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Inventory Management System Implementation for Non-cork Material

Tomás Pinto Leite Magalhães Martinho

Master Thesis

Supervisor at FEUP: Prof. Alcibiades Guedes

Supervisor at Amorim & Irmãos Engenheiro Rui Castanheira

Co-Supervisor at Amorim & Irmãos Engenheiro Vitor Hugo

U.PORTO

FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

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Abstract

The current scenario, with increasing competition in the industry, resulting from higher standards and demand from the market, require changes in the supporting of management decisions. With the growing automation allied with better human practices, it is possible to produce better with less costs. If from on hand we have higher competition inside and outside of the sector, from the other we have better informed and more demanding clients.

That way, the biggest challenge of the industry is to adapt to the change, through efficient management of resources and processes, reducing errors and maximizing productivity. In this context, tools to support the flux of information and managing inventories can help to reduce workflow and produce better and efficient results, with positive impact in the productivity and strengthen the strategical positioning of the company. Then, the classification models and inventory review methods contribute to a successful setting of mechanisms to support the organization.

The goal was to develop and implement methodologies that allow the purchasing department to have a supported and integrated view of the necessities of order and raw material, through optimized models of inventory management. An initial description of the current situation was done, identifying problems and inefficient processes.

Furthermore, with use of ABC and XYZ analysis, sought to identify items with higher relevance, as well as the consumption behaviour. To complement the project, it was targeted inventory management models that allow an efficient inventory management. Besides the main project, it was aimed a complementary project focusing on the physical warehouse and its organization.

In conclusion, what is presented is an optimized model of inventory management, which was tested and implemented to achieve a balance in the replenishment and capacity to answer internal requests and consequently reduce the chances of stockouts or unpredictable demand.

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List of abbreviations

μ – Average

σ – Standard Deviation

Cv – Coefficient of Variation

EOQ – Economic Order Quantity

FOQ – Fixed Lot

H – Holding Costs

LT – Lead Time

POQ – Periodic Quantity Lot

Q – Optimal Quantity to Order

R – Review Period

s – Reorder Point

S – Maximum Quantity

SGPR – Sistema de Gestão de Produção de Rolhas

SS – Safety Stock

Z – Service Level

1 Introduction

The present dissertation was developed in a business environment within the scope of the Master in Service Engineering and Management of the Faculty of Engineering of the University of Porto, in Amorim e Irmãos, an Industrial Unit of Grupo Amorim specialized in cork stoppers production.

From the company's point of view, this project arises from the necessity to create a well conducted process to manage the non-cork inventory inherent to the restructuring of the logistics department.

The logistics concerning the non-cork material is fundamental in the sense that it affects what is essential to provide a quality service and final product to the clients. Also, it is important to develop a model to provide the best management decision practices of inventory management and replenishment to be possible to control and monitor the investment that is done in stock without damaging the service level.

Throughout the report themes related to the inventory management, such as the review models and product categorization concerning the supply chain.

As a result of the project it is expected to be developed a platform that works as an inventory management decision support tool. Also, this tool is expected to automatize and standardize the decision process, increasing the allocation efficiency of the material.

1.1 Problem Description

Concerning the project that was done in Amorim & Irmãos, the main problems that were behind the need of a system to manage the non-cork material were:

- Purchasing and replenishment decisions decentralized, with mainly only one central warehouse serving as hub to others units;
- Lack of tools to follow the existing stocks and the needs;
- Lack of knowledge concerning the costs of keeping the material and ruptures / stock-outs;
- Process undefined and not standardized.

1.2 Research Questions

In order to address to the problem described above, it is necessary to answer to some research questions imposed.

In this particular case the research questions are the following ones:

- What products should initially the efforts point out to?
- Does the lack of inventory management affects companies investment?
- The physical warehouse affects the central management of inventory?
- What is the most suitable model to manage the inventory integrated in this context?

1.3 Study and Project Development at Amorim & Irmãos

The project was initiated integrating the production context of the unit and familiarizing with the systems and contents that the unit contained. Also, It followed the purchasing, reception and storage of the products that I would be working on with. This was important in this early phase to acknowledge the processes inherent to the project and the different products, which are very important components in the development of the intended system.

The exploration of the actual system that the unit has, AS400, was also important because of the lack of tools besides excel that currently the unit persons use. So it was essential to study the architecture of the data base, its menus and functionalities, to extract the needed tables and menus to the excel sheets, which was the main tool behind the system.

After analysing the common possibilities of methods to build the inventory management system, it was time to study the line basis for which family of products to focus on. So it was made an analysis based on the historical consumptions and the costs of the products. Also it was taken into account the fluctuation and variation of the internal consumption of each product. The final products that were chosen were the least variation on the consumption and the most consumed throughout the past years of analysis.

Apart from what was outlined for the system, it was also carried on a study to implement visual management, 5S in the warehouse and the use of kanban's to represent the necessities.

The result from the project, was a tool built to help to support decisions concerning stocks purchasing and replenishment. The only way to measure the efficiency of the algorithms and method used to calculate the different parts of the tool, would be comparing previous periods with the current months or year.

This tool was made, to be used by two persons, one the responsible for the purchase and the other one was the responsible for the internal logistics.

1.4 Report outline

Regarding the structure of the report, it is divided in seven chapters that contain several sub-chapter each.

