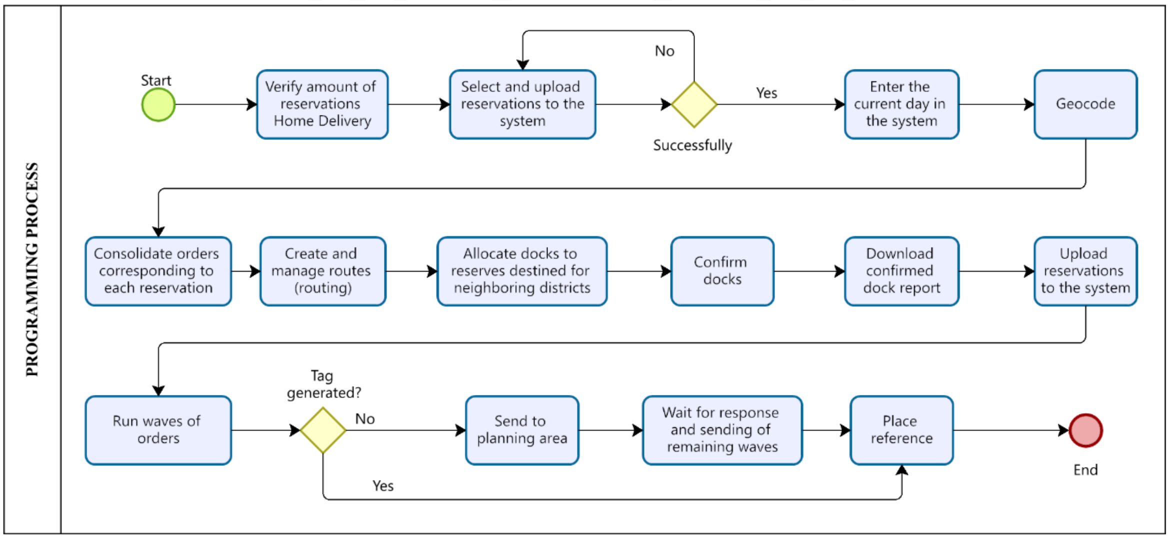

Figure 4. Block diagram of the programming process

To collect the current values of the indicators of interest, historical data corresponding to ten months of the development of this process was used. This is due to the fact that the company only has data since June 2022. The databases used are closely related to the micro processes to be analyzed. In the first place, the database of reentries made it possible to identify the number of states that correspond to the cause of absent customers, which is related to the scheduling process, since successful scheduling should result in a minimum number of absent customers during dispatches. On the other hand, the database of operation loading times is directly related to the HD process, since the variability of these times demonstrates the lack of standard in this process.

5. Results and Discussion

5.1 Numerical Results

To begin with the results, the current value of the indicators selected for the variables explained was compiled, based on the defined sample. This can be seen in Table 3 below.

Table 3. Current value of selected indicators

Indicator	Formula	Current value
Proportion of claims originating in DC among total claims (%)	$\frac{\text{Number of claims originated in DC}}{\text{Total number of claims}}$	38.81%
Proportion of reinstatements due to claims for damaged product or damaged product out of total reinstatements (%)	$\frac{\text{Number of readmissions due to complaints}}{\text{Number of DC omnichannel reentries}}$	22.4% product damaged, 1.36% product incomplete
Total omnichannel shrinkage in the DC (units of product shrinkage)	$T_{(sDC)} = S_{(\text{damaged, broken, incomplete, bad condition})\ DC}$	2781 units
Percentage of omnichannel shrinkage over total omnichannel reentries in the DC (%)	$\frac{\text{Number of omnichannel shrink}}{\text{Number of DC reentries}}$	23.80%

Subsequently, the model of the current process in Arena was developed and it was confirmed that it represents the reality of the operation, comparing the results of such model with the current values of the indicators previously presented.

