Improvement of a Transportation Network
Worten's Case Study

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Abstract

Faced with increasingly competitive markets, companies tend to expand their brands and services geographically. Thus, in order to ensure that the service provided to the customer meets its expectations and serves as a differentiating factor to the most direct competitors, the logistics network plays a decisive role in companies' success. The need to distribute products in the right time, quantity and location implies rigorous and thorough management of the distribution network, ensuring the highest possible profitability of resources minimizing transport costs while increasing the service level provided to the customer. Worten, the largest consumer electronics retailer in Portugal, recognizes that its distribution network is not properly optimized, showing opportunities for improvement, particularly regarding the creation of synergies between the multiple existing distribution channels and the change of the assumptions that have been in place for too long, requiring a critical review. This reality motivated the development of this dissertation. In the present work, a logistical network characterization was carried out, with a special focus on transportation, where the main inefficiencies in several flows are identified. In order to frame the problem, a review of the existing literature on transport, distribution, lean thinking and e-commerce was carried out. Subsequently 3 case studies were defined where several methods of analysis, such as Value Stream Map, were used to analyze the operation and identify and eliminate waste. Finally, proposals for disruptive initiatives that will make operations more efficient and adequate to the current market scenario are presented.

Keywords: Efficiency; Logistics Network; Transportation, *Value Stream Map*; Worten

1. Introduction

Faced with increasingly competitive markets, companies tend to geographically expand their brand and services. Thus, in order to ensure that the service provided to the client is in accordance with their expectations and serves as a differentiating factor for the most direct competitors, the logistics network plays a decisive role in the success of the companies. The need to distribute products in the correct time, quantity and location implies strict and thorough management of the distribution network, ensuring the highest possible profitability of resources in order to minimize transport costs while increasing the level of service provided to the customer.

Worten, the largest retailer of consumer electronics in Portugal, recognizes that its distribution network is not

properly optimized, offering opportunities for improvement, in particular as regards the creation of synergies between the various existing distribution flows and the change of assumptions that have been in force for a long time without being reviewed and challenged. This reality motivated the development of this dissertation.

In this work, the present work intends to contextualize and characterize the logistics network, with a special focus on the distribution area in order to identify the main inefficiencies of the various flows. Initially, the literature on transport, distribution, lean thinking and e-commerce will be reviewed. Subsequently, alternatives will be defined to the inefficiencies identified and, after testing and simulating their implementation, the results will be presented that will allow conclusions to be drawn from the work developed and to be developed.

2. Worten's Case Study

2.1 Problem Description

Worten, founded in 1996, is an organization characterized by its competence in the field of consumer electronics and entertainment. Its excellence is translated into the proximity and quality of the services provided to consumers, either through their physics scattered throughout the national territory or through their home delivery services. With only one distribution center to meet all needs and operating with essentially three logistical operators, transport operations represent a core branch of the quality of the company's operation and the logistics costs verified.

Having the quality of the service provided to the client as a key factor, premises and particular modes of management were defined to each service (Figure 1).
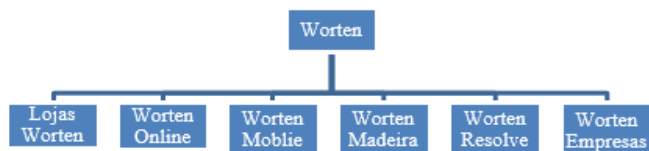

Figure 1 Worten's Services

In this study will focus on Chronopost, that is responsible to deliver all Worten Mobile, Worten Online and Worten Resolve cargo, and Luís Simões that is in charge of delivering cargo to Worten stores.

However, this individualization is a very complex and expensive task for the company, both in terms of information management and in terms of resources used. Focusing on transportation area, this procedure has led to a record of 10 million euros in 2016.