In the first chapter it will be addressed exclusively the main goals that are intended to be achieved, a small presentation and framework about the company, the internship and the development of the project.

The second chapter cover the literature research carried out and adapted to the context, concerning the methods of product classification, review models of stock management.

The third and fourth chapter are of contextualizing the initial situation that was presented and the methodologies used throughout the project development.

The fifth chapter concerns the collecting of the product and product distinction using the methods described in the literature review.

The sixth and seventh chapters integrate the development and results of the main project, and also the complementary project developed in the company.

Finally, the last two chapters present the improvement proposal described according to the experience lived in the past months in the company and the final reflection regarding the project developed.

2 Theoretical Background

In this chapter it will be presented the literature review, integrating the most pertinent and adequate tools for this study case.

2.1 Product Classification

Managing Inventory is considered to be a continuous process of planning, organizing and controlling inventory with the purpose of monetize the investment and consequently the costs of it, while balancing supply and demand.

So, it is imperative, an attention in the management of those material that are important, concerning the quantity moved, quantity ordered or stored, which affects the fixed costs that companies incur.

So, considering that the stocks have a considerable weight on the investment of companies, they are obliged to proceed to its analysis to identify and structure the products which are more rentable to the company.

According to Gonçalves (2010) the investment that is done in stock of a given product depends on to variables:

- The quantity consumed per year;
- Cost of each unit of the product.

2.2 ABC Analysis

Based on this assumption, and according to Heizer and Render (2000) the ABC Analysis constitutes an important tool to manage, plan and control quantities of material to stock.

This method constitutes one first approach and allows to have a global vision about the ratio cost/consumption/quantity of each product. (Hoppe, 2006). The ABC Analysis, also known as the ABC Curve, which is based on the Pareto Principle. This principle was born in the XIX century by an Italian economist, named Vilfredo Pareto who conducted a study about the wealth distribution on Italy, where he concluded that wealth wasn't equally distributed.

Since then, this kind of principle has been transposed to an industrial environment, being that of such application only a little margin of products result in a big percentage of the costs and a big quantity represents a small percentage of the costs involving the stock.

Bearing in mind this assumption, the ABC Analysis could reveal itself to be a simple and effective management tool, because it allows to easily understand which products represent more money in the end of the year to the company balance.

This analysis is important and used in controlling and managing stocks, because it is a tool that focus on the products and materials that require more attention and care.

The ABC classification in function of the annual consumption is the method that deserves more attention in the literature, according to Heizer and Render (2000).

Some divergences appear to exist between the literature concerning the percentages delivered to each classification.

The figure 1 represents an analysis of Pareto, commonly known as ABC Curve, and the classifications attributed according to Hope (2006).

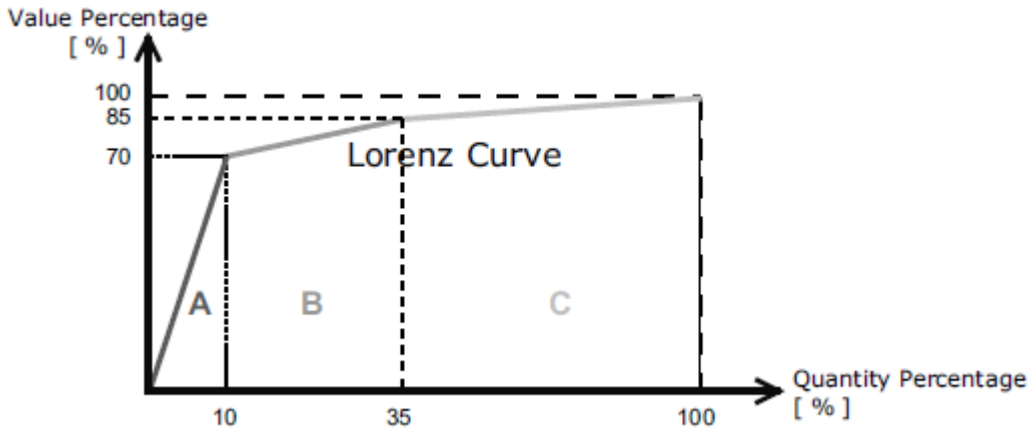


Figure 1 – ABC Curve, (Hoppe, 2006)

Although, Yang et al (2009), argues that commonly the products of type A represent 80% of the consumption/cost, represent about 20% of the total products. It is classified as product B, the ones that represent 15% of the consumption and as C those that add the remaining 5% of the inventory.

Some other authors, as is the case of Devnani, et al (2010), who believe as well that commonly the A classification is attributed to 10-15% of products which represent 70% of the consumption. The classification B is represented by 20-25% of the products, and 20% of the criteria. Finally, the C classification integrates the last 65-70% of the products representing the final 10% of the consumption.

Considering the requirements of this project, and the limitations that could exist when using only ABC Analysis, this analysis is not enough to go along with all the criteria that is needed to do a precise categorization of products, because of the demand variation and fluctuation throughout the period of analysis.

2.3 XYZ Analysis

Bearing what was said before, the XYZ Analysis appears as tool to fill the gap to the criteria for a precise product categorization and analysis.

Then, this analysis allows to evaluate the importance that certain products represent for the company, increases the effectiveness when classifying products as well as it management being able to predict the frequency of provisioning and consumption (Devarajan and Jayamohan, 2016).