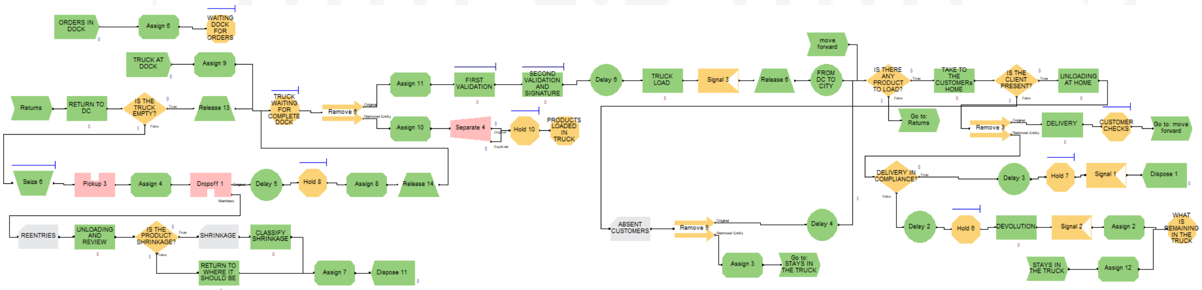

Figure 5. Simulation model of current dispatching process

The following is the result obtained from the simulation model of the current situation, presented in Figure 5, which was obtained after running 30 repetitions of the model with a period between 40 and 45 hours per repetition, obtaining the confidence interval, at 95% confidence, for each relevant indicator. All this can be seen in Table 4. It can be deduced that the simulation model presented is valid since the actual values of the indicators are within their respective confidence intervals. As for the omnichannel shrinkage indicator in the DC, its current value is 25.50 shrinkage units and this is within its confidence interval, which contains values between 21.4576 and 25.8744 shrinkage units. Likewise, the absent customers indicator has a current value of 35.0625 absent customers, which contains values between 31.1758 and 37.1562 absent customers. Finally, the reentries indicator has a current value of 109.5190 units, which contains values between 99.7428 and 111.3172 units.

Table 4. Reality contrast with current model simulation report at 95% confidence level

Indicators	Values of current situation	Confidence intervals
Reentries (units/repetition)	109.5190	[99.7428 ; 111.3172]
Shrinkage (units shrunk/repetition)	25.5000	[21.4576 ; 25.8744]
Absents (customers/repetition)	35.0625	[31.1758 ; 37.1562]

In this way, opportunities for improvement in the omnichannel process were identified. One of these is the number of customer complaints, the most critical reason being "Damaged Product" according to the Pareto Diagram in Figure 6. In this case, the improvement that will be proposed in the research will be focused on the DC, since it is the source of 39% of the claims, besides having a great variety of SKU's. As evidence of the previously mentioned problem, it is known that during the first 15 weeks of the year 2023 (from 1/01 to 16/04) there were a total of 4378 reentries in the DC. When products are re-entered into the company's DC, there is a possibility that a percentage of these products may become waste in the reverse logistics process, which would result in economic losses. During the same period, shrinkage was generated, representing 23.80% of the reentries in the DC.

5.2 Graphical Results

The data from both databases were analyzed by means of the Pareto Diagrams presented. The first diagram, shown in Figure 6, indicates that the main reason for complaints that influence the generation of shrinkage in the process studied is Damaged Product, since this type of re-entry is automatically considered shrinkage. The second diagram, shown in Figure 7, indicates that the main reason for reentry was customer absence, which is relevant to the study because it generates unnecessary handling of the load.