In this sense, adopting a lean approach consisting of a set of 5 principles - specify value; identify the value chain; analyze the flow; evaluating the pull method and the search for perfection (Womack *et al.*,1996) - Worten needs an in-depth analysis of all its logistic distribution processes to evaluate the possibility of creating synergies among the various existing flows in order to monetize available resources. In addition, it is intended to evaluate if the logistical assumptions defined for each service at the time of its creation still fit in the needs of the market or if they have become obsolete and represent an inefficiency for Worten's current reality.

2.2 Identified inefficiencies

Through a primary analysis of the entire transport network, three possible improvement opportunities have been identified.

2.2.1 Case study I: Review of Chronopost's transportation flow

In this case study, it is intended to evaluate whether the current distribution and billing method provided by the logistic operator Chronopost is most appropriate to the current situation since there is an annual increase of 12% in the e-commerce market (U.S Department of Commerce 2018). Any flow made by Chronopost, originating from the Worten distribution center in Azambuja, can be divided into

three phases (Figure 2):

- **Primary Transportation:** Initially, all cargo related to home deliveries, supply of mobile stores and the PIS service (Worten Online), is dispatched on D-day from Worten's distribution center and sent to the Chronopost Lisboa 1 Warehouse.

- **Middle Transportation:** A first sorting of the merchandise is carried out, consisting in allocate the articles in the respective truck in charge of transporting, at dawn of D + 1, the merchandise to the corresponding Chronopost warehouse. This allocation of each article by one of Chronopost warehouse is done according to the postal code of destination of the article. This happens because each of the 13 Chronopost's warehouses has defined a range of postal codes from which it is responsible.

- **Final Transportation:** Finally, in the respective Chronopost warehouse that covers the delivery area of each order, on the morning of D + 1, the merchandise is further sorted to divide the articles by smaller vehicles and deliveries are made.
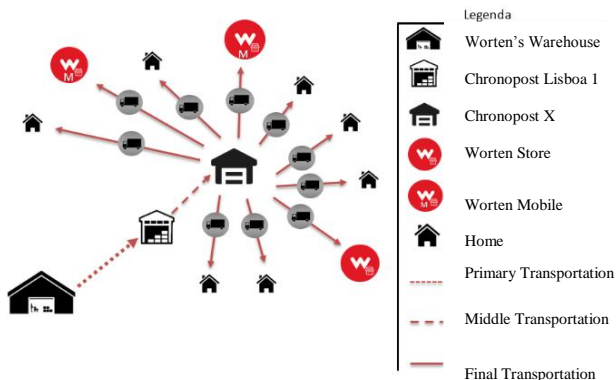

Figure 2 Illustration of Chronopost logistic flows starting in Worten's Distribution Center

For the transaction of each good from Worten's warehouse to a certain address a representative guide of this flow is created. Each guide will have an associated cost depending on the weight range and the route in which it fits. For example, despite two goods having traveled through the same distribution centers and possibly delivered by the same employee on the same day - these flows will have a

individual and independent billing of the rest because they have different destination addresses. So, despite having one or 100 goods, Worten will not optimize its resources and transportations costs per article transported. In addition, the current features of Chronopost's distribution service for next business day delivery requires that the production of merchandise at the Azambuja distribution center is limited to a 4p.m. cut-off time (the last hour that will allow customer's orders to be prepared and delivered for next-day delivery).

To identify opportunities to improve profitability of the current processes, a Value Stream Mapping will be done to visualize, align and focus the value chain of these articles throughout the distribution network.

2.1.1.1 Value Stream Mapping

VSM, "a pencil and paper tool that helps to understand the flow of material and information along the path of a product through the supply chain" (Rother and Shook 2003), is used to define and map the several steps in the Chronopost distribution process and the average time spent on them.