Similar to the ABC Analysis, also this analysis obeys to certain standards of classification of the products.

According to Dhoka (2013), the XYZ Analysis classifies the products in an inventory according to a criteria of variation of the demand. This method integrates the products with uniform demand in the category X, while the ones with some or more variation in the category Y and the irregular demand classified as Z.

To procced with this kind of analysis, it is necessary first to determine the demand variation coefficient (Cv) of each article. This coefficient, is determined by the relation between the Standard Deviation (σ) and the Average Demand (μ) has it is shown in the equation bellow:

$$Cv = \sigma/\mu$$

According to the figure bellow, we can check the classification X, Y and Z for products based on their coefficient variation.

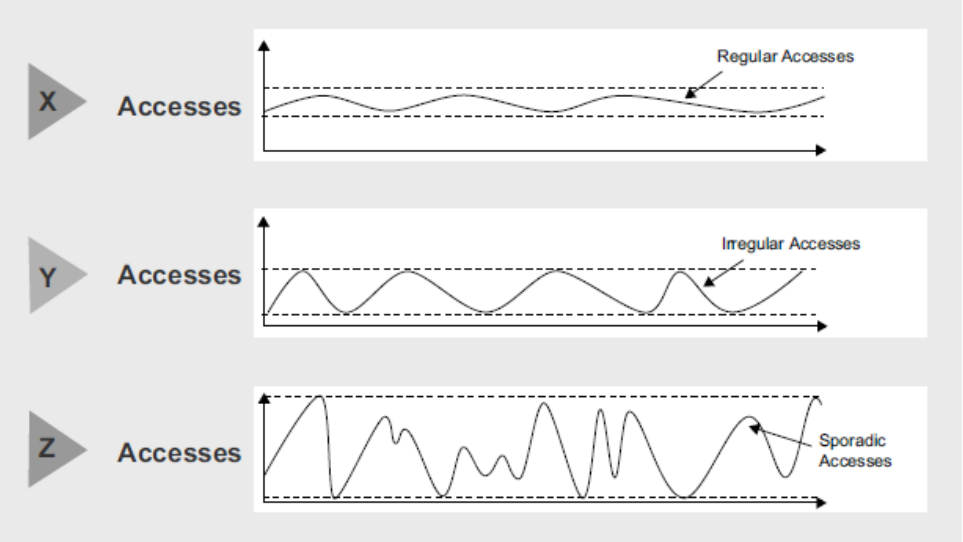
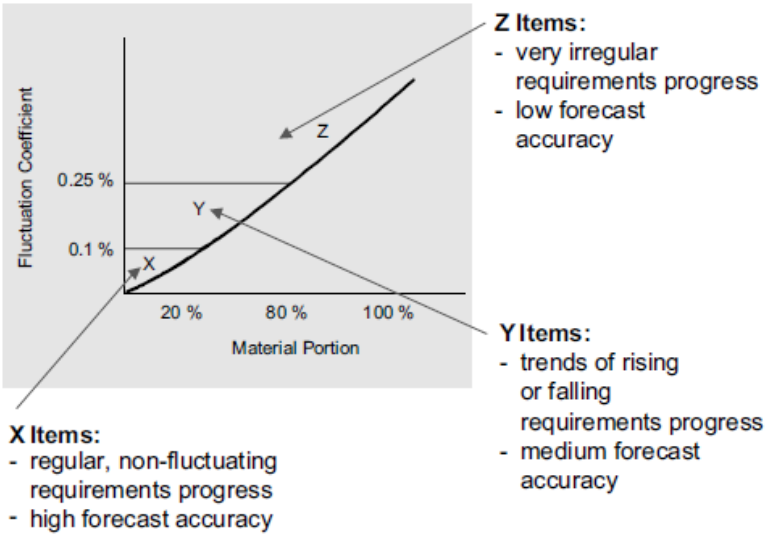


Figure 2 - XYZ Analysis with Accesses and Fluctuation for Material (Hoppe, 2006).

Nevertheless Hoppe (2006), also agrees that it is possible to integrate product classifications according to the following basis on the fluctuation coefficient in relation to products portion, as shown in the figure.



Tom Figure 3 – Fluctuation Coefficient according to product portion (Hoppe, 2006).

2.4 Inventory Management and its Importance

Every company has to face the productivity challenge. The creation of goods requires changing resources into goods, and the more efficiently companies do that, the more productive they are and more value is added to the final product. Heizer and Render (2011) refer to productivity as the ratio of outputs (goods) divided by the inputs (resources, raw material, labor).

So when it is considered improving productivity it also means improving efficiency. According to several authors, there are several ways to do that, but in a consistent way there are only two:

- Reducing inputs while keeping outputs constant;
- Increasing output while keeping inputs constant.

To do so, it is advised to look closely to inventory management as a part of productivity challenge, and ways to improve it. Grant et al (2015) defend that keeping a sustainable management of operations is also an important part, when allocating and using effectively resources and labor to increase productivity.

In figure 4, it is shown the flux of resources through transformation ending with the output.