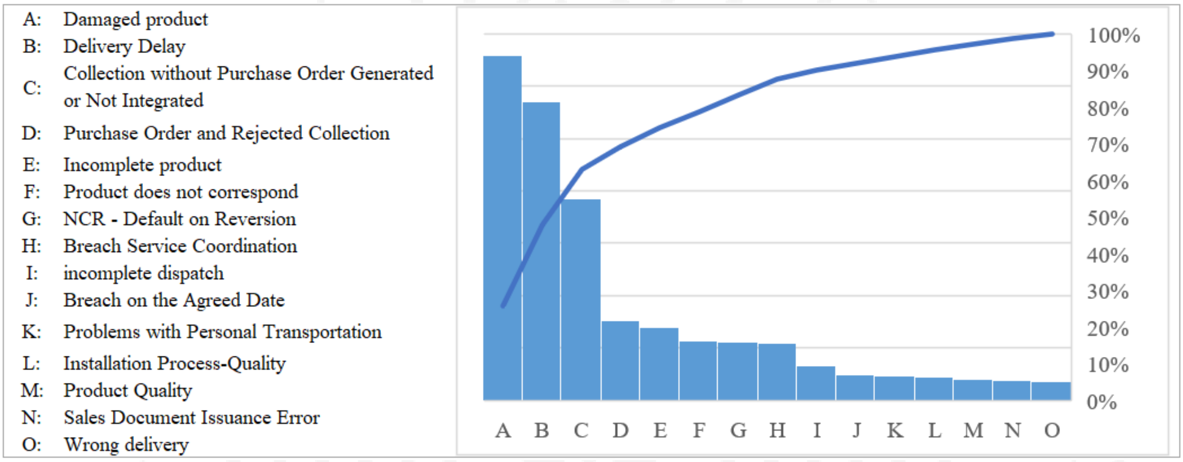

Figure 6. Pareto Diagram of reasons for complaints

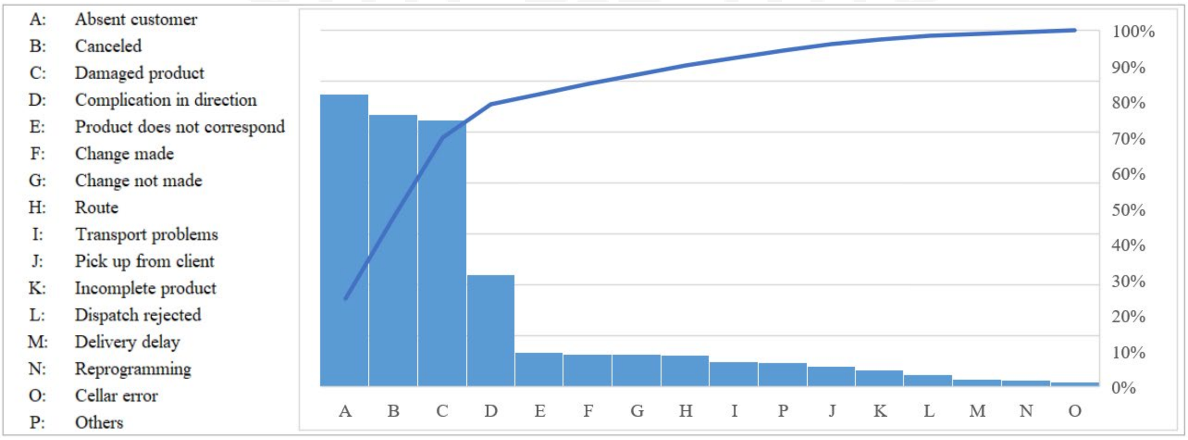

Figure 7. Pareto diagram of reasons for reinstatement

To identify the root causes to be prioritized for the "Damaged Product" problem, an analysis was made using the Ishikawa Diagram tool shown in Figure 8.

