# Analysis and minimization of stockouts in stores in a food retail supply chain:

## The case study of Jerónimo Martins

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### Abstract

This paper deals with a recurring problem on a worldwide scale, which are the stockouts in stores and which can be found in the supply chain of the Pingo Doce stores. Through the analysis of a Pingo Doce store's stockouts and the literature review, it was concluded that stockouts are a critical problem that leads to tangible and intangible losses, and that it should be of the utmost concern to any retail company to pay attention to finding proposals for improvement in this matter. In this paper, two replenishment models were found, based on the Theory of Constraints (TOC), to deal with the problem under study. The results obtained from their implementation were very interesting regarding the stockouts elimination and inventory levels reduction.

**Keywords: Jerónimo Martins, Supply Chain, Retail Industry, MRP, Stockouts, Theory of Constraints**

### 1. Introduction

By 2014, according to the European Commission, the retail sector accounted for 4.3% of the gross value added of the European economy. Retail companies face an endless number of challenges, such as globalization, the rapid development of technology, problems related to the uncertainty of demand and the need to improve customer service on a daily basis (Hsu and Wang 2004; Briscoe *et al.*, 2004; Colicchia and Strozzi, 2012). This sector, especially for the Portuguese reality, has undergone some changes over the last years, being one of the most concentrated and competitive of Europe and having as one of its main leaders acting, the JM Group (BPI, 2014). Given the sheer number of challenges that need to be addressed and the increasing level of customer demand, companies must ensure a sustainable business based on the efficiency of internal and external operations, as well as global customer satisfaction, so that they can take advantage of growth of the sector (Duman *et al.*, 2017). Faced with this reality of increasing competitiveness and level of demand, JM must guarantee the satisfaction its customers, being of the greatest concern at this moment that the market goes through, always satisfy the customer, never leaving him disappointed, especially due to stockouts. Stockouts in addition to representing direct negative consequences that can be quantified in terms of potential lost sales, also represent negative consequences in terms of brand image and reputation. Therefore, the purpose of this paper is to find a replenishment model that minimizes stockouts at JM's Pingo Doce stores, specifically for slowmovers products.

The remainder of the paper is organized as follows. In section two, the case study is presented through the analysis of the stockouts problem for a Pingo Doce store. In section three, works regarding the retail industry, importance of planning and control in the management of supply chains, analysis of global stockout problem and replenishment models of the theory of constraints (TOC) are reviewd. In section four, the store sample and the time horizon of the study are selected and the procedure to follow to achieve the slowmovers products sample is developed. In section five, two replenishment models are implemented, and the results obtained are discussed, as well as, is defined a set of recommendations for the company through the conclusions drawn on the improvement proposals developed. In section six, the main conclusions about the work are presented and suggestions for possible future developments that may be carried out by the company are made.

## 2. Case-study

Jerónimo Martins (JM), is a Portuguese company of international renown that operates in the food business, food distribution and specialized retail sectors. To guarantee customer satisfaction is one of the most important aspects in concern of JM.

In order to allow the operations that deal with merchandise flow to be carried out with the greatest efficiency and rigor, it is necessary for JM to have the information integrated so that the departments are interconnected and informed in real time. For this reason, JM uses the SAP system (Systems, Applications and Products in Data Processing) that is an ERP (Enterprise Resource Planning) system that allows an integrated management of the various departments. Based on the information contained in the SAP system, MRP (Materials Requirements Planning) calculates the quantities needed to replenish to more than 400 Pingo Doce stores and an average of 28.000 products. The MRP is automatically processed overnight from Sunday to Monday, where the required quantities of each product are indicated for the starting week. This suggestion is the weekly planning basis, but every day the MRP is updated so that adjustments to reality are made.

