SEVEN
publicações acadêmicas

Implementation of minimum stock with the aid of the ABC Curve in a maintenance warehouse

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ABSTRACT
Despite the huge amount of capital invested, the stock sector is extremely important because it regulates the flow of materials and acts as a kind of buffer in the differences between incoming and outgoing materials. In this way, the warehouse can speed up day-to-day activities and provide supplies in urgent situations, reducing or avoiding various undesirable costs.

Keywords: Minimum stock, ABC curve, Warehouse.

INTRODUCTION

Despite the enormous capital invested, the inventory sector is extremely important, because through it there is a regulation of the flow of materials serving as a kind of buffer in the differences between inputs and outputs of materials. In this way, the warehouse can speed up daily activities and supply in urgent situations, reducing or avoiding several undesirable costs.

Inventory management represents a strategic job for companies, as it acts directly on the organization and competitiveness, thus having the ability to restrict or make available inputs for new investments. The implementation of inventory improvements is extremely necessary, as the globalized market has become increasingly dynamic and flexible, requiring faster and faster responses from companies. In this way, it is necessary to have an increasingly efficient inventory management, becoming a great differential in the face of the competition (KLIPEL, 2014).

But for this to occur in the best possible way, it is necessary to implement some tools, thus reducing the use of resources that were once used incoherently and promoting the most efficient use of the warehouse. Currently, some of the most commonly used tools are the minimum inventory and the ABC curve.

The ABC curve is an extremely important tool that advises the inventory manager, because through it it is possible to identify and allocate treatment and attention proportional to its importance. In

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addition to inventory management, many companies use this type of tool to define sales policies, establish priorities for production scheduling, and other various types of problems (LOPRETE, 2009).

Another extremely important tool is the application of the minimum stock in the warehouse, because through it the company maintains its activities independently, giving autonomy for a certain time. Safety stock is usually given through the application of a calculation that is based on several variables such as monthly consumption, inventory management systems, trust in suppliers and deadlines (SNEGE, 2016).

OBJECTIVE

This work aims to demonstrate the optimization of a strategic implementation of improvement in the warehouse sector, to solve the main problems encountered and avoid consequences, with the application and their respective results of the minimum inventory and ABC curve tools.

METHODOLOGY

The choice of the theme of this research was motivated by the importance of a warehouse within a company, mapping its processes and using an improvement tool, both for academic knowledge and for competitiveness and profitability where this model is proposed. Visits were made to the warehouse in order to verify the process closely, which is the best method to get to know it in detail. The visits were made constantly over a period of 12 weeks inside the warehouse, which is the time necessary to get to know the process of ordering products and services and to carry out the interviews provided for in the methodology of this work. After the visit, it was possible to map the warehouse process, for a better visualization of this sector and then to be able to identify possible failures, bottlenecks and operating costs that cause losses to the company. Through the process flowchart, there was a thorough analysis in order to identify where the minimum stock and ABC curve tools could be implemented.

As for the methodological procedures, this research is classified as applied, because the study directed here is proposed to solve the problems involved in the area addressed in this research. It was carried out through direct observation and data collection, in which the subject is directed to collect information. As for the approach, it is qualitative and aims to deepen the knowledge that refers to management and storage in the warehouse. In this case, the focus is to collect data to clarify some problems in the day-to-day of companies, especially in the area that involves maintenance. It is also quantitative, as it aims to collect concrete facts such as numbers and thus obtain a basis for drawing accurate conclusions.

Regarding the objectives, the research is characterized as exploratory and descriptive, as the study aimed to describe the characteristics of certain contexts in the work environment. The case study method was used as a basis.

For Yin (1994), the case study is a methodological approach to research that is especially appropriate when we seek to understand, explore or describe complex events and contexts, in which several factors are simultaneously involved. In this way, the case study is a good opportunity to identify, describe and analyze how process mapping contributes to a company's organizational strategy.

This research is also exploratory. Gil (2002) describes this research as that which aims to provide greater familiarity with the problem, in order to make them more explicit or to constitute hypotheses. It is used when there is not enough information to answer the problem or when that information is not organized properly. According to Gil (2002), descriptive research has as its primary objective the description of the characteristics of a given population or phenomenon, or the establishment of relationships between variables. There are numerous studies that can be classified under this heading, and one of its most significant characteristics is the use of standardized data collection techniques, such as the questionnaire and systemic observation.