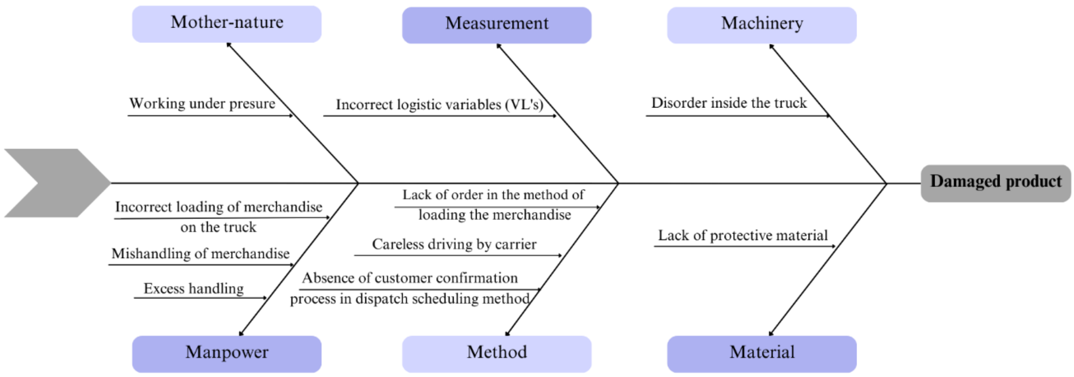

Figure 8. Ishikawa diagram of reentries due to damaged product.

5.3 Proposed Improvements

To reduce the shrinkage generated in omnichannel, there are two proposals for improvement. The first one will be implemented in the scheduling process and will attack the root causes that indicate that the dispatch scheduling method does not consider the customer's confirmation and that there is an excess of handling. The second will be applied in the HD process and will attack multiple root causes such as incorrect loading of goods on the truck, poor handling of goods and lack of order in the loading method.

The first improvement proposal consists of implementing a confirmation process for scheduling the dispatch of orders. The aim is to obtain a verbal confirmation from the customer that he/she will be at home on the scheduled date and time, which will avoid unnecessary handling of orders that cannot be received on the scheduled date. By avoiding the preparation of such orders, the risk that they will be damaged in any part of the process, thus reducing waste, is reduced. To develop this improvement, a Dispatch Confirmation Process Guide will be implemented, presented in Figure 9, which shows the stages of the confirmation process and an example of the call and its possible results. Among these, it could happen that the customer agrees to receive the order on the scheduled date and, in such a case, the status of the reservation will be changed to "Confirmed" in the system. On the other hand, it could happen that the customer is not available to receive the order on the scheduled date, so the dispatch will be rescheduled to a date and time requested by the customer. This call will be made 24 hours before the first schedule and, if the customer is not available, the customer will be contacted again 24 hours before the proposed date to confirm availability with certainty.

Delivery Confirmation Process Guide

Steps

1. Determine customers who are scheduled to have their order shipped.
2. Call each customer to confirm their presence at home on the scheduled delivery date and time.
3. There are two options derived from the customer's response in step 2:
   3.1. The customer confirms their presence: proceed to communicate the customer's response to the relevant areas and prepare the order for subsequent dispatch.
   3.2. The customer does not confirm his presence: the shipment is rescheduled, so the order is not prepared until the customer confirms his presence in another call prior to the rescheduled date.

Confirmation call template

Glossary:

Customer Service: CS
Costumer: C

Example of a Call:

CS: Good morning, may I speak to Mr. Vargas?
C: Good morning, yes, this is Mr. Vargas
CS: Mr. Vargas, how are you? We are calling you from [company name] about your order that includes [product(s) in the order]. Do you recognize this order?
C: Yes of course, I placed it a few days ago.
CS: That's right sir. We are calling you because the delivery of your order is scheduled for [mention scheduled day, date, and time frame] and we wanted to confirm that you will be at home to receive your order at the time of delivery.

Option 1:

C: Yes of course, I will be present.
CS: Very good sir, then I will proceed to confirm the delivery of your order which will be arriving on the date mentioned. Thank you very much, have a nice day.
C: Thank you very much.

Option 2:

C: Oh no, I am sorry I will not be at my home address on that date/time.
CS: I am sorry to hear that sir, could you give me a date when we can deliver your order to reschedule the delivery, please?
C: Yes of course, please deliver my order on [day, date and time frame as requested by the customer].
CS: Alright sir, I have rescheduled your delivery for [day, date and time as requested by the customer]. The day before this new date we will be contacting you again to ensure your availability to receive your product.
C: Thank you very much for your support.
CS: It is my pleasure to help you, have a nice day.