Initially delivery services of Chronopost were illustrated in a sequential way from the point where goods are shipped (Worten's distribution center), passing through multiple stages, until it is deliver to the final destination. In this representation, the PT corresponds to the sum of the number of hours required to perform each activity (TA). In turn, LT is calculated by summing the time of accomplishment of each step (TR) and the waiting time (WT) to do it. Finally, the efficiency of the process (PCE) will be calculated, in percentage value, as the division of the PT with the LT (equation 1):

$$PCE = \frac{\sum_{i=1}^{n} T_{Ai}}{\sum_{i=1}^{n}(T_{Ai} + W_{Ti})} \times 100\% \qquad (1)$$

Using information colleced in 2016, combining all data of the participants in the VSM and respecting the subtitled symbology, the flow was mapped (Figure 2):
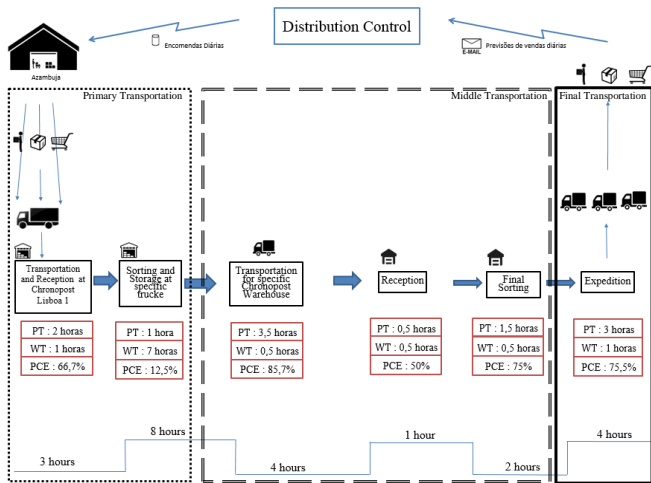
Figure 2 Value Stream Mapping of Chronopost's flow

Middle and final transportation presented satisfactory PCE values. On the other hand, the primary transport presented an unsatisfactory PCE. The transportation of merchandise to a warehouse at 40km and subsequent reception and sorting represents an opportunity for improvement since 8 of these 11 hours correspond to waiting time (WT) and an associated PCE of ~ 27.3%. This reality translates into an increase in the lead time of delivery without adding any value to the service provided since there is no handling of the merchandise. Regarding that there is a time limitation form Chronopost and afterwards the goods will be stored for long periods of time, a review of Chronopost's primary transportation process is needed.

2.2.2 Case study II: Consolidation of Worten's stores supply pallets

The division of flows inside the warehouse, excessive restraint not to group too many articles for fear of damaging them, the need to satisfy the stores in the mode of shipment of the merchandise and apprehension of changing existing processes, leaded to an excessive wastage of space the pallets (Figure 4). In this context, the was identified the need exploit existing operating assumptions in the company that have become obsolete and need to be reviewed because Worten pays the transportation of each pallet.

Noticing this, to improving the daily processes, a change of the current paradigm that requires that each pallet only

includes articles of a certain production flow of Worten's distribution center was requested. As alternative, a stage of consolidation of pallets in the daily flows in the warehouse was proposed.

2.2.3   Case study III:

Figure 4 Two cases of inefficient consolidation of pallets

The investment made in the Worten Resolve service in the year 2016 had the effect of an exponential growth in the volume of repairs carried out. With the scope of providing a quality and efficiency service to customers, freight services are carried out whenever there is information from stores that have an article for repair or an indication from the repairer that an item is repaired and ready for collection. This led to Worten at a total cost of more than 1.4 million euros in 2016, motivating the collection of information on all transport flows in order to characterize the service in detail and obtain information from the guides transported daily. Based on the analysis of this information, the following proposals were presented for review of the distribution operation:

- Logistic operator: In the Worten After Sales Service, regardless of the number of units, weight - up to 40kg - or typology of articles, Chronopost will always be the operator responsible. However, there are flows between stores and repairers that stand out from the rest with the high volume transported between the two daily. In this way, the proposed alternative is to evaluate the adaptation of the logistics operator according to the characteristics of the transportation request in order

to change the transportation of the merchandise as economically as possible.