The necessary quantities are calculated considering the sales during the four weeks preceding the time, on which an average is calculated. If the product has been on sale for any of these four weeks, that week is not incorporated into the calculations. MRP also considers the current stock, which is the level of inventory that is intended to have in store and is based on 2 components: (i) theoretical coverage: ensure that the store has a product in inventory for a given number of days; (ii) minimum stock: this component refers to the space allocated to the product on the shelf. Then, the greater number of the two components prevails over the quantity to be ordered from the warehouse. In the end, MRP also applies a seasonal factor based on the previous year's historical data.

Although everything is carried out as rigorously as possible, stockouts have been something that happens every day in Pingo Doce stores. SAP provides a simple evaluation, registration and control of stockouts, and every morning provides an Out of Stock (OOS) event report, which shows the percentages of each item that are already in breach or are about to happen and assigns a cause to each of these events. These causes are assigned automatically by SAP, and can be: master data - blocking problem, the data is not properly parameterized, or there is a missing parameter; service level - supplier does not deliver the quantity agreed in the stipulated delivery time; warehouse delay - delay in transportation between warehouse-store; change of MRP - suggestion provided by MRP is incorrectly changed by store manager; promotion - sales increase higher than expected due to price reduction; reactive/new - when a product is new or is reactive (it no longer belongs to the set and has now been reactivated); forecasting - sales forecasts and estimates are too low; peak sales - exponential sales increase (a value is stipulated which, if exceeded, is considered a peak sales, and no longer a case of forecast error); risk coverage - when risk coverage is incorrectly estimated; stock regularization - any case that leads to errors in the stock count in the computer system (loss of stock, transaction errors, inaccessible inventory and cases of misidentification of the product) that lead to the system registration of negative stock, and requires a stock regularization.

To make a first analysis about the stockouts, a Pingo Doce store was selected. This analysis of approximately two months was performed based on an analysis of more than 10.000 observations of stockouts and it was verified that:

**(i)** The business areas with the greatest number of stockouts were the areas 1002 and 1003 because they are business areas where the perishability component is of great importance, and therefore it becomes even more difficult to predict the quantities required, and area 1001 that covers a very broad group of products.

**(ii)** There is an average of 209 missing items on the shelves per day.

**(iii)** The stockous are constant and the highest occurences happen on Monday and Tuesday. This occurs because it is on the weekend that the largest flow of clients happens and on Sundays there are no stores' replenishments, thus becoming unavoidable the low levels of stock on Monday. Also, Tuesday verifies many stockouts, because it is the day when the promotions of the Pingo Doce stores begin.

**(iv)** The most obvious cause of stockouts was the service level. In second and third places were found the promotions and changes made in MRP, respectively.

It was also noted that there could have been a daily increase of € 62,91 in sales value just for grocery items only if the stockouts caused in this area by service level were resolved. It should be considered that this represents an estimate for only 1 store for 2 months, considering only 1 cause of OOS events for 1 business area. As such, it is important to refer that there are more than 413 Pingo Doce stores, 10 business areas and 10 possible causes of OOS, and it is easy to understand how this value becomes crucial in JM, having a considerable monetary impact. Therefore, stockouts should be a priority to keep the business competitive and sustainable, and this section justified the need to find a replenishment model that reduces stockouts at Pingo Doce stores. The Supply Chain Department of JM requested for this proposal to be made considering the slowmovers articles.

## 3. Literature Review

Companies should consider the efficient integration of the supply chain, to achieve an overall optimization of the same, making all processes more efficient. According to Barbosa-Póvoa (2014), this is a difficult task and the use of tools to support decision-making becomes mandatory. The activities that should be aided by these tools integrate decision making that covers three levels of planning:

- Strategic: long-term, analysis of the needs of exploration and implementation of new opportunities for action, as is the case of the network design phase;
- Tactical: medium-term, to reconcile the company's capacity with the final needs (inventory policies, transport strategies, material flow and resource planning);
- Operational: short-term, scheduling plans, definition of routes and loading of trucks, and allocation of human resources.