Figure 9. Confirmation Process Guide

The second improvement proposal consists of developing a new model for the process of loading goods directly to the customer. This takes into account the logistic variables of the products, particularly the weight to know if it is a product that can support others on top or not. The resistance of the product in question must be considered, if it has a maximum resistance of 20 kg, then only products that the sum of their weights does not exceed 20 kg can be loaded on top of it. Also, consider the dispatch route that the truck will follow to avoid unnecessary handling at the time of unloading the goods at the customers' homes and to avoid delays in such unloading. The orders will be arranged according to the order of the destinations to which the truck is headed. In other words, the loading will begin with those reservations belonging to customers whose homes are the last destinations on the established route. In this way, the carrier and the stevedores will have within their reach the orders to be delivered to the first destinations and so on, saving time during unloading, since they will not look for the order among all the products in the truck, but only in those within their reach. In addition, two areas of the truck have been established to hold products that have been rejected by the customer for any reason. These zones are located at the ends of the truck, in the part closest to the door. They can be identified as the yellow zones in Figure 10. For small/medium products, stackable bins will be used to keep the truck tidy inside and provide additional protection for these products. These bins are numbered according to the zones of the truck divisions, making it easier to identify which one to load first. This serves as a visual aid to avoid errors by the stevedores during loading, thus speeding up the process. This new model will become a standard for loading goods in the HD process and will be included in the respective document. Finally, after applying the improvement in the omnichannel dispatch process, the diagram will look as shown in Figure 10.

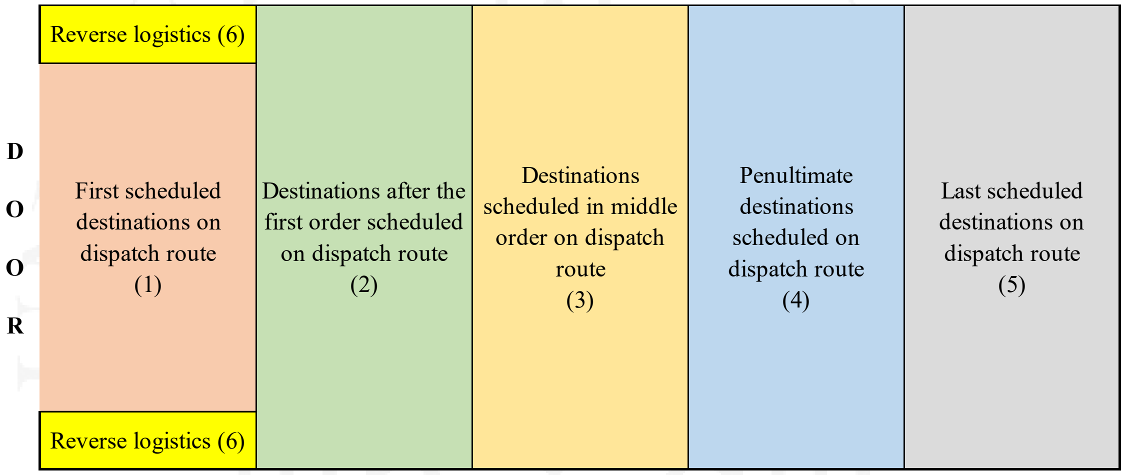

Figure 10. TOP view of order distribution inside truck

5.4 Validation

Figure 11 shows the change in the flow of the omnichannel dispatch process when applying the proposed improvement in the loading method, as evidenced in the 'Validation 1' Process, to which the classification of orders was added, at the same time as the first validation. Both this Process and other modules have a blue box behind, which represents the changes that occur due to the improvements, either in terms of time or percentages.

