Implementation of inventory policy: a supporting decision-making tool for a food distribution company

Implementação da política de estoque: uma ferramenta de apoio à tomada de decisões para uma empresa de distribuição de alimentos

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ABSTRACT
In a competitive environment that is the market for the distribution of food and cleaning products to private homes and companies, operating at a low cost is a matter of survival. Proper inventory management is the key point for operational efficiency. Currently, the studied company operates with two warehouses, one of its own and the other rented. Faced with the impossibility of continuing to rent this warehouse, the moment of decision-making has arrived: to buy the rented warehouse or not to buy it? The objective of this work is to carry out an investigation of the ideal inventory and purchasing policy of the company, to establish the best way to manage its operations, and thus define the adequate levels of inventories, which will provide the identification of the necessary storage capacity, in order to guarantee a balanced operation that offers a level of service to the end customer. This necessary storage capacity will define the need for space, and therefore, it will help the company to make the best decision, as well as supporting a new level of customer service and reducing inventory costs.

Keywords: inventory management, stock police, warehouse management.

RESUMO
Em um ambiente competitivo como é o mercado de distribuição de alimentos e produtos de limpeza para residências e empresas, operar com baixo custo é uma questão de sobrevivência. O gerenciamento adequado do estoque é o ponto-chave para a eficiência...
operacional. Atualmente, a empresa estudada opera com dois armazéns, um próprio e outro alugado. Diante da impossibilidade de continuar alugando esse armazém, chegou o momento da tomada de decisão: comprar ou não comprar o armazém alugado? O objetivo deste trabalho é realizar uma investigação do estoque ideal e da política de compras da empresa, para estabelecer a melhor maneira de gerenciar suas operações e, assim, definir os níveis adequados de estoques, o que proporcionará a identificação da capacidade de armazenamento necessária, a fim de garantir uma operação equilibrada que ofereça um nível de serviço ao cliente final. Essa capacidade de armazenamento necessária definirá a necessidade de espaço e, portanto, ajudará a empresa a tomar a melhor decisão, além de apoiar um novo nível de atendimento ao cliente e reduzir os custos de estoque.

**Palavras-chave:** gerenciamento de estoque, polícia de estoque, gerenciamento de armazém.

### 1 INTRODUCTION

Due to the constant changes in the consumer journey, companies have been facing much more competitiveness, so even more important is to have the right product, in the right time, at the right location, with the quality expected, at the lowest possible cost (GUPTA et al., 2022). To focus on reduce overall cost and improving performance, flexibility and integration are essential in the Supply Chain (SC) (MAIOROVA & BALASHOVA, 2023). Therefore, the inventory plays a significant role to guarantee the optimal use of resources and the desired customer service (AHMADI et al., 2020).

The necessity of inventory in the SC is influenced by the supply and demand uncertainties. If for one side, to achieve high service levels, large safety stock and high inventory are required, on the another side, to operate with costs over control, low safety stock and low inventory are more interesting (RALFS, & KIESMÜLLER, 2022). This is a common tradeoff that companies faced every day, what amount of safety stock and warehouse capacity are necessary to provide high service level to customers (GUPTA et al., 2022). To have an efficient use of resources, environmental effect, cost optimization and better service, inventory models and police application are needed (SARKAR et al., 2018). SC’s efficient utilization requires an inventory model, which take into account: storage, product delivery, lead times, demand patterns, and reliability on demand forecasting and in the lead time agreed in the role value chain (CHAUDHARY et al., 2023). To obtain internal and external customer satisfaction as well as achieve internal quality, inventory management is one of the critical points that need to be treated. It is important to manage when the item need to be produced or bought, where it will be located and when to sell it (ZAMBRANO-BRAVO & ZAMBRANO-FARÍAS, 2022).
is vital to a firm’s success in order to maintain competitive advantage, a high level of
flexibility in ordering policy to fulfill quick response to the market demand (TAO et al.,
2017). Some important variables need to be considered in the inventory management to
set the ideal level in terms of finance for the company: total cost of holding inventory,
total cost of ordering, backlog costs, logistics costs, among others. (ZAMBRANO-
BRAVO & ZAMBRANO-FARÍAS, 2022).