Allied to the planning component, there must always be a performance control and verification component to assess the impact of the decisions made and the performance of the chain. In 1997, Supply Chain Council introduced the first version of the SCOR model, which was designed to analyze and identify improvement opportunities in material, information and workflows, and consists of 4 steps: analyzing the competition; configure the flow of materials; align levels of performance, practices and systems; implement the improvement actions.

Despite overall efforts at planning and control, there still exists an average of 8.3% retail products that are not available on the shelf (Gruen and Corsten, 2008). Stockouts have a direct impact on the financial performance of retailers and the immediate sales losses associated with these events are estimated to represent 4% of sales (Gruen et al., 2002), which is equivalent to almost 5% of sales (Sivakumar, 2010). In addition to the negative financial impact, stockouts are also known as events that diminish brand or store loyalty, jeopardizing future sales. In the figure 1 are summarized the conclusions of the literature review regarding possible causes and consequences of the stockouts.

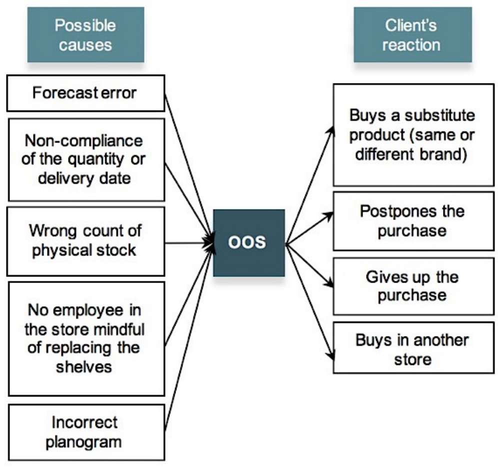


***Figure 1*** *- Causes and consequences of stockouts*

One way to combat stockouts is to apply a robust and adequate replenishment model, and to do so, one must first understand the pattern of the demand of the items. Ghobbar and Friend (2002) and Syntetos (2001), suggest four demand patterns: intermittent, erratic, lumpy and smooth. To perform the categorization, two measures were introduced: Average Interval Demand (AID) and Demand Variability. AID corresponds to the average concerning the time interval ($t_i$) between two consecutive consumptions of the same product, where n represents the number of periods where the demand is different from zero, as shown in Eq. (1).

$$AID = \frac{\sum_{i=1}^{n} t_i}{n} \tag{1}$$

The Demand Variability is determined by the square of the relation between the standard deviation (σ) and the average of the demand (μ), as indicated in Eq. (2):

$$C_v^2 = \left(\frac{\sigma}{\mu}\right)^2 \tag{2}$$

- Intermittent: arises randomly with several periods of search equal to zero; those articles with intermittent search whose dimension of each search is approximately one, are called articles slowmovers (AID > 1.32 week; $C_v^2$ <0.49);
- Erratic: demand-size variability is high; is a demand that can be considered constant, however its size presents great variations (AID <1.32 weeks; $C_v^2$> 0.49);
- Lumpy: intermittent and erratic, that is, the sizes of the demand present a great variability and appear randomly with several periods without demand; (AID> 1.32 weeks; $C_v^2$> 0.49);
- Smooth: Consistent over time, ie consumed regularly and has a low variation in the size of the demand (AID <1.32 weeks; $C_v^2$<0.49).

In what matters the replenishment model, this work explored the alternative of applying the Theory of Constraints (TOC), which was identified as a possible solution to the inventory management challenge.

## 3.1 Theory of Constraints

In the late 1970s, Eliyahu Goldratt, through the creation of computational scheduling and control software known as Optimized Production Technology (OPT), formulated the principles and foundations of TOC, (Balderstone, 1998). TOC arises as a philosophy which argues that any organization has at least one constraint that prevents it from achieving the desired goals, and in this way, the constraints must be identified and optimized so that the system's performance comes closer to the desired one (Tsou, 2012).