The work was carried out in a port company involving sectors such as warehouse, purchasing and maintenance. These sectors are completely linked, as the work of one is completely dependent on the other. The company is located 60 km from Fortaleza, in Pecém. The choice of the company is due to the fact that it has a system with many problems, with an inventory of more than a thousand items, thus making it possible to implement a tool to improve storage management.

Regarding the technical procedures for data collection, bibliographic and documentary references, interviews and field research were used. Through the research carried out in the port company, knowledge of the problem raised was acquired, gathering detailed information, with the objective of apprehending the totality of the various situations of study.

As the research has an exploratory character, data collection was done through interviews with the manager of each sector and with employees involved and data history of the software used for warehouse management. For Gil (2002), the interview is certainly the most flexible of all the data collection techniques available to the social sciences. The focused unstructured interview was used, precisely so that the interviewer has the freedom to find reasons pertinent to this research. At first, in an informal conversation with the warehouse manager, he was asked which area of the warehouse presented the greatest problems, and the area of ordering materials and services was mentioned.

DEVELOPMENT

In order to meet the proposed objectives, this topic was elaborated from the consultation of authors related to the theme and is structured in: Importance of the Warehouse for Inventory Management in Maintenance, ABC Curve, Demand Forecasting and Minimum Stock.

IMPORTANCE OF THE WAREHOUSE FOR INVENTORY MANAGEMENT IN MAINTENANCE

According to Marques (2009), a warehouse is a space intended for the physical management of inventories, with the function of storing, preserving, receiving and dispatching materials when they are requested, in accordance with current storage regulations. One of its main objectives is to avoid divergences and loss of materials necessary for the daily life of the organization. As it is a unit responsible for the control and movement of goods, it must have adequate facilities, as well as sufficient handling and distribution resources for a quick and efficient service. Safely guaranteeing the materials entrusted by the company, aiming at their preservation and integrity until final consumption.

The types vary according to each company, and can be warehouses, distribution center (DC) or warehouses. In this way, they are essential for the company's business, as they are the largest financial and organizational assets. According to Fernandes (2003), some of its functions are:

- Receive and check quantitatively and qualitatively the products acquired by the company;
- Distribute the stocked materials according to the requisitions and needs duly authorized by the company's managers;
- Receive for safekeeping and protection the materials acquired by the company;
- Deliver the materials upon authorized requests to the company's users;
- Dispatch the materials to third parties as per documented request, keep system records up to date,
- Maintain the accuracy of stocks, maintain the cleanliness and tidiness of the entire environment;
- Control inventories, giving the issues and entries in the system as soon as possible.

In Klipel's (2014) view, inventories constitute all the goods and materials that are kept by a company to meet future demands. They can be seen in various ways: finished products, raw materials, machines, inputs, products in process, auxiliary materials in the maintenance process, accommodated in suitable warehouses or warehouses. For a good management of a warehouse, it is necessary a good job of the person in charge, as it is the place where materials of great value are kept; therefore, it is the management of a company's assets. The storekeeper must always ensure the quality of the materials in his custody and the conformity of the existing stock. It is also your role

the verification of invoices with the purchase order, the storage of the physical stock and the information represented in the warehouse management system, the inputs and outputs of materials. The presence of financial controls in the warehouse helps in the identification of the most important items in terms of movement, integration with the accounting system and monitoring of inventory growth.

Klipel (2014) understands that inventory management refers to the entire process of purchase requests, receipt, storage and use of items crucial to the operation of a company. Inventory control ensures that production lines do not stop producing due to machine failures or lack of consumables. However, a management mistake is the low demand and a large amount of items stocked. An adequate approach regarding the replacement of parts from stock is a differential for companies, as it reduces costs, and maintains the appropriate level of service.