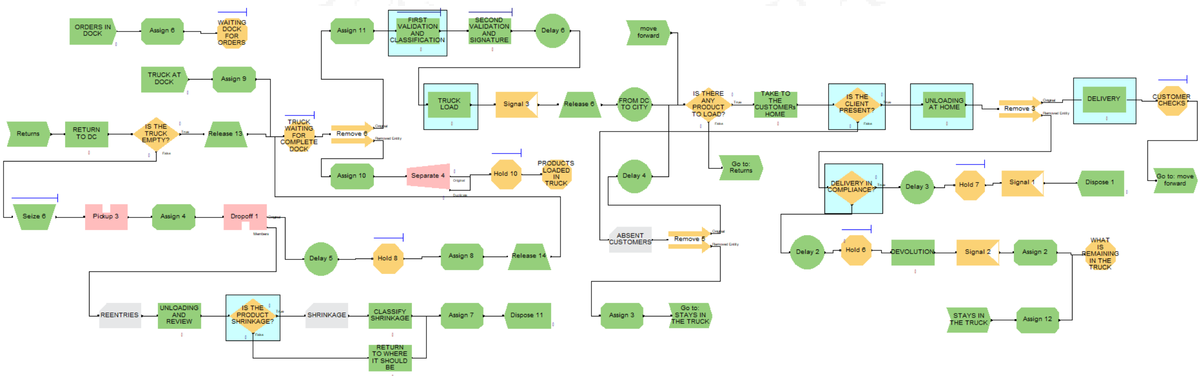

Figure 11. Simulation model of improved dispatching process

The graphical results of the simulated model intervals will be presented below.

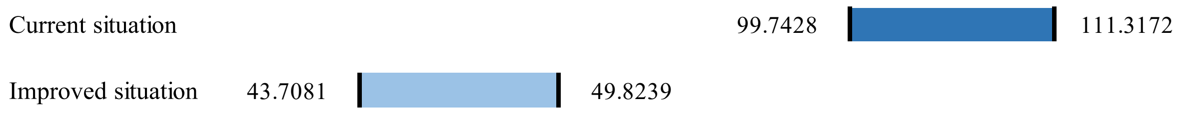

Figure 12. Confidence Interval - Reentries (units/repetition)

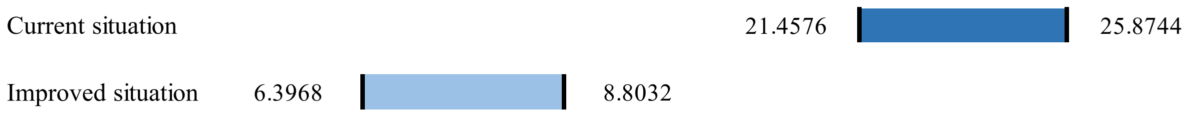

Figure 13. Confidence interval - Shrinkage (units shrunk/repetition)

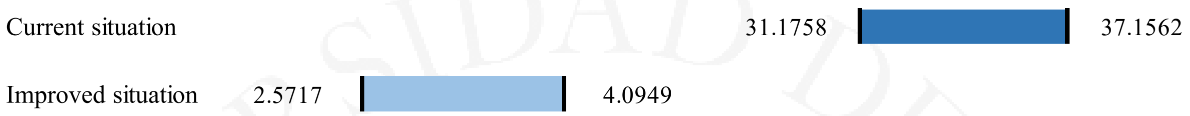

Figure 14. Confidence interval - Absent customers (number of customers/repetition)

For the quantity of reentries indicator, the simulated improvement yields a confidence interval between 43.7081 and 49.8239 units of product re-entered, resulting in values lower than those obtained in the current situation, according to its confidence interval between 99.7428 and 111.3172 units of product re-entered, which can be seen in Figure 12. For the quantity of wastage indicator, the simulated improvement yields an approximate confidence interval between 6 and 9 units of product wasted, resulting in lower values than those obtained in the current situation, according to its approximate confidence interval between 21 and 26 units of product wasted, which can be seen in Figure 13. For the number of absent customers indicator, the simulated improvement yields an approximate confidence interval between 3 and 4 absent customers, resulting in values lower than those obtained in the current situation, according to its confidence interval between 31 and 37 absent customers, which can be seen in Figure 14. Based on the comparison of intervals, it can be affirmed that the modeled improvement achieves the results expected in the research.