Although it was created as a production method, TOC has been developed for a management theory, and can now be applied to situations outside the production context. Goldratt, in his book "It's Not Luck" (1994), presents the concepts and methods to apply TOC in the supply chain. The TOC supply-chain replenishment methods are called TOC-SCRS and have been increasingly implemented by companies (Wu et al., 2014) and have presented successful results: improvement in stockouts ratios and efficiency in responding to market changes, reducing inventories and lead times, which leads to increased sales and, consequently, profit and customer satisfaction. (Walson and Polito, 2003; Wu et al., 2010).

Then, two models of replenishment based on TOC are presented, which will be the models that will be applied in section 5.

### 3.1.1 Dynamic Buffer Management

Dynamic Buffer Management (DBM) is a TOC-based replenishment model that performs buffer size corrections according to actual demand. First, the initial value of the buffer size is determined using one of two methods (Cox III and Schleier, 2010):

**(i)** Paranoia factor: multiply the value of the average demand during the replenishment time by the paranoia factor (1.5 or 2), in order to avoid sales peaks;

**(ii)** Reliable Replenishment Time (RRT): consists of using the maximum consumption observed during the RRT as the initial buffer value. It is called "reliable" because there is a high probability (90% - 95%) of an order arriving at the destination within the stipulated time. It is different from the replenishment time which is calculated on an average basis, the RRT being greater than the average and closest to the maximum value.

Then, the buffer is divided into three control zones: green, yellow and red, and each zone contains one-third of the buffer value (Yuan et al., 2003), and two correction categories are defined:

- Too Much Green (TMG): Inventory level penetrates the green zone (more than two-thirds of the buffer value) and stays there for a long period of time. It means that the size of the buffer is excessive and that the inventory is accumulating, in which case the

DBM reduces the level of the intended buffer;

- Too much Red (TMR): opposite situation to the one above (inventory level below one-third of the buffer value), where there is a risk of stockout and DBM increases the size of the buffer, in order to stabilize the buffer penetration in the yellow zone.

Yuan et al. (2003), states that DBM has a great applicability, being a simple and effective model, but still, there are authors who consider this tool, although powerful, too simple and with lack of mathematical rigor. Thus, over time, several mathematical models were developed in order to calculate the optimum buffer size.

### 3.1.2 Model of Wu et al.

The model proposed by Wu et al. (2010, 2013) was chosen among the several attempts to formalize a mathematical model for the TOC-SCRS found in the literature, since it is the one that presents a more solid theoretical support and that best suits the context of the problem.

Wu et al. (2010, 2013) proposed a model that presents a replenishment mechanism that should be applied to all POS in the supply chain and aims to combat the conflict between excess and stockouts. The model contains 3 inputs: replenishment frequency, RRT and consumption. The outputs are the desired buffer level and the replenishment quantity (Wu et al., 2010, 2013). The RRT is composed of:

**(i)** Frequency of replenishment of an item, that is, the time between two consecutives replenishments; corresponds to the time interval between two deliveries;

**(ii)** Replenishment duration required, the period of time between the time the order for the article is made until it is delivered at the intended location.

Later in section 5, some rules and adaptations made to DBM will be explored and the model proposed by Wu et al. Will be presented.

## 4. Data analysis

As mentioned above, the purpose of this paper is to find a replenishment model that minimizes stockouts at JM's Pingo Doce stores, specifically for slowmovers products, so it is of the most concern to first find the critical slowmovers to whom the models will be applied.

Having this in mind, first there were chosen the Pingo Doce stores to include in the study and the time horizon of it. There were selected 10 stores to be analysed through a year (corresponding to 2017). Then, there were conducted 4 ABC anlysis, as explained next:

**1.** $\text{Slowmovers}\begin{cases}\text{Sold quantity}\downarrow - \text{C}\\ \text{Number of transactions}\downarrow - \text{C}\end{cases}$

Two ABC analyzes were performed, one on the quantity sold and the other on the number of transactions, as indicated above. For each, the C classes were chosen, since they were the ones that represented the low quantities sold and the low number of transactions, being these differentiating characteristics of slowmovers. The categories that were included in the two classes C of both analyzes were selected, and the initial universe of 216 categories was reduced to only 78.