In the view of Maestrelli (2018), inventory management in maintenance can be divided into five stages, the first being inventory inventory. Through this inventory, everything that is stored is known, and it is essential that companies have this knowledge. The inventory process consists of identifying, classifying and counting products that are stored. It is necessary to quantify the products and make an analysis of what really needs to be there or not. With this balance, you can decide what to do with goods that are damaged or stored unused, and check if anything is missing.

The second method of inventory categorization is the ABC curve. Its main purpose is to make it clear which products are most important to the company. Provides a mechanism to identify items that will have a significant impact on the overall cost of inventory, while also providing a mechanism to identify different categories of actions that will require different management and controls.

This is followed by the analysis of consumption in the last 36 months. In this stage, the movement of the stock in the last 3 years is analyzed, and, based on this history, several important information about the maintenance stock can be extracted. Control is established of what should really be stored, what does not need to be stocked but bought when needed, and what does not need to be in stock.

The fourth step is the division into categories. The division into categories persists into: stock items, *make-to-order items,* and obsolete items. Here the IMD (Average Interval between Demands) is calculated, and this calculation is essential to be able to divide the inventory categories.

The last step is the resupply point, and here it is necessary to know the stock security for each item and the quantity that must be purchased for each item. A safety stock is one that must be prevented from delays on the part of the supplier and variations in consumption.

Also in the view of Maestrelli (2018), good inventory management of materials for maintenance should follow the five steps. Inventory management is directly linked to risk management, therefore, it is necessary to control so that you do not have unused items, as the cost will be high. In the same way, if the demand is below the need, because when there is some maintenance there will be risks.

The function of inventory management is to enhance the effect of sales feedback and the adjustment of production planning. At the same time, it should minimize the capital invested in inventory, as it is expensive and gradual, since the financial cost increases (DIAS, 1993).

Inventory management performs an extremely important function, as it has the objective of defining and planning inventory level controls. It is responsible for defining the planning and control of stock levels. Its role is to analyze all stages of storage and movement of items, aiming to ensure that all capital invested in inventory is monetized with the necessary safety (MARTELLI, 2015).

According to Martins (2006), the management of inventory items directly influences the quality of the products and the profitability of the company, becoming necessary in a *just-in-time* management . In this way, it is possible to reduce the number of items in stock and the service time for the customer as much as possible.

ABC CURVE

The ABC Curve, also known as the Pareto principle or the 80/20 principle, originated in the region of Italy, approximately in the year 1897. It was developed by economist Vilfredo Federico Damaso Pareto after conducting several studies on the distribution of wealth and income of local inhabitants. In these studies, Damaso Pareto observed that most of the region's income belonged to a small fraction of the population, following a proportion of approximately 80% and 20% respectively, that is, 20% of the people controlled 80% of the wealth (POZO, 2000).

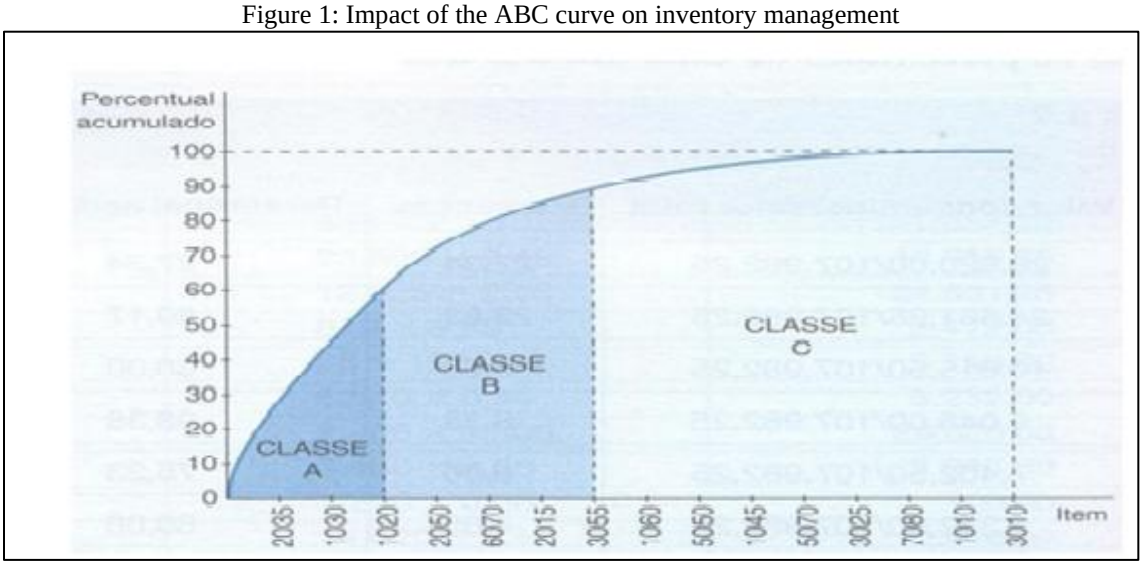
According to Carvalho (2013) "the ABC curve is a method of classifying information of great relevance, as it has the ability to separate the items of greater importance or impact, which are usually in smaller numbers."