Normally it is difficult to find an optimal and correct management of logistics
costs because of the degree of complexity and difficulty to put in place an efficient
inventory management (ALBURQUEQUE-POZO et al., 2022). To achieve success when
managing inventory, Alburqueque-pojo et al. (2022) evaluated the main tools to calculate
and define the inventory policy, standing out Periodic Review System (R,s) and Economic
Order Quantity (EOQ).

In this case study, the company’s activity is concentrated in retail trade, a sector
characterized by high competitiveness due to the presence of large distribution centers
(supermarkets). Therefore, for Small and Medium Companies (SMEs) to stand out in this
sector, they need high operational efficiency to present a high level of service to their
customers and achieve sustainability. According to Abdullah et al. (2018) most of SMEs
from retail sector and different countries faced the problem regarding warehouse
management, where their research showed that 62.3% of SMEs have difficulty in
inventory forecast and service level. Atnafu, and Balda (2018) cited that SMEs have
problems in the warehouse management, directly related to cash flow, because for a small
company the inventory represents a large percentage of the total budget.

To stay competitive in the market, the company has increased its product portfolio
to provide better service to its customers. This fact made the number of references and
the stock increase, thus all the storage in just one warehouse became complicated. At this
time the company made the decision to rent a second warehouse to facilitate the logistics.
Nowadays, due to the impossibility of continuing to rent this warehouse and taking into
account the intention of achieving an optimization of its operations, the company faced a
strategic decision to be made. The general objective of this study is to analyze the supply
chain of the company to support the correct decision making: to buy or not to buy the
second warehouse, which nowadays is rented by the company.
2 THEORETICAL BACKGROUND

To base this project, a deep research work was carried out on the state of the art of the main topic addressed, which is Inventory Management.

2.1 INVENTORY MANAGEMENT

Ballou (2004) defines inventories as accumulations of raw materials, supplies, components, work-in-process and finished goods that appear at numerous points throughout a company's production and logistics pipeline. For May et al. (2017) the reasons for maintaining inventories are related to customer service or to pay for indirect savings derived from them. The main functions of the stock could be cited as: improve customer service and reduce costs.

Although inventories enable competitive advantages, as said before, having excess inventory can cause financial problems for organizations. These available inventories can cost, per year, between 20 and 40% of their value (BRUNAUD et al., 2019). Therefore, carefully managing inventory levels can lead to relevant savings. Inventories are considered losses, which in other words means that inventories can absorb capital that could be better used in some other way. In addition, inventory can hide quality problems, as the productive system takes longer to perceive an issue due to the lungs made through inventories (BALLOU, 2004).

Pérez (2006) explains that inventory management usually has some cost classifications, which are used to perform the calculations and thus define which levels are appropriate for each supply chain:

1. Acquisition cost: it is the one derived from buying or producing the items. If the material is obtained outside the company, the cost will be the price negotiated with the supplier, however, if the supply is internal, then the cost will be the cost of production.

2. Ordering cost: This is the cost of issuing the purchase or production order.

3. Maintenance cost: it is associated with the cost necessary to maintain the item for a certain period of time, usually the cost per year. These costs can be detailed in: the capital invested in the inventory or opportunity cost; inventory handling, warehouse costs, staff costs, insurance, and finally, the costs caused by depreciation, physical deterioration and obsolescence.
2.2 INVENTORY POLICY

Setting the right amount of inventory for each product or raw-materials, taking into account a proper methodology, which is based on reliable data instead of opinions and interests from different functions along the company, is the role of the inventory policy. Since his development, many industries and organization are using the model to define and manage their stock (CHAUDHARY et al., 2023).

A reliable inventory policy is able to define two main inventory parameters: safety stock and the economic order quantity. From these parameters is possible to calculate the maximum and the average inventory, complementing the inventory policy metric (ASADABADI, 2015).