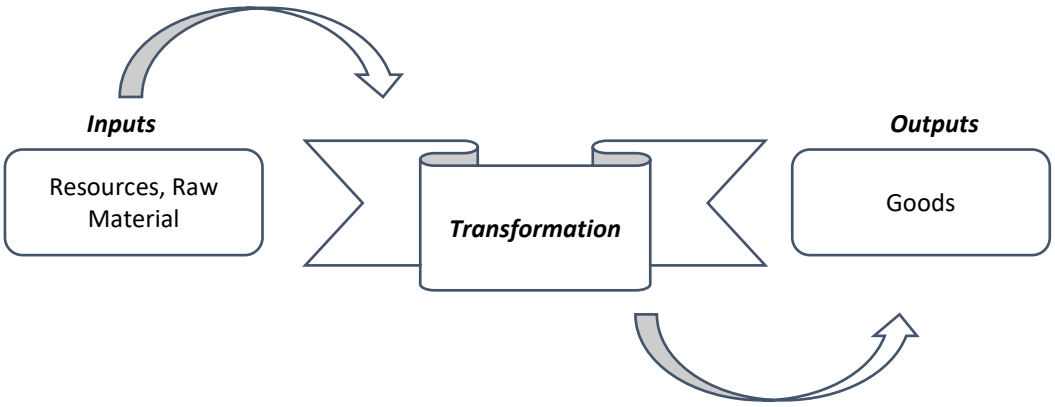


Figure 4 – Productivity ratio.

Adapted from: Heizer and Render (2011).

As the supply chain is complex and evolving with the increased demand and quality requirements, all the key aspects of the supply chain should be clearly defined and controlled by the right instruments.

As Hoppe (2006) argues, many companies will find standard key figures as inappropriate, and these figures often are not used by the organizations for pursuing objectives, as they don't fit as right means of control.

We can verify then, that one of the most common mistake made by companies, is the isolated use of logistics key figures. As an example, managing the professionalism of inventory management based mainly by inventory turnover or range as the result, may be blurred.

All the costs must be considered, following the example, as the risk of low inventories potentially goes unnoticed, the transport costs could increase simultaneously with time. We should then, combine properly all the strategies ahead of the supply chain.

Following what has been said until now, it is assumable that at a strategic and financial level, stocks are an important aspect to the well-being of a company. So it is necessary, besides considering the relevant costs and key figures, to adopt well defined politics of management to achieve companies' objectives, being then adopted stock controlling methods for the purpose.

The term stock, as shown in figure 5, is used to be referred to the existences of raw material, consumables, components and finished products of a company.

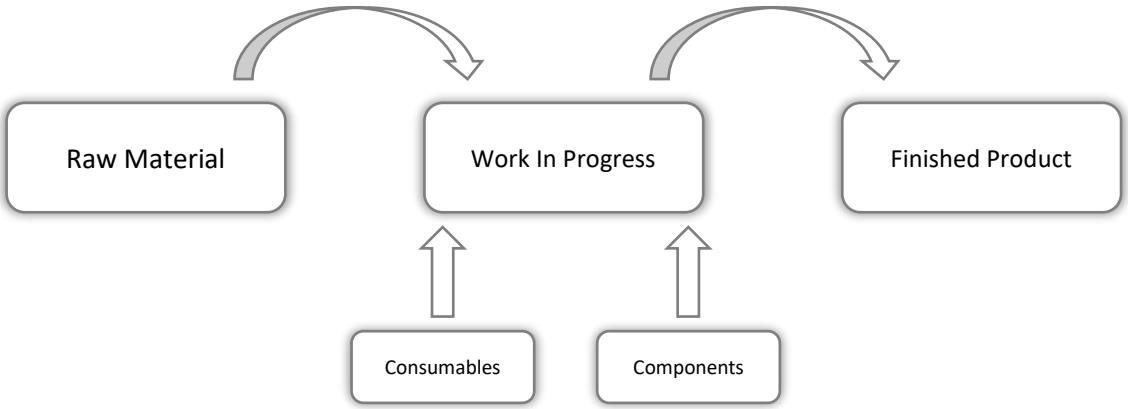


Figure 5 – Stock Interpretation.

Adapted from: Marques (2015)

According to Gonçalves (2010), stocks can be grouped into different categories, such as work in progress stocks, seasonal stocks, and safety stocks, among others. Maintaining and following closely safety stocks as its own reasons, and according to the author, who argues that they serve to strengthen the well processing of stock managing against fluctuations of demand and variations in the lead time of the suppliers.

It is necessary to understand the financial and economic impacts that are involved in the inventory management and storing, considering also the labour cost which is an important variable cost that most of the companies don't include when analysing the costs.

Most of the working capital invested in the companies, is represented by stocks, this is why it constitutes a cost that should justified and properly controlled. This is done having by basis the service level, the levelling between the demand and the replenishment time and quantities, imposing conditions to answer to seasonal variations and fluctuations, errors and problems in the production and supplying, and finally the capacity to answer to the not forecasted demand.

Following this line of thinking, several authors defend that the decision to provide a comprehensive service level is a strategic one by the companies.

Hoppe (2006), argues that compromises must be found and priorities set, looking to gear towards objectives such as cost minimization and capacity optimization.

To achieve such high and desirable service level, one must have to increase the warehousing stock so that it is possible to satisfy the demand with finished products. The production must

be able to start processing orders when it is released and at the same time distribution able to deliver it on time (Heizer and Render, 2011).