**2.** $\text{Critical Slowmovers}\left\{\frac{\text{Sold quantity}}{\text{Number of transactions}}\uparrow - \text{A}\right.$

The third ABC analysis aimed to capture the slowmovers that presented a pattern of consumption near the frequent existence of peak sales, in the sense that occasionally a small number of customers would be enough to buy almost the entire amount in the store, leading to stock breaches. This was performed on the previously identified slowmovers, where the categories that were in class A were selected, which corresponded to those that presented the highest quotients related to the quantity sold on the number of transactions. Thus, it was possible to narrow the sample even further, from 78 categories to 45.

**3.** $\text{Crit. Slow. with sales impact}\left\{\text{Sales value}\uparrow - \text{A}\right.$

Finally, the last ABC analysis was performed on the 45 categories of critical slowmovers found, to finally obtain only those that translated into a higher sales value of the Group, as indicated above. Thus, it was possible to reduce the initial sample of 216 categories of articles to a final number of 17.

Nevertheless, each category presents a considerable number of articles, and we opted to analyze only articles in the Whisky category, since it was the one that presented the greatest monetary impact in terms of sales, representing 16% of total sales value obtained through critical slowmovers.

At the end of this procedure, the conditions were then fulfilled to carry out more detailed analyzes, since the sample was already fully determined.

Once determined that it would be the Whisky category to be considered in the present study, for the year 2017, it was determined the type of demand that the products included in this sample presented, through the dmenad characterization proposed in section 3 by Ghobbar and Friend (2002) and Syntetos (2001). It was found that most of the articles presented an intermittent demand pattern, where demand appears randomly with several demand periods equal to zero (AID > 1.32 week; $C_v^2$ <0.49), and all the products here identified presented an average demand for a unit, which allowed the use of the slowmovers classification, and thus this characterization served as confirmation that the ABC analyzes previously performed had in fact focused the problem on the products of greater interest.

## 5. Models implementation

After having defined the sample to be studied, the replenishment methods under study are presented. They were applied to six Whisky products, concerning three Pingo Doce stores in Lisbon. The stores chosen were located in Lisbon in order to avoid as much as possible the seasonality. And there were chosen different sizes stores in order to capture the different realities that JM as to deal with (stores chosen: Campo Santana superstore, Parque Europa superstore and Loures megastore).

Firstly, in this section the two proposed replenishment models are presented: DBM and the model proposed by Wu *et al.*, which will be mentioned hereinafter MWEA. Both methodologies that were followed for their application are presented through schematic images (figure 1 and 2, for DBM and MWEA, respectively).

Secondly, in this section the results obtained are shown and analysed, as well as some final recommendations to the company are made concerning possible future developments.