For Serrano (2011), the safety stock is created to avoid the lack of inventory during the provisioning period. The safety stock serves to face the uncertainty of demand and supply lead time. In periodic review models the safety stock must be calculated following the formula, where \( S´d \) is the Standard Deviation of historic demand, \( Z \) is the service level, \( STE \) is the standard deviation of the lead time, \( D \) is the average daily demand and \( TE \) is the lead time.

\[
s´d = Z\sqrt{TE\sigma_d^2 + d^2 s_{TE}^2}
\]

A efficient starting point for balancing costs and determining the best inventory level cycle for an item is to calculate the economic order quantity (EOQ), the lot size that minimizes the total annual costs of ordering and maintaining inventory (GALKIN et al. 2022).

EOQ calculation formula is presented above, where \( D \) is the annual demand, \( S \) ordering cost, \( I \) storage cost and \( C \) item cost. (2)

\[
Q^* = \sqrt{\frac{2DS}{IC}}
\]
Reorder point inventory control assumes that demand is perpetual and continuously acts on inventory to reduce its level. When inventory is reduced to the point where its level is equal to or less than a specific quantity called the reorder point, an order quantity is placed for the supplier to replenish the inventory level (TAO et al., 2017). The effective level of inventory at a given point in time is the sum of the quantity available in stock plus the quantity ordered, minus any need for inventory output, such as backorders or assignments for customers.

Thus, the average inventory in periodic review models must be an adaptation of the EOQ model, since now the safety inventory must be taken into account, that is, added to half of the economic purchase lot. Explained that, the maximum inventory for an item is the sum of the safety stock and the EOQ (SVOBODA et al., 2021).

Average inventory = Safety Stock + EOQ/2
Maximum inventory = Safety Stock + EOQ

3 PROBLEM FORMULATION

To arrive at the key answer of the research, buy or not to buy the second warehouse, the following steps were planned as the scope of the project: definition of the analysis horizon, that is, the time within the analysis must be sustainable; projection of future demand for the horizon of analysis; study of the best inventory policy, which has as output the volume of units by reference to be stored; transformation of the information generated (volume of units per reference) into the need for spaces (pallets); Analysis of the installed storage capacity versus the diagnosed need. To guarantee the quality of the development of the project, periodic and face-to-face meetings were held at the company's headquarters, involving the general management and the purchasing and commercial departments.

The focus of the work is strictly the logistics vision. It is necessary to take into account that strategic factors can influence the final decision, even if they are not aligned with the final result of this project. For this reason, the final decision will be made by the management of the company, encompassing all the factors that it deems important.
3.1 COMPANY CURRENT SITUATION

In this case study, the focus is a family business that distributes food, cleaning and beverage products to private homes and companies, which began its activities in 1973. It is currently being managed by the second generation, with its headquarters in in the north part of Spain, where the company has purchased a warehouse in the year 2000. The company can be represented as a supermarket in a warehouse format, where customers buy without having to travel to the supermarket, but through calls to the call center, or through their website. Thus, the company provides a differentiated service to its customers, who save time, have more comfort and avoid physical effort. Due to these characteristics, the company's main customer is the elderly, who are responsible for 56% of the total billing. The most convenient way that customers use to proceed with their purchases is the call center, which handles 85% of the total volume, offering closer contact with the customer and their needs.

It has 8 product lines available to its customers. The company currently manages and distributes 600 references. In this project, 396 references were considered, and the other references are fresh products, which use a refrigerated chamber for storage, which has no storage capacity restriction, and due to technical aspects, should not undergo any alteration.

To store the products, an own warehouse and a rented warehouse are used, with conventional and drive-in shelves, a chaotic storage system, seeking to concentrate the best-selling items near the picking area. The demand of the clients is distributed by each one of the routes that will be carried out the following day. All orders are grouped according to the product reference and the picking is prepared 3 times a day. The distribution carried out is distributed in 41 routes: 27 weekly and 14 fortnightly.