This method has the function of making a quick decision action with a great impact on the company. As can be seen in figure 1, the ABC curve can be divided into three distinct categories, which according to the author Pozo (2000) are:

- Class A: these are the most important items that should receive all the attention in the first moment of the study. The data classified here correspond, on average, to 80% of the total monetary value and a maximum of 20% of the items studied (these values are guidelines and are not rules);
- Class B: these are the intermediate items that should be dealt with immediately after the measures taken on the class A items, they are the second in importance. The data classified here correspond, on average, to 15% of the total monetary value of the stock and a maximum of 30% of the items studied (these values are indicative, and not rules);
- Class C: these are items of lesser importance, although bulky in quantities, but with reduced monetary value, allowing a longer period of time for their analysis and action. They should only be

treated after all items in class A and B have been evaluated. In general, only 5% of the total monetary value represents this class, but more than 50% of the items form its structure (these values are indicative, not rules).

Figure 1: Impact of the ABC curve on inventory management



Source: MARTINS, ALT, (2006, p.214)

DEMAND ACCURACY

All inventory management has as a rule the forecast of material consumption. According to Dias (1993): "the forecast of consumption or demand establishes future estimates of the finished products marketed and sold. It is therefore estimated which products, how much and when will be purchased by customers."

DIAS (1993) states that: "the basic information that allows us to decide what will be the dimensions and the distribution over time of the demand for finished products can be classified into two categories: quantitative and qualitative".

Quantitative: sales history, type of customer, field of activity, influence of advertising, etc.

Qualitative: opinion of managers, salespeople, buyers, market research, etc.

Demand management is basically constituted by the analysis of the market to gain an understanding of the future needs of consumers. Knowing how demand will change over a period of time allows companies to maintain the correct amount of stock available. A poorly realized forecast can result in a lack of material and, consequently, a drop in sales or even in an excessive inventory (DIAS, 1993).

MINIMUM STOCK

The use of minimum stock, also called safety stock, is one of the most important pieces of information for inventory control. By definition, it is the minimum quantity that must be kept in stock, in

case of any eventuality such as delays in resupply, ensuring the constant and efficient operation of production, without the risk of shortages. It can also be determined through estimated consumption projection, base calculations and statistics. A fundamental piece of information for such a strategy is the replenishment time, which is the time spent from the verification that the stock needs to be replenished to the exact moment the material arrives at the company's warehouse.

This time can be divided into three parts (DIAS, 1993):

- Order issuance: time it takes from the issuance of the purchase order until it reaches the supplier;
- Order preparation: time it takes the supplier to manufacture the products, separate the products, issue invoicing, and get them ready to be transported;
- Transportation: Time it takes from the supplier's departure to the company's receipt of the ordered materials.

PRESENTATION AND DISCUSSION OF RESULTS

In the data collection process, four semi-structured interviews were applied, in stock and maintenance, with the appropriate people responsible for the areas. It was also possible to obtain information and identify stock shortages through the Topmanager software. The software is used in the company for purchase requests, requisitions of material from some sector for withdrawal in stock and is also used for quantitative control of items. The application of the minimum inventory was based on a monthly average carried out through the total consumption of the items during the entire year of 2019. This annual survey was carried out through a history of requests for the year 2019 registered in the system.