- Frequency of collection in stores and repairers: Currently, whether the store / repairer contains one or several repair processes for distribution, Chronopost will collect. In this way, the intended improvement is to define specific days of collection in order to aglomerate repair processes and to make the journey more profitable, since Chronopost's billing method is based exclusively on weight grades in which each volume inserts and even within these same ranges, the higher the weight (up to 40kg), the lower the weight per kilogram carried (figure 5).
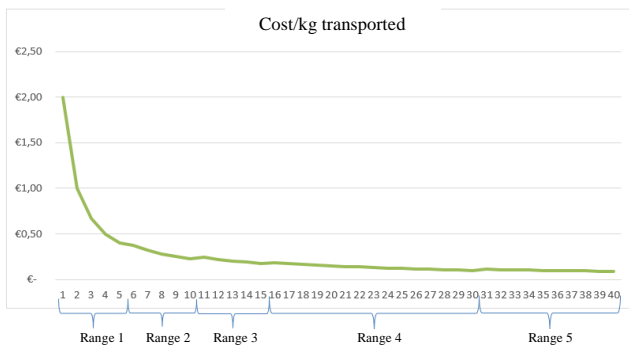

Figure 5 Cost per kilogram transported by Chronopost

3. Case Studies Resolution

The purpose of this chapter is to analyze in an analytical way the case studies presented in the previous chapter. For this the chapter will be divided into three sections that correspond to the three case studies. In order to present the future operations (to-be) that intend to mitigate the identified inefficiencies, after simulation and possible implementation of the proposed alternatives, the impact of these alternatives will be evaluated in order to draw conclusions from the work developed.

3.1 First Case Study Resolution

There will be 2 different proposals for this case study. The first simulation will rely on the transportation of goods from the Azambuja distribution center to the Chronopost Lisbon 1 distribution center. In the second simulation, the primary transport will be eliminated and the middle transport flow will be allocated on the carrier Luis Simões and there will be a direct flow between Azambuja and all 13 Chronopost's warehouses. Since Luis Simões only deals with pallets, the total volume of goods transported daily will be added and an estimation will be made on the number of pallets that would be needed to store and transport these goods.

- Calculation of the total daily cost of primary transport to be made by Luís Simões:

An expression was defined that allows to estimate the total volume of goods sent daily and the number of pallets to which they correspond. Allowing to calculate, the total estimated daily transport value:

$$\frac{\sum_{j=0}^{n} V_{SKUj}}{Vpalete} * 5,35€ \tag{2}$$

Table 1 Rentability of increasing Luís Simõe's flows and decrease
The numerator of equation 1 corresponds to the sum of volume (V) of the goods (SKUj) transported according to the total number of goods (n) for each day. Regarding the denominator, although the useful volume of a pallet corresponds to 1.00 x 1.20 x 1.80 = 2.16 m³, to avoid damages - excess weight or overload on the goods that form the basis of the formation of the pallet - Vpalete is attributed the value of 70% of the total volume, that is, 1,50 m³. Lastly, in order to obtain the cost of transporting the Azambuja pallets to the Chronopost Lisboa 1 warehouse, the value of € 5.35 corresponding to the value charged by Luis Simões for a pallet delivered in the Lisbon district was allocated.

- Calculation of the total daily cost of capillary transport to be performed by Luís Simões:

$$\frac{\sum_{j=0}^{n} V_{SKUj}}{Vpalete} * CHRk \tag{3}$$

In this alternative, instead of the goods being shipped to the Chronopost Lisboa 1 warehouse, Luís Simões is in charge on transporting goods to the multiple (k) national

Chronopost warehouses. Since each of the 13 Chronopost warehouses is responsible for a certain range of national postal codes, it was needed to, according to postal code of the destination address of each article, allocate the corresponding Chronopost warehouse (k). In this way, the daily analysis will be performed 13 times, where the variable CHRk corresponds to the cost per pallet transported to the warehouse k that varies according to the Chronopost's warehouse location.

In the next step, a simulation was done by adding the total daily calculation of equation 7 to the real costs verified to the transport the goods by Chronopost that day. Naturally, the same simulation was done to equation 8 (alternative 2).