3.2 PURCHASING PROCESS

The portfolio currently works with sixty-one suppliers. During the week, the stock of all of them is reviewed with an average distribution of twelve suppliers per day. The first factor to consider is that the demand planning process are not established, and therefore, purchases are made considering historical consumption data, which usually has a horizon of the last six months. Some inventory management parameters are used to facilitate the calculation of purchasing needs: minimum, maximum and average inventories. These parameters were calculated according to the experience of the planner, based especially on consumption, but not taking into account data such as delivery lead
time, demand deviations and the lead time of the suppliers, storage capacity and ideal service level.

3.3 WAREHOUSE PROCESS

In the early 2010s, the company acquired a goodwill. With this acquisition, it was possible to double the revenue and make a larger investment: the purchase of a warehouse that would allow sufficient storage capacity to optimize purchases. This warehouse was acquired in the north part of Spain, with 735 square meters of surface area with shelves with a capacity of 419 storage spaces, including the picking area. The picking is ordered by families, to avoid displacements at the time of delivery. All products with stock are stored in a chaotic manner to optimize warehouse space.

Seeking to expand its business and with the objective of providing comfortable purchasing experiences to its customers, the company's current warehouse became too small, due to the new volumes of references that would be handled. Thus, the company decided to rent a second 500 square meters warehouse to expand its operation. The second warehouse is located exactly behind their own warehouse, open-plan and serves as storage and picking for bulky and returnable items. It also serves as a space to park delivery vehicles.

4 RESULTS AND DISCUSSION

According to what was exposed in the methodology chapter, to develop this project, guaranteeing that the key question is answered, a reasoning map was planned that includes five stages are detailed in the figure 1.

Figure 1: 5 steps of project development

4.1 HORIZON ANALYSIS

To help the company to have greater visibility of the decision, the project is developed to support the five-year growth horizon. This data was provided from the strategic business plan and is aligned with its horizon and perspectives. It was considered
that the company's strategic objective is opening up new sales channels and increasing sales on the online channel. Furthermore, this growth is not linear for all references.

4.2 DEMAND FORECASTING

The processes that are currently structured in the company do not contemplate Demand Forecasting. However, for the analysis that the project carries out, it is necessary to forecast future sales volumes to identify the best inventory policy to be implemented. Thus, the sales data for the last 3 years have been taken, by month and by reference. An ABC analysis was prepared, which shows that 30% of the number of references is responsible for 84% of the sales in euros. Graphic 1 present this analysis.

![Graphic 1: ABC analysis](source: Authors (2023))

It is also perceived that there is a large variation in the sales volumes of each reference between the months of the analyzed history. The standard deviation in relation to the average monthly sales by reference usually presents a vision of the size of the sales variability that the company's portfolio has. From the graph below, the information has been obtained that only 16% of the number of references (green) has a coefficient of variation of less than 30%, that is, the standard deviation divided by the monthly average does not exceed 30%. On the other hand, graphic 2 present the demand randomness analysis, where 21% of the references (red) have a coefficient of variation greater than 100%, which indicates a high instability of the data. The other references (yellow), 63%, present a coefficient of variation between 30% and 100%.
To consider the increase in sales defined in the company's strategic plan to forecast sales volumes at the reference level for the next five years. The growth projections proposed by the company are creating a new sales channel through public tenders, promoting the WEB channel and increasing sales of the traditional channel (call center). In the case of public tenders, sales are concentrated only on references A, since the company has more competitive prices for these products. For references B and C it is expected to grow by 7% per year. The total growth, references A, B and C, can be verified in the graphic 3 using the current year as a reference, that is, 100%.

It has been assumed that the means and standard deviations will grow linearly. For example, if a reference has a monthly average of 200 and a standard deviation of 50 and the growth forecast for the following year is 20%, its demand forecast will be 240 units and its standard deviation of 60 units.
4.3 REVIEW OF THE INVENTORY POLICY

The company's purchasing and inventory planning process currently has 61 suppliers, every day a review of inventory and supplier are is done, and at the end of the week, all are covered. Because it is a process that requires significant investments in information technology and availability of human resources, which could have an impact on the company's workforce, it was decided to maintain periodic inventory review as the methodology. The lead time of the suppliers, due to their strategic localization and the availability of stock, are usually no longer than one week.