However and looking back to what has been said, pursuing this strategy counteracts the objective of minimizing costs and optimizing warehouses. Therefore, the decision to provide a high service level always requires a clear and precise definition of sub goals.

As the inventory is one of the biggest investment that is done by the companies, those that see themselves obliged to structure a constant and strategic evaluation to maximize the return on the assets. In the figure 6 we can verify the relation between the service level that is intended and the investment that is necessary to the context.

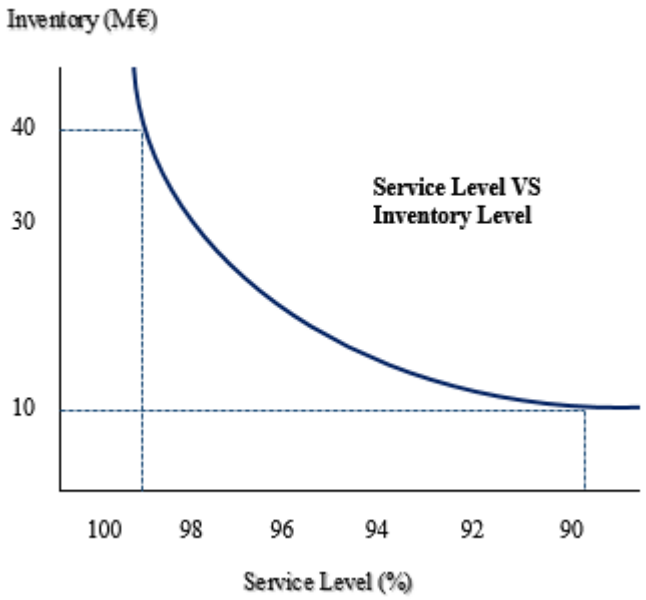


Figure 6 – Service Level vs Inventory Level.

Adapted from: Almada-Lobo (2012).

2.5 Stock Management Models

Has we've seen throughout the past literature review, the stocks represent immobilized investment, depending on the sector companies are in. The discussion about the importance of the costs associated to the stocks, is a pertinent and relevant one. Most of the authors, argue that even if the stocks seem indirect or irrelevant, meanwhile they point out to a crucial strategy to compete in worldwide markets when decreasing the costs.

The necessity for stocks arises from the fact that there is an incompatibility between demand and offer. In logistics and production, the existence of the stocks it's supported by a lot of factors, including the economies of scale of the purchase and transport and minimizing stock-outs for example.

So considering its importance and the necessity of its existence, several technics and philosophies approach this question with the best practices. Bearing this perspective in mind, the following sub chapters' focus on two common methods used to manage inventory.

According to Gonçalves (2010), there are two main types of systems to control stocks:

- Continuous Review;
- Periodic Review.

The first model, as the name suggests, there is a continuous review over the stock level that currently exists. As for the second model, the level of existence of the inventory is reviewed on a temporary basis previously defined.

2.6 Continuous Review Model

The most common continuous review system is the reorder point, quantity to order (s,Q), where "s" denotes the reorder point and "Q" represents the optimal quantity to order, as presented in the figure bellow.

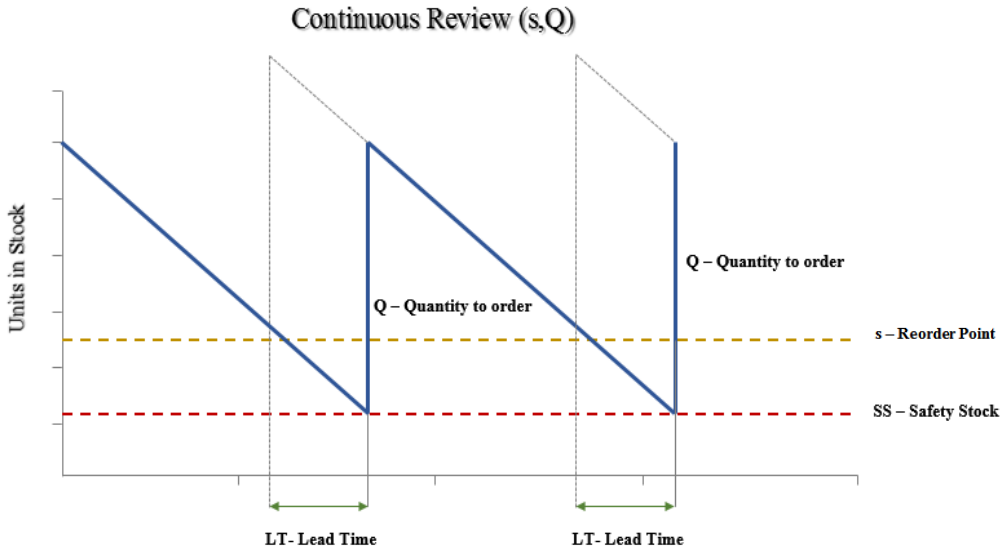


Figure 7 – Continuous Review System.

Adapted from: Gonçalves (2010).

According to the author, the Q quantity should be a quantity defined for each product, but nevertheless could be defined according to other criteria based on consumption or clients of that specific product.

The quantity s is defined accordingly the following formula:

$$s = (\mu * LT) + SS$$

Where the μ stands for the Average Demand, LT for the Lead Time and SS for the Safety Stock.