The decrease in the number of reentries and no-shows was due to the improvement in the dispatch scheduling process with the implementation of the confirmation call, which reduced the unnecessary handling and loading of products that would not be delivered, thus reducing the number of products that could be reentered due to customer no-shows. In addition, the reduction in wastage was due to the improvement in the home dispatch process, which consists of classifying orders according to zones on the dispatch route and placing them in the truck so that the first ones to be delivered are closer to the door and considering the resistance of the products in case they are stacked. The use of numbered crates according to zones for small or medium-sized products facilitates the loading process, since having the products better located and correctly distributed simplifies the unloading process at the customer's house, providing greater order in the truck, which in turn reduces excessive and unnecessary handling throughout the entire home dispatch process. Likewise, this improvement has an effect on the reduction of the reentry quantity indicator since fewer products would be handled during reverse logistics.

Finally, the Control stage will be carried out with the help of the indicators mentioned above. These will be calculated on a weekly basis, so that the effect of the new loading model can be visualized. In case there is an unusual variation in the indicators, an alert will be given that a review of the process and the respective adjustments are necessary. Furthermore, these changes will be documented, so that everyone in the company will be aware of the new charging model.

6. Conclusion

The generation of shrinkage is an existing problem in the retail sector and affects both the economic results of the company and the level of service provided and the satisfaction perceived by the customer. With respect to the objectives, it was possible to define that the process in which the greatest number of shrinkages is generated is the one related to dispatch to the end customer, which has as its antecedent the lack of order in the method of loading merchandise in the distribution center. The main causes of shrinkage in the HD process were also identified. Some of these, such as excessive handling, mishandling of goods and incorrect loading of the goods on the truck, were related to the Labor factor, and others, such as the lack of order in the loading method and the lack of customer confirmation in the dispatch scheduling method, were related to the Methods factor of the cause-effect analysis. In addition, specific improvements were proposed for the mentioned causes, which were the implementation of the confirmation call in the scheduling process and the standardization of the loading method. As a result, it has been demonstrated that, at 95% confidence, the proposed improvement achieved a reduction in the number of reentries, wastage, and absenteeism, as evidenced by the decrease in the confidence interval limits. This fulfills the objective of the research by reducing the amount of waste generated in the process. If the company decided to adopt the proposed improvements, it would be able to reduce the number of reentries, the shrinkage generated, and the number of customers absent during home dispatch. The reduction in shrinkage would result in a reduction in the resulting economic loss and the improvement in the scheduling method would reduce the unnecessary handling of those products that the customer could not receive due to their absence, which would also reduce possible losses due to shrinkage that could be generated during the unnecessary trip and would improve customer satisfaction.

During the development of the research there were certain limitations, one of them being the lack of accessibility to carry out a pilot since the operation of the company cannot be stopped or hindered because it would affect the level of service. Despite this, the simulation was a useful alternative to obtain consistent results in the study. Another limitation was the lack of data standardization of the different company databases. An example of this is the database for receiving readmissions, since the reasons for readmissions did not have a standard name, as defined in the reasons for claims, but a description made by the person in charge of entering the information into the system, and this had to be standardized manually. Finally, another limitation was the existence of atypical periods identified in the data, which did not allow a direct analysis without the need to smooth the times corresponding to these periods. For future research, it is recommended to strengthen the optimization model, taking into account the detail of the logistic variables of the SKUs such as volume, exact dimensions, weights of each unit, as well as to perform a more in-depth analysis by families or SKUs, considering the frequency of purchase. In addition, it is suggested to explore the possibility of implementing small shelves or racks inside the trucks that will be delivered to the customer's home, so that the products do not suffer damage in transit and are better secured to the structure. Likewise, this study does not consider the variability of travel times within the city, so it would be convenient to take this aspect into account in future research. Likewise, it would be a great contribution to consider route optimization as a complement to the improvement to be proposed. Finally, if possible, it is suggested to carry out a pilot that could complement the results of a simulation of the optimization model to be proposed.

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