However, Luís Simões, in both alternatives, is in charge on performing part of the service previously provided by Chronopost. Due to this fact, it is not reasonable that the tariff charged by Chronopost is the same in the flow currently in force and in these two alternatives presented. As such, in order to negotiate with Chronopost a reduction of the tariff practiced, it is intended to idealize the percentage reduction that would have to be applied in the Chronopost billing so that the cost of transportation Luís Simões combined with the cost of transportation Chronopost does not exceed that which was verified on that day.

Table 1 Estimated costs for both alternatives

	REAL	10%		15%		30%	
		Alternative 1	Alternative 2	Alternative 1	Alternative 2	Alternative 1	Alternative 2
Nº OF INEFFECTIVE DAYS	-	31	58	30	40	30	38
TOTAL COST (€)	765.629,6 €	666.273,0 €	694.175,1 €	628.246,4 €	656.147,6 €	591.752,4 €	619.653,6 €

Analyzing table 1, it is possible to verify that the reduction of the Chronopost tariff by 10% - it is estimated that it could reach 20% if the second alternative applies - would provide a minimum reduction of 70 thousand euros per year.

3.2 Second Case Study Resolution

After some resistance by the operational managers in the warehouse and the stores on adding a stage of consolidation of merchandise, a pilot test was validated. Regarding that it was a test that would be established in a universe of only 10 Worten stores for a month, there was a need to select 10 stores in a judicious way so that a sample of all types of existing stores were studied. To ensure that the choice of stores to be as assertive and representative as possible, a Data Mining technique was used, which consists in the use of the k-means clustering algorithm.

This model allows to separate the stores in groups considering their characteristics. Applying this model, it is intended to form 10 distinct groups (clusters) of stores according to the characteristics of their shipment. As such, the stores will be grouped according to the following characteristics verified in 2016: **X1:** Average of 701's[*] goods sent / week; **X2:** Average 708's goods sent / week; **X3:** Average trips to the store / week; **X4:** Average volume of pallets shipped / week.

Collecting this information, 10 stores were chosen in a random manner whose characteristics will serve as fictitious clusters. Based on these values, it was applied the equation 4 which consists of the sum of the squares of the differences between the four characteristics (X1, X2, X3 and X4) of a store and a cluster. The application of this equation allows to calculate the distance of all Worten stores with each of the ten chosen stores previously chosen.

$$\sum (Shop\ A - Cluster\ B)^2 = (X_{1A} - X_{1B})^2 + (X_{2A} - X_{2B})^2 + (X_{3A} - X_{3B})^2 + (X_{4A} - X_{4B})^2 \ (4)$$

For each store, it was identified the fictitious cluster that presented less distance and, therefore, more similar characteristics, and the store was allocated to the cluster in question. When all stores were allocated to a cluster, the

average of the four characteristics of the constituent stores of each cluster was calculated and the values of the 10 clusters intended were obtained. In order to definitively define the 10 clusters, the process was repeated until no store changed the cluster in which it was located. After this, at the end of 13 iterations the 10 groups of stores were defined and it was possible to choose a store representative of each cluster.

Once the action objects have been chosen, it was defined that the consolidation would be carried out by an operator after all the merchandise of a given store was produced and placed in the respective store the shipping port.

Thus, for one month the merchandise consolidation stage was carried out (exemplified in figure 6) in ten Worten stores and the quantity of consolidated pallets, the type of articles in question and the time spent by the operator were recorded.

Figure 6 Example of a result of one successful consolidation

As such, in order to evaluate the return of each consolidation, to the saving associated to the consolidation of two or more pallets, the investment made in human resources (FTE) is subtracted. According to Worten policies it was valued in € 7.5/hour. During the pilot project the following results were obtained (table 2):

Table 2 Result of Pilot Project

PILOT PROJECT	
Consolidation	**Values**
PERIOD	20 DAYS
SHOPS	10 SHOPS
OPTIMIZATION	627,00 €
FTE COSTS	93,25 €
RETURN	**533,75 €**

Due to the fact that the pilot project focused only on 10 stores, the data were extrapolated to simulate the stage of consolidation of pallets in all stores during the month of May. Finally, through the data obtained in the pilot project, a return on investment of over € 7,300 was estimated in May (Table 3). Extending the time horizon, an annual return of € 85,198 was estimated.