### 5.1 Methodology

**• DBM**

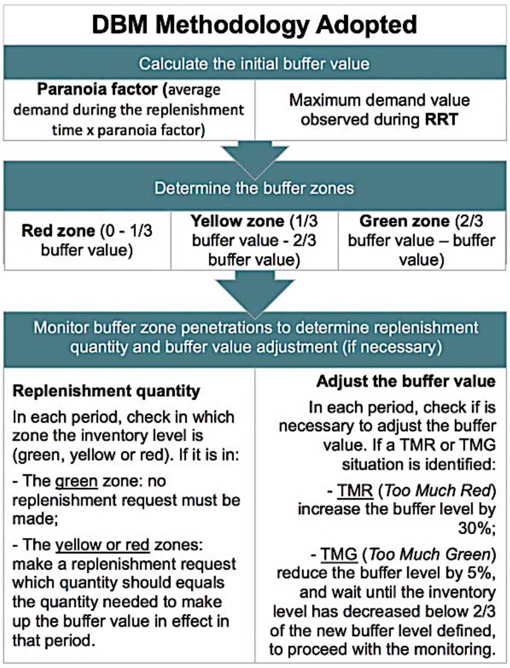


***Figure 2*** *- DBM Methodology*

Besides, it was also apllied a rule created specifically to the slowmovers context. The rule defended that as long as a replenishment request has not yet been delivered to the store, no further request should be made. The implementation of this rule, without causing inconvenience, was only possible thanks to the low replenishment lead times that JM can ensure and thanks to the good relations it maintains with its suppliers.

The cooling period used, which concerns the period of time the system takes to absorb the action taken and to stabilize, was twice the replenishment duration, as suggested in the literature by Schragenheim *et al*. (2009).

**• MWEA**

The notations used for the MWEA were as follows:

Sets and indexes

***I***: se of products
***i***: product index, *i* = 1, 2, ..., I
***J***: set of planning periods
***j***: period index, *j* = 1, 2, ..., *J*

Parameters

$d_{i,j}$: consumption of product *i* in period *j*

***$f_i$***: replenishment period of product *i*, i.e., the time interval between two consecutive deliveries
***$l_i$***: interval of time needed to transfer product i from the upstream node to the next node in the chain
***$r_i$***: reliable lead time need to replenish *i*, $r_i = f_i + l_i$
***$t_{i,j}$***: total consumption of product *i* during the time period between $(j - r_i + 1)$ and *j*

Variables

***$S_i$***: buffer level of product *i*
***$Q_{i,j}$***: replenishment quantity for product i during period *j*
***$R_{i,j}$***: quantity received from product *i* during period *j*
***$V_{i,j}$***: inventory level of product *i* at the end of period *j*

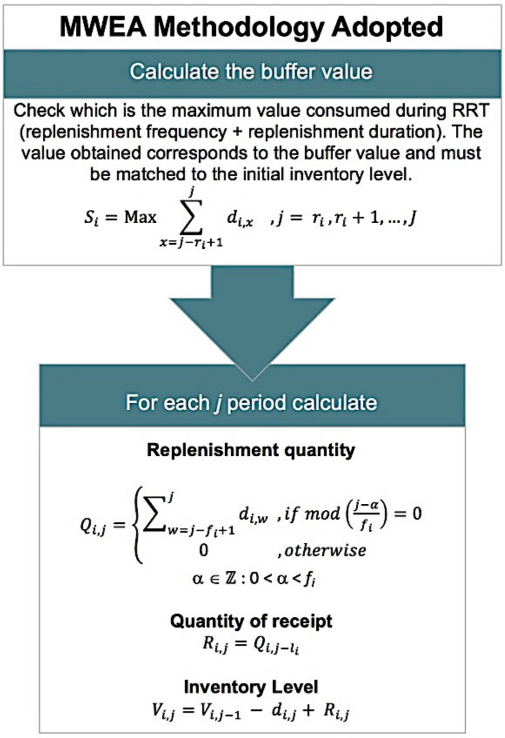


***Figure 3*** *- MWEA Methodology*

The replenishment methods presented above were applied to six Whisky products, concerning three Pingo Doce stores.

### 5.2 Results

The results obtained from the application of the previous methods described are shown in table 1. The results columns represent the variations obtained when comparing the real case verified in JM during 2017, and the proposed cases using the replenishment methods here explored.

As one can see the results obtained from both method implementations were very positive bringing great improvements in terms of reducing stockouts and inventory levels for all products being analysed.

Regarding the reduction of the inventory level, it was verified that DBM presented better results for the cases that had greater consumption averages, standard deviation and variances, whereas for the opposite case (minor consumption, standard deviation and variance values) was the MWEA model that presented more satisfactory results.