The company does not have historical data on delays in purchase orders, so it was agreed to use a coefficient of variation of lead time of 25%, according to the planner's experience. Inventory planning parameters are currently established purely according to the knowledge of the planner, that is, there is no scientifically based methodology to calculate optimal inventory levels. For the calculation of the periodic review policy with the reorder point, the calculations were made taking into account the current planning process, and also the projections for the next 5 years. This work has proposed the following parameters and methods of calculation:

4.3.1 Safety stock

Was calculated based on the formula presented on section 2 of this research. To give an example, we take the reference "Pack of 12 bottles of water" to calculate the safety stock, which has as data: Average monthly sales: 3,163 units; Standard deviation: 641 units; Lead time: 3 days; Lead time deviation: 25%; Service level: 98%; Review period: 7 days.

\[ S'd = 2 \sqrt{(3+7)*641^2 + 3.163^2*(3+7)*25^2} \]

The same safety stock calculation methodology was used for the other references. This number is the minimum stock that you should target for the planning process. It would be ideal for this model to use sales forecasts as demand and as demand deviation, to use the forecast error measure. In this work, a future projection of the demand was made, but since the company does not have the demand planning process implemented, the data from the historical deviation proportional to the new forecast demand has been used.
4.3.2 Reorder point

The reorder point consists of the sum of the safety stock and the demand during the lead time. In other words, it is possible to reach the reorder point by multiplying the average daily demand by the supply lead time, adding this part to the safety stock, as shown in the formula below:

$$PR = S \cdot d + \text{Demanda Promedio (días)} \cdot \text{Lead Time}$$

For the example mentioned above, the calculation of the reorder point would be:

Reorder Point = 909 + (3.163/30)*3
Reorder Point = 1.225

4.3.3 Average inventory

The average inventory is the sum of the safety stock plus half part of the purchase lot. For this study, the possibility of changes in the minimum purchase lots from suppliers has not been considered, therefore, the economic purchase lot policy was not used. The review period and the minimum batch already underway in the company have been considered. In this way, if the minimum lot is greater than the demand of the periodic review period, then the minimum lot is considered as the lot. On the other hand, if the minimum lot is less than the demand for the periodic review period, the demand for the review period adjusted according to the physical conditioning characteristic of each reference is considered a purchase.

Using the example of the Pack of 12 bottles of water, the average inventory would be calculated:

Avarage inventory = Safety Stock + EOQ/2
Avarage inventory = 909 + 607/2
Avarage inventory = 1.212

As a result of the calculation of the new inventory policy, it is possible to perceive a considerable reduction in the average inventory levels, inventory values and days of coverage. The graph below shows the average inventory reduction (in product units). The
new inventory policy has made it possible to reduce the inventory level by 30% compared to the result of the previous year. In addition, this policy supports sales growth within 5 years, with a margin of 6%.

Graphic 4: Inventory Policy projection for 5 years

Comparing the current days of coverage with the projected ones, a 30% reduction is obtained in relation to the one made in the previous year.

Graphic 5: Days of coverage based on inventory policy

4.4 WAREHOUSE CAPACITY

After analyzing the number of units per reference to be stored in the next five years, it was necessary to transform the unit of measurement of the analysis: volume of units per reference for quantity of pallets. Firstly, the packaging of each reference has
been analyzed, since some are sold individually and others in packs. For the individual references, data has been obtained on: packaging model, number of references per package and number of packages per pallet. For the references that are sold in packs, the relevant information was the number of packs per pallet.

The company's inventory is physically divided into normal pallets and picking pallets. This occurs due to its logistics operations restrictions. To facilitate the analysis, it was decided to verify the percentage that the average inventory of each reference occupies in terms of pallet racks.

Due to the work characteristics of the company and to avoid displacements when preparing the distribution loads, all the references must be available in the picking area. Due to this, for the SKUs that have an average inventory of more than one pallet, a space has been allocated in the picking area and the other pallets will be stored chaotically in conventional or drive-in racks. For the SKUs that occupy less than one pallet, it was necessary to verify their occupancy, since for spaces that have more than one SKU it is not possible to fill the pallet more than 50% so as not to impair the agility of daily handling. Through this methodology, it has been possible to transform the unit of measurement of the analysis: from the volume of units per reference to the spaces required for storage.