APPLICATION OF MINIMUM STOCK

The inventory calculation was mainly based quantitatively through the monthly average of 2019. The formula used was:

$$EM = D \times TR / PP$$

Where:

PP = Order point (stock for 1 month);

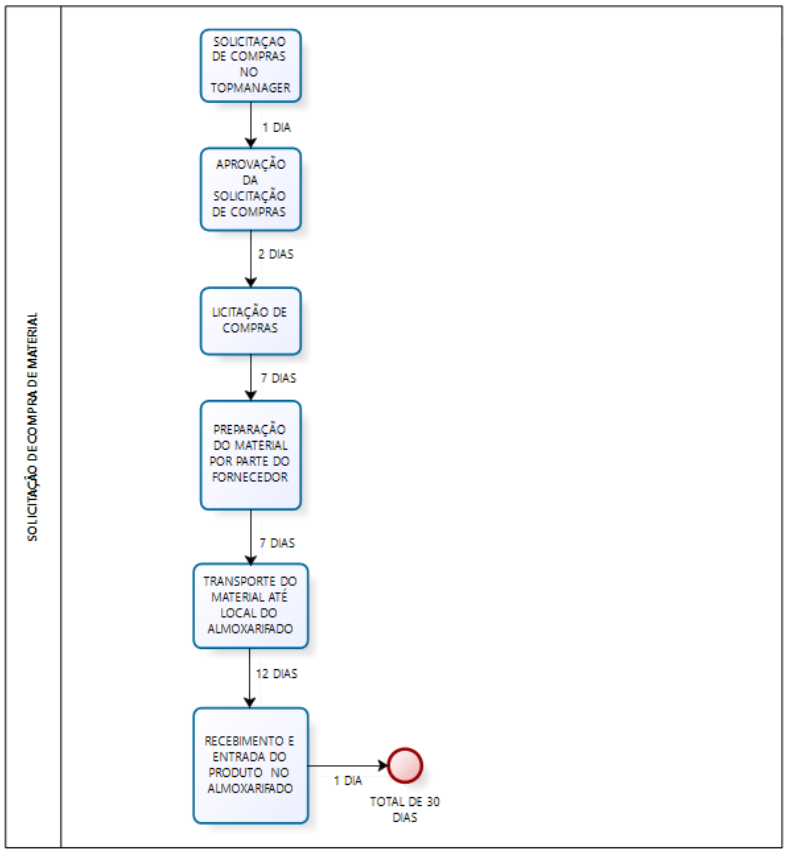
D = Demand (monthly average calculated for the year 2019);

TR = Replenishment time (average time from the request to the arrival of the material);

MS = Minimum stock.

Remembering that the replenishment time was calculated through an approximate average value of days taken from the purchase request to the arrival of the material in stock, as can be seen in the flowchart in figure 2.

Figure 2: Purchasing Process for Inventory



Source: Prepared by the author (2020)

In the qualitative application, the results were found through interviews, which were obtained with the managers of the sectors studied. It was noticed that some items that were in the warehouse did not have a history, making the overall process difficult.