Considering the stores, it was in the supermarket of Campo Santana that the greatest improvements were achieved in what concerns the inventory level reduction, followed by the megastore of Loures and, finally, it is in the supermarket of Parque Europa where the smallest improvements are achieved.

As for the occurrence of stockouts, it is verified that in the application of the MWEA model these were entirely eliminated, which is no longer the case for the DBM application. Thus, it can be considered that the MWEA model is more conservative, protecting more effectively the system from peak sales situations.

It is also worth remembering that for the application of DBM it was necessary to adapt the method for slowmovers products, and if it is the intention of the company to apply this tool to a larger portfolio of products maybe some rules have to be withdrawn, or new rules have to be created. On the other hand, the MWEA model may present good results without any adaptation being made, remaining identical to the procedure described in section 5.1. Nevertheless, in the present case as a form of simplification of the model the application of the model MWEA was annual, but it is suggested the application of the model with a monthly time horizon, not annual, so that the value of the buffer is updated in a more continuous way, that is, so that the buffer is calculated based on a month and not based on a year.

Finally, not being an exception, the presented results also contain some limitations, especially the fact that in both models sometimes too small replenishment quantities were requested to be sent to the stores, which would not be enough to make a box of units of the product in concern. This issue needs to be analyzed in the Group's operation in order to be found a solution. However, it is suggested storing the Whisky bottles in the warehouse to the

*Table 1* - *Results obtained*

| | Product code | Store code | Features | | | | | RESULTS | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average consumption quantity | Standard deviation of the consumption quantity | Variance of the consumption quantity | Average Interval Demand (AID) | Replenishment frequency; Replenishment duration; RRT | ΔStockout days (days) | ΔStockout days (%) | ΔAverage Inventory Level |
| DBM | 732083 | 480 | 1,32 | 0,61 | 0,37 | 0,63 | fi = 9; li = 3; ri = 12 | 3 to 0 | -100% | -48% |
| DBM | 309212 | 480 | 2,89 | 1,85 | 3,42 | 0,19 | fi = 4; li = 3; ri = 7 | 0 to 0 | - | -15% |
| DBM | 520940 | 687 | 1,22 | 0,5 | 0,25 | 0,67 | fi = 10; li = 6; ri = 16 | 19 to 0 | -100% | -36% |
| DBM | 68204 | 687 | 1,56 | 1,41 | 1,99 | 2,27 | fi = 22; li = 4; ri = 26 | 3 to 0 | -100% | -34% |
| DBM | 356976 | 811 | 1,19 | 0,39 | 0,15 | 1,6 | fi = 17; li = 5; ri = 22 | 0 to 0 | - | -66% |
| DBM | 732083 | 811 | 1,14 | 0,49 | 0,24 | 1,45 | fi = 13; li = 4; ri = 17 | 5 to 3 | -40% | -51% |
| MWEA | 732083 | 480 | 1,32 | 0,61 | 0,37 | 0,63 | fi = 9; li = 3; ri = 12 | 3 to 0 | -100% | -42% |
| MWEA | 309212 | 480 | 2,89 | 1,85 | 3,42 | 0,19 | fi = 4; li = 3; ri = 7 | 0 to 0 | - | -9% |
| MWEA | 520940 | 687 | 1,22 | 0,5 | 0,25 | 0,67 | fi = 10; li = 6; ri = 16 | 19 to 0 | -100% | -50% |
| MWEA | 68204 | 687 | 1,56 | 1,41 | 1,99 | 2,27 | fi = 22; li = 4; ri = 26 | 3 to 0 | -100% | -29% |
| MWEA | 356976 | 811 | 1,19 | 0,39 | 0,15 | 1,6 | fi = 17; li = 5; ri = 22 | 0 to 0 | - | -69% |
| MWEA | 732083 | 811 | 1,14 | 0,49 | 0,24 | 1,45 | fi = 13; li = 4; ri = 17 | 5 to 0 | -100% | -49% |