4.5 WAREHOUSE: ANALYSIS BETWEEN DEMAND AND CAPACITY

Once the number of spaces necessary to store the inventory projected in the analysis horizon (five years) has been defined, it is necessary to compare the capacity, that is, the installed storage capacity versus the demand generated by the study. The graph shows that the need for racks will occupy a maximum of 87% of the installed capacity in 5 years horizon, considering the strategic sales increases. In other words, 365 spaces of the 419 spaces of installed capacity will be occupied. The average used by the operation in the previous year was 375 holes.
5 CONCLUSIONS

The key question that this project set out to investigate was: to buy or not to buy the currently rented warehouse? Based on the results, it is concluded that it is possible to store the projected demand for five years through a readjustment of the inventory policy, which also makes it possible:

- Decrease the inventory average by 30%, in units;
- Decrease investment in inventories by approximately 20,000 euros, which corresponds to 25% less compared to the current one;
- Decrease the need of storage space by 32%, making it possible to operate with its own warehouse, taking into account an increase in sales of 57% within 5 years, which would allow the company to operate with an occupancy of 87% of the installed capacity.

The greatest benefit achieved by the company is not having to disburse the amount of over 300 thousand euros corresponding to the value of the acquisition of the warehouse, which is actually rented by the company. This amount corresponds to 20% of the total annual revenue of the company, with which it is possible to understand the importance that this saving represents for this SME.

With the development of this work, the company has in its hands the clear answer to the key question, with the logistical approach. Other non-logistical factors can be analyzed in conjunction with this project, in order to complement the analysis and support the correct decision-making. These other factors may be, for example, the investment opportunity in the warehouse due to a competitive price or the strategy of buying it to
generate benefits through rental, among other factors, are not part of the scope of this project.

6 FURTHER RESEARCH

Below are some points detected as improvement opportunities for the company, despite the scope of the project not encompassing them. These are points that are part of business logistics, but due to particularities and limitations, they have not been able to be worked on this time. However, it is noted that they can provide an advantage if implemented later.

Análisis MTS x MTO: In this work it was considered that the inventory system for all references will be MTS - Make to Stock, since the company's business is based on fast delivery to the end customer and using the complete product portfolio as a competitive differential. But, there is an opportunity to further reduce the average inventory if it were possible to align the flexibility in the supply terms between the client and the suppliers, making some references only be purchased after the client's order has already been inputed, characterizing an MTO – Make system to Order.

Demand Forecasting Process: To carry out the safety inventory calculations, the standard deviation of the sales history has been used. However, if the company had a demand forecasting process in place, the forecast error data would be used, which is typically less than the historical deviation data. This would allow even greater inventory reduction. In addition, greater visibility of the supply chain and more speed of reaction to changes coming from the market would be achieved. A detailed vision of the future would give the company greater power over its suppliers.

Economic Order Quantity (EOQ): The minimum purchase lots used for the analysis were based on the commercial agreements with the suppliers. However, a potential for improvement in inventory levels has been perceived if it were possible to implement the methodology of Economic Order Quantity. It would also be possible to generate competitive advantage through the correct analysis of opportunities of economies of scale, if the variations of the methodology of economic batches of purchases for quantity discounts are used.
7 MANAGERIAL AND PRACTICAL IMPLICATIONS

Despite being a theme already widespread in the literature, it is perceived that the concepts of inventory policy and safety stock calculations can be applied in companies of different sizes and segments. The research reinforces that the correct use and application of an consecrated methodology can provide significant gains with its application such as inventory reduction, reduction of operating costs and increase of the level of service.

Regarding the managerial implications, with this research it was possible to implement a calculation methodology to define the company's inventory policy and thus allow a better use of the useful area of the warehouse and avoid the need to invest in a new space to increase capacity, avoiding a significant expense for the company.
REFERENCES


Serrano, María J. E. 2011 Gestión de aprovisionamiento. Madrid, Ediciones Paraninfo SA.