DATA APPLICATION AND FORMATION OF THE ABC CURVE

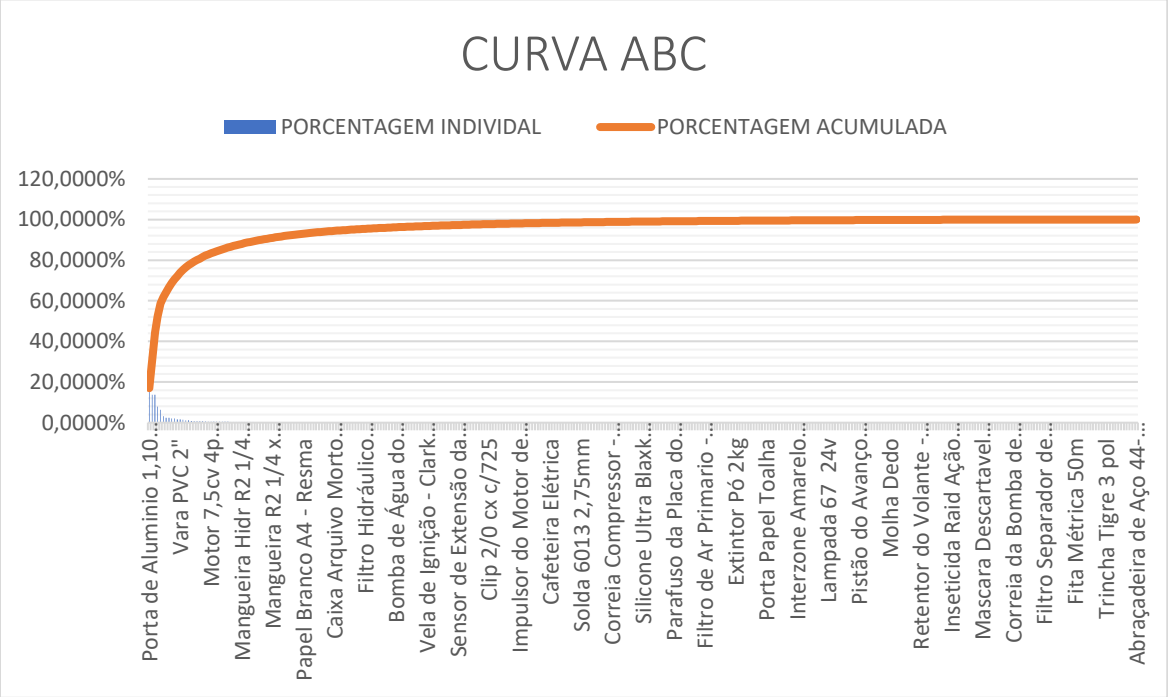
The ABC curve was also performed through the history of 2019 data collected from the Topmanager program. It was possible to collect the value of each object and the number of items by the monthly average of onenyear elapsed. For classification A, the cumulative percentage value of up to 80% was given, for B it was 95% and for C it was 5%. Table 1 and Graph 1 show the behavior of the curve.

Table 1: Classification of the items

CLASSIFICATION	CUT	SKU PROPORTION	VALUE PROPORTION
A	80%	4,82%	79%
B	95%	15,86%	16%
C	100%	79,32%	5%

Source: Prepared by the author (2020)

Graph 1: Application of the ABC Curve in the surveyed warehouse



Source: Prepared by the author (2020)

ANALYSIS OF RESULTS

With the help of interviews and software, it was possible to obtain and identify problems in the warehouse and maintenance sectors. Due to the absence of minimum stock, several times the machines were stopped longer than expected, and due to this urgency the company opted for an emergency purchase. In these cases, the materials to be purchased usually suffer an increase in price, due to transportation, which is usually by air. Another problem found was the location of some items in inappropriate places. For example, some high-value materials were found in unsafe places and other items that have a large output were in hard-to-reach places, making it difficult for those responsible for the sector to move around.

FINAL THOUGHTS

It can be said, then, that by implementing the minimum inventory and the ABC curve in the warehouse, it is possible to solve many day-to-day problems, only with the internal effort of the company's team, at no cost. The main objective of the research was to analyze the management of

materials in a company, through the identification of the procedures used by the warehouse, including receipt, storage, distribution and control, also evidencing the way it is structured.

The implementation of the minimum stock had a lot of significance in improving the company's management. Through this tool, there was a significant decrease in costs. Since the organization of the materials improved, it was possible to observe the items of greatest need, a necessary number was requested to supply the minimum stock and as the purchase was high, the final price decreased. In addition, the most important items were identified, and in this case, a minimum stock was established so that there was no need for an emergency purchase. Another advantage was the reduction in resupply time, because as there is now greater follow-up, orders are being placed in advance, reducing the downtime of the machines in maintenance, whether corrective or preventive.

The application of the ABC curve was very important, because through it a better organizational vision was obtained. The C-rated items were upstairs (the warehouse is divided into two floors, where the upstairs is the warehouse and the access for requisition collections) and easier to access for the warehouse to deliver to the requester. Consequently, the C-rated items are the smaller items, which makes it possible to transfer them upstairs and downstairs. Items B and A, on the other hand, were placed on the lower floors. Due to the high values of items A, the security system on the 1st floor was intensified and a fire suppression system was also installed.

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