unit. This measure would not reduce the efficiency of the chain (when viewed as a whole), because in fact the unpacking task has to be performed in anyway before being delivered to the final consumer, so it would be the anticipation of a task that would lead to the inventory reductions shown above. If it is not in the interest of the Group to carry out the abovementioned procedure, because it would obviously cause some logistical problems in terms of order execution in the warehouses, one could try to agree with the suppliers some kind of more flexible delivery including packaging smaller quantities. Once again, this would be an operational issue to be discussed by the company, which presents itself as an action to be taken following this work.

Although the implementation of any of the models may lead to significant improvements in the Group's reality, the implementation of the MWEA model is suggested, since the Group has requested that the main goal should be to minimize stockouts. In addition to the MWEA model responding positively to this requirement of the Group, it has also been implemented in its entirety, without the need for adaptations, which are often too specific and withdraw the flexibility of implementation to a larger portfolio of products. Another argument that supports the suggestion of the implementation of the MWEA model is that there was no indication that the model would not present equally satisfactory results for any other type of product, leading to the belief that there may be a potential applicability that goes far beyond what was here presented throughout the document, which in the case of the DBM tool would probably have to be adapted to each specific case.

Finally, it is suggested a more in-depth analysis to be carried out with a sample containing more products and more stores (should verify the applicability of the model not only to slowmovers products), and later a pilot case with the implementation of the model, which must be integrated into the MRP calculations.

## 6. Conclusions

The increasing level of competitiveness nowadays leads to an increase in the level of demand to which companies have to be able to match. Not being an exception, the JM Group, a nationally and internationally renowned company, must always maintain its efforts at the highest level so that it is not overtaken by competition. This paper intends to have an auxiliary role in the process of improving the current MRP of the Group, especially for the Pingo Doce stores, in order to minimize the stockouts that occur on a daily basis.

Initially, a first approach was taken to the case study, in order to get to know JM better, how it works in day-to-day, what operations exist within its supply chain and how they work. It was also determined the various elements that constitute the case study, where the operation of the MRP was explored, once it is the replenishment system used by JM for its stores. Next, a simple first analysis of the stockouts was carried out as a way of introducing the problem under study and it was found that these are in fact a problem in Pingo Doce stores and that their impact in monetary terms is of concern, in addition to the impact they may have on the reputation and customer loyalty of the brand. The need to pool efforts to combat stockpiles and the importance of good planning and exemplary stock management was thus justified.

Subsequently, a review of the literature was carried out as a way to get a better understanding of the retail industry and its evolution, the importance of good planning and a good evaluation of the supply chain so that it can be overcome on a daily basis, and it was verified that although the problem of the existence of stockouts exists and is alarming, few results have been achieved in the direction of its resolution. At the end of the literature review section, it was also introduced the replenishment models that served as improvement proposals to be implemented in the present study. The selection of the models to be explored was based on TOC models. The DBM tool and the MWEA model were selected, being these two models of replenishment that belong to the TOC-SCRS, which are simple and easy to apply. The obtained results were excellent and allowed to eliminate stockouts in the cases studied and, simultaneously, reducing the inventory level also in store.

Finally, this work explored new approaches to replenishment models, and it would be interesting to carry out a pilot case in a store of the Group to verify if the results would be effectively better than those proposed by the solution currently used. If the Group wishes to implement any of the models explored in this dissertation (DBM or MWEA), it is recalled that there is a limitation regarding the size of the boxes that should not be forgotten, as well as a more exhaustive study before proceeding to their implementation should be taken into account, since these models (like any other) can always be better adapted to the reality of JM and more studies could be done to achieve even better results. Since the Group had access to a greater number of real data and more efficient computational tools, it would certainly be possible to obtain more assertive answers about the implementation of the replenishment models proposed by TOC in the JM Group, or not.

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