While the Safety Stock (SS) is determined based on the formula bellow.

$$SS = Z * \sigma * \sqrt{LT}$$

Where Z denotes the Service Level constant and the σ the Standard Deviation of demand during the lead time period.

This model where the need of follow closely and continuously the stock level, is due to several factors including markets or demand tendencies. This uncertainties could lead to stockouts or stock shortages, and therefore replenishment problems.

From the other hand, in the case that an order is not made since the Reorder Point (s) is achieved, there is a big probability of a stockout to occur. So the s is intimately related with the LT and the consumption that the product could have since the order is done until its reception.

According to Gonçalves (2010), another method is used when applying continuous review, the s, S being "s" the Reorder Point and S the level of replenishment to have per each different unit. Feldman (1978), states that "S" is determined by the difference of the current stock level and the maximum stock for each unit/product. This is a hybrid method, commonly known as Min-Max.

2.7 Periodic Review Model

Gonçalves (2010), when considering the periodic review model, denotes two similar systems used, being (R, S) and (R, s, S).

The system (R, S), as shown in the figure bellow, consists in evaluating in a periodic way the stock, whose period is defined by R, and when being verified an order made until the level defined by S.

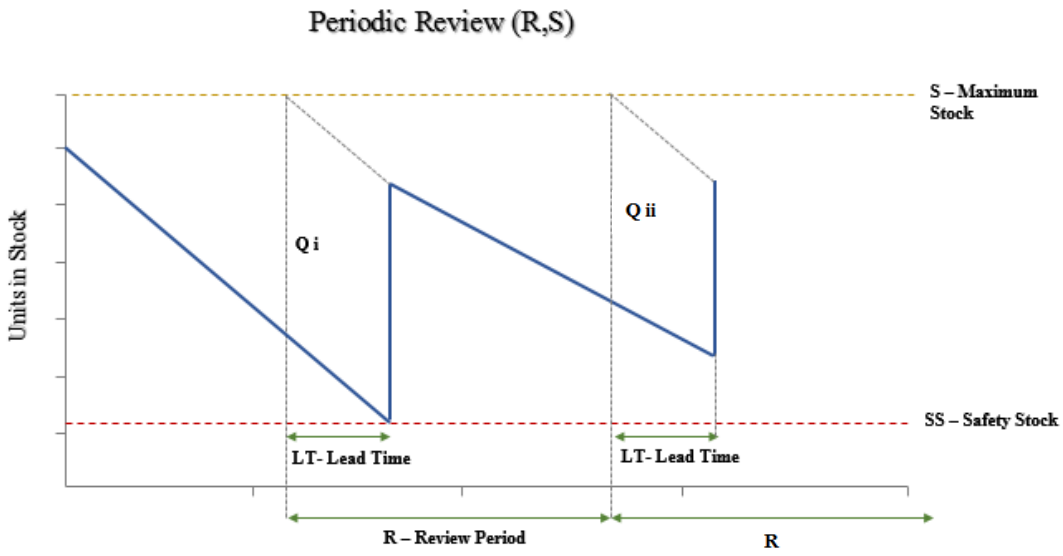


Figure 8 – Periodic Review System.

Adapted from: Gonçalves (2010).

The system (R, s, S) works similarly to (R, S), but when the quantity in stock is less than s, an order will be made until S is levelled (Gonçalves, 2010).

In this system the S level can be determined the following way:

$$S = \mu * (LT + R) + SS$$

Where μ is the Average Demand, LT the Lead Time and SS the Safety Stock.

To determine the SS in this system, the following formula is used:

$$SS = Z * \sigma * (\sqrt{LT + R})$$

Once the variables above are determined, the quantities to order (Q'), as shown in the figure 8 previously, can be defined by:

$$Q = S - Current\ Stock$$

With this method, the stock should be reviewed frequently, and that such revision should be translated into weeks or at least once a month.

Nevertheless, it is necessary careful analysis, because of what kind of register the demand stands in the context and depending on the review cycle stablished, since the longer the cycle the bigger the risk taken.

2.8 Economic Order Quantity

In the past two sections, it was introduced the variable Q standing for the quantity to order. Besides the standard formula for the Q, presented in the periodic review, several authors suggest that there are two methods of quantity to order calculation:

- Ptak and Smith (2011) agree that one of the methods is the Fixed Lot (FOQ), which it's based on ordering fixed sized lots in a constant way, previously defined according to certain specific criteria.
- Gonçalves (2010) argues that the other common method used is the Economic Lot (EOQ), which was initially developed by Ford W. Harris in the early 90's. According to the author, this method is based on certain assumptions, like the demand being constant and continuous.

The EOQ is determined by the following formula:

$$Q = \sqrt{(2 * A * \mu / H)}$$

Where A is the cost of the order, μ the average demand and H the holding costs.

Several other authors refer other models to calculate the lot size. The Periodic Quantity Lot (POQ) is based on the EOQ formula and from the annual demand, though it orders to a future period.

The Wagner-Within algorithm, it is a well-known high complex mathematic process, which evaluates all the ordering options, taking into account the necessities for the period and hoping to achieve the optimal cost solution for the situations and problems presented in the context.

Having available a forecast of product demand d_t over a relevant time horizon *t=1,2…..N*. Also, there is an ordering cost s_t which is incurred for each order and there is an inventory holding cost i_t per item per period, where the ordering and holding costs can vary with time. The algorithm proves how many units x_t to order to minimize the sum of all costs.

The inventory is denoted the following way:

$$I = I_0 + \sum_{j=1}^{t-1} x_j - \sum_{j=1}^{t-1} d_j \geq 0$$

And the functional equation representing the minimal cost is:

$$f_t(I) = min_{x_t \geq 0\, I + x_t \geq d_t} [i_{t-1} I + H(x_t) s_t + f_{t+1}(I + x_t - d_t)]$$

Where H is the heaviest ordering cost function.

Evans (1985) says that the algorithm considers the policies of ordering at period *t***, *t****=1,2,…., t*,* and filling the demands d_t, *t = t***, *t*** *+ 1,…., t*,* by an order. Adding $H(x_{t**})$ $s_{t**} + i_{t**} I_{t**}$ to the costs of acting optimally for the periods *1* to *t****-1*. From the *t** alternatives, the minimum cost policy is selected for periods *1* through *t**. Proceeding to period *t***+1* or stopping if *t***=N*.

2.9 Safety Stock

In both Review models, it was introduced the term of the Safety Stock. According to Silver et al (1998), who argues that this term Safety Stock is considered to face off the uncertainties in demand in a short period of time and the variation and fluctuation of the lead time in order replenishment.

According to Bragg (2011) this Safety Stock is fixated and defined once by companies, and it is only reflected once the stock outs occur and force its review. This safety stock, then is used as a Buffer to soften unusual events, allowing to balance the service level. Nevertheless, with it comes additional costs invested, while all products should be targeted by a careful evaluation of the demand variation, to stand off to this extra investment and to be precise in the size of the safety stock.

Also, the rupture costs are difficult to obtain. So, the safety stocks are calculated through a service level which implicitly expresses those costs.

Several authors, define the safety stock formula when considering forecasting errors or other unusual or unpredictable events the following way:

$$SS = K * \sqrt{(\sigma^2 * (l + t)) + (x^2 * var(l))}$$

Where K stands for the intended service level factor, the first part of the equation denotes de forecast error protection and the last part the supplier variability protection.

The figure 9 represents the safety stock and the context where it is inserted.

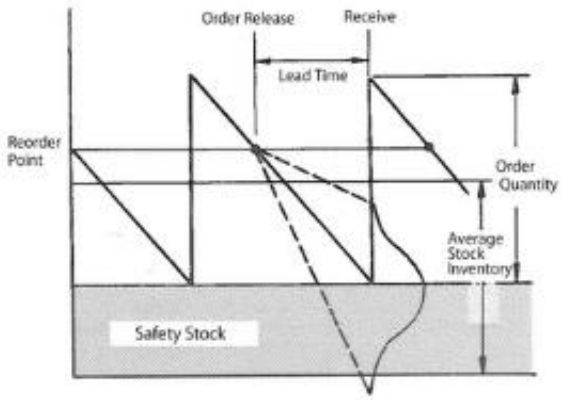


Figure 9 – Safety Stock representation

Adapted from: Bragg (2011)

2.10 Lean Principles

The main principle that relates stock/inventory management issues is the elimination of waste, also referred to as Muda.

Muda in industry, as mentioned before, refers to everything that is beyond the minimal quantity necessary of resources to add value to the product, being equipment, material, space or labor.

Coimbra (2013) states the following seven types of waste:

1. Excess of production: the production always should be equal to the real demand of the client. This is considered the worst of the wastes, because it leads to the others.
2. Waiting: this kind waste refers to unproductive and inactive times for people, equipment or others resources. It is caused by several problems as bad balancing, lack of material, tool changing or mal functions. In the traditional production system this times or periods constitute a considerable percentage of production time.
3. Transport: while several times necessary, the movement or transfer of products in the production line doesn't add value, therefore it should minimized reducing the distances between spots.
4. Stock: all the inventory/stock should be targeted for elimination. All the material without use in a foreseeable future is considered waste, representing stationary money and occupied space. The final product stock is symptom of excess production and high levels of stock can hide other problems related to quality, transport, lead time, availability, setups, organization..
5. Defects: the waste that is associated with the production defects occur when a product can satisfy the necessities and requirements of the client. It includes all the costs related with reprocessing, repair, inspection and returned orders.
6. Movement: the last waste refers to movement that doesn't add value, being it movement of people, grab tools, go search for material. Usually, this muda is related to non-ergonomic work station.

i. Kaizen Way of Thinking

In Japanese, Kaizen means change for better. The kaizen spirit is to do always better continuous improvement. According to Imai (1996) when applied in work, this philosophy means everyone doing better, every day in all areas since the administration to the shop floor.

Kaizen improvements can be small and individually insignificant, but when considered all together throughout time the cumulative effect is significant.

Coimbra (2013) argues that Kaizen is based on 5 principles:

1. Create value to the client, where the client is always in the first place and where his necessities should always be understood considering quality, costs and lead time. Every time consider the internal client besides the final client in the chain.
2. Go to the Gemba. Gemba is the Japanese word for the space or local or the real action happens. The activities that add value happen always in the Gemba. In production Gemba stands for shop floor, and to detect and analyse a problem it is essential to start from data that reflect the reality avoiding assumptions, and for that purpose this information/data is collected in the Gemba.
3. Eliminate Muda, Muri and Mura. Muda means waste and this waste should obviously be eliminated. All the operations that don't add up value are considered waste while an

activity which the client is willing to pay is an activity that adds value. Mura means variability and it is associated to uncertainty and instability. Muri is translated to excess of work or overload and it is related with the waste of time and/or energy.

4. People involvement. This 4th principle means to not judge or blame people. Most of the times when problems occur the easiest way is to find guilty people instead of understanding what went wrong. In the Kaizen context the problems are faced as opportunities for improvement and this improvement implies participation, appreciation and maximization of peoples' potential.
5. Visual Management. The visual management focus the idea that an image is worth 1000 words and that visual management implied to processes is the most efficient and intuitive path to perform a task.

ii. 5S Cycle

This methodology was create in Japan with the objective to maintain the optimal conditions in the work stations.

A good organization in the work area is a basic principle to ensure an efficient management of the human and material resources of any team.

According to Coimbra (2013) the 5S cycle is defined by 5 steps:

1. Seiri (screening): this step ensures the review of the work place, where only the things that are necessary should stay. Meaning withdraw tools, materials and other accessories that are not indispensable to the process;
2. Seiton (arrangement): ensure that is a place and spot for everything and everything is in it space. Identify without ambiguity the objects and the spots, and arrange the material with more frequent usage closer to the person.
3. Seiso (cleaning): the idea on this step is to restore the initial conditions of the installation and equipment's and to make the problems visible. Define cleaning procedures and ensure that the necessary tools for the job are available.
4. Seiketsu (normalization): to create visual norms that allow the first three steps to correctly followed. In this step visual management should be used the maximum as possible.
5. Shitsuke (discipline): define audits and checklists to monitor and sustain the success of the previous steps and avoid returning to old habits.

3 Initial Situation – AS IS

First of all, and despite all the problems that will be described as the ones that were encountered throughout this project, it is necessary to understand the problem from different perspectives and users (future and present) to create a viable and proper solution to the demanded requirements.

The increased demand for cork stoppers and the increased quality requirements has turned the market into a rolling ball, which from itself requires over and over more solutions offered to satisfy each of the clients in a unique way and perspective. The company feels the impact of the growing complexity on the production of this unique products with such demanding requirements. This is also reflected by the lack of mechanisms to manage other important tools, which could fit the solution of the incapacity to keep up with the market growth.

1) Problem One

The main problem is the slow improvement on the communication inside the company, with lots of data spread within a lot of folders, turning this into useless information with no response to the requirements and the development of the product.

2) Problem Two

Also, the problems are related to the redundancy of information in the different phases of the process (both production and purchasing of material), and from the lack of key information when considering the provisioning.

This is where the project developed in the company comes in, because it takes a key part in the heart of the company, the supply chain. When the supply chain and planning fails, everything could potentially fail. And for the supply chain to work, also the management component which takes an important role, should also work the same way.

3) Problem Three

Concerning specific problems around the project, the fact that there was not a centralized tool to manage the non-cork material makes it difficult to articulate with all the units and to go on with the production effectively. So, as mentioned before the project will be addressing non-cork material more specifically the chemicals and packaging material. The fact that the project only addresses these two components will be explained in the categorization of the products in the final phase of the report. The chemicals are an important component for the treatment and cleaning of the cork, and thinking about the demanded quality of the market, this is an important part to consider to manage properly. Also the packaging material has a role when facing to the external side of the business, where the clients stand, both internal and external. It affects the quality of the service level provided by the company, as it is demanded to always be available for the expedition and dispatch.

4) Problem Four

Another problem found was the fact that the purchasing process of this material was not standardized. The department in charge of this operation only had the outdated database to check the stock status (unpleasant to relay on and not user friendly) or by an internal request from another unit, which would trigger the purchase of the intended material request.

5) Problem Five

Most part of the material (around 90%) is stored in the central unit, and after that is dispatched to other units, which is considered a transfer and an internal purchase. Virtually the material can appear in another warehouse, when physically and in reality it can be in central warehouse, causing stock warnings or problems.

This led to the last problem encountered, the warehouse management. It was clear the lack of efficiency in storing, leading to waste in all kind of ways in the warehouse. Basically, all principles (Lean, Kaizen) that are used nowadays in most warehouses, weren't clear in this one.

3.1 Purchasing Process

The central department of purchasing is an important department in every organization. It has the mission of ensuring the replenishment of the raw material and additional indispensable material to the organization activity, negotiating prices and lead times with suppliers, verify the formal accomplishment of the technical specification of the products, etc.

This should be done in order to ensure the existence of quality and quantity of the material so that the objectives of the organization can be achieved. In this functional picture, it is easily understood the importance of the roll that is done by the planning, keeping up with the market rhythm, and that without them the company not being able to ensure the production activity without ruptures or spikes.

The quality of managing the stocks in this department is directly affected by the fact that there isn't a clear vision of the necessities and consumptions of raw material. The impact of the inventory management process and control is direct and the way it is done currently doesn't give the warranty and liability of information, producing grey areas in the knowledge of the current stocks, leading to useful or extra weekly meetings because of this content.

Therefore, the conclusion is that there is a large margin to evolve in this area that is directly affected also by the system to be developed in this project.

To better understand how the purchasing is processed, in figure 10 is illustrated the process since the internal client order to the replenishment process, according to the matrix of responsibilities.