Table 3 Extrapolation for all Worten stores

EXTRAPOLATION TO ALL STORES	
Consolidation	**Values**
PERIOD	20 DIAS
SHOPS	141 LOJAS
OPTIMIZATION	8.597,50 €
FTE COSTS	- 1.286,89 €
RETURN	**7.310,61 €**

3.3 Case study III: Monetization of the Worten's Resolve transportation flow

Following some conditions that the characteristic of the service lacks, namely in the level of service (lead-time) provided to the client, it was defined that the days that could be suppressed would be the Tuesdays or Wednesdays. As such, using Microsoft Excel tools it was possible to manipulate the data to simulate the supply of the Tuesday collections and estimate the total weight that would be collected on Wednesday. For this purpose, a condition has been defined in the Excel tool where you want to define a theoretical collection date. Depending on the date the collection was registered, the word "Second" will be paid if

the actual day of collection was on weekday 2, "Wednesday" if it was on weekday 3 or 4, "Thursday" on the day of collection. if it was on day 5 and "Friday" if it was on day 6. With this information, using a pivot table, a Microsoft Excel tool that allows you to summarize, analyze, explore and present data, it was possible to organize the data in a way to simulate the supply of the Tuesday collections and add those articles to the collections made on Wednesday.

Once the total weight of the articles is obtained, the weight scale and transport cost value charged by Chronopost (figure) is assigned. Table 4 and 5 exemplify the simulation performed at week 6 on the Wrt Lisbon-CPCDI flow.

Collection and billing values verified:

Table 4 Collection and billing values at week 6 of 2016

Week	6				
	Monday	Tuesday	Wednesday	Thursday	Friday
Total Weight	26	14	19	40	22
Total Cost	3,10 €	2,75 €	3,10 €	3,60 €	3,10 €

Collection and billing values estimated:

Table 5 Collection and billing values estimated for week 6 of 2016

Week	6			
	Monday	Wednesday	Thursday	Friday
Total Weight	26	33	40	22
Total Cost	3,10 €	3,60 €	3,60 €	3,10 €

As can be seen, in this small example that includes only one flow and a sampling of only 3 weeks, a saving of: Estimated Value - Estimated Value = € 45.05 - € 38.10 = € 6.95 was estimated. Extending the simulation for the more than 25,000 existing streams and reproducing them for the totality of records for the year 2016, a saving of 30,156.84 € / year was estimated.

4. Conclusion and Future Work

The characterization of the problem allowed to understand that there are 3 points that must be reviewed in detail in order to evaluate if they represent an opportunity for improvement. The main motivation was the need to create synergies between the various flows that guarantee the daily distribution of the various Worten services and essentially to review operational processes in force and which, because of the internal warning of change, have become inefficient and unrelated to the reality of are not reviewed and amended. The reduction of costs of the various transport services of Worten has been presented as the maximum challenge to be achieved, obtaining alternatives that in their total amount to a reduction of 200.00 € / year, guaranteeing the preservation of the level of service provided to the client - and in case number 1 decrease the lead time in one day for 30% of goods delivery - and the optimization of resources, allowed to conclude that the objectives of the study were fulfilled.

Finally, for future developments, the initiative presented - subsequently aborted once its study time exceeded the duration of the internship - consisted in the creation of mini warehouses in certain national zones in order to support the current only Worten warehouse located in Azambuja , will certainly be an interesting study for the future of Worten. Additionally, the exploration of the railway line that is located next to the warehouse - Azambuja's Espadanal station - could boost and monetize the transportation of large quantities of merchandise over long distances.located next to the warehouse - Azambuja's Espadanal station - could boost and monetize the transportation of large quantities of merchandise over long distances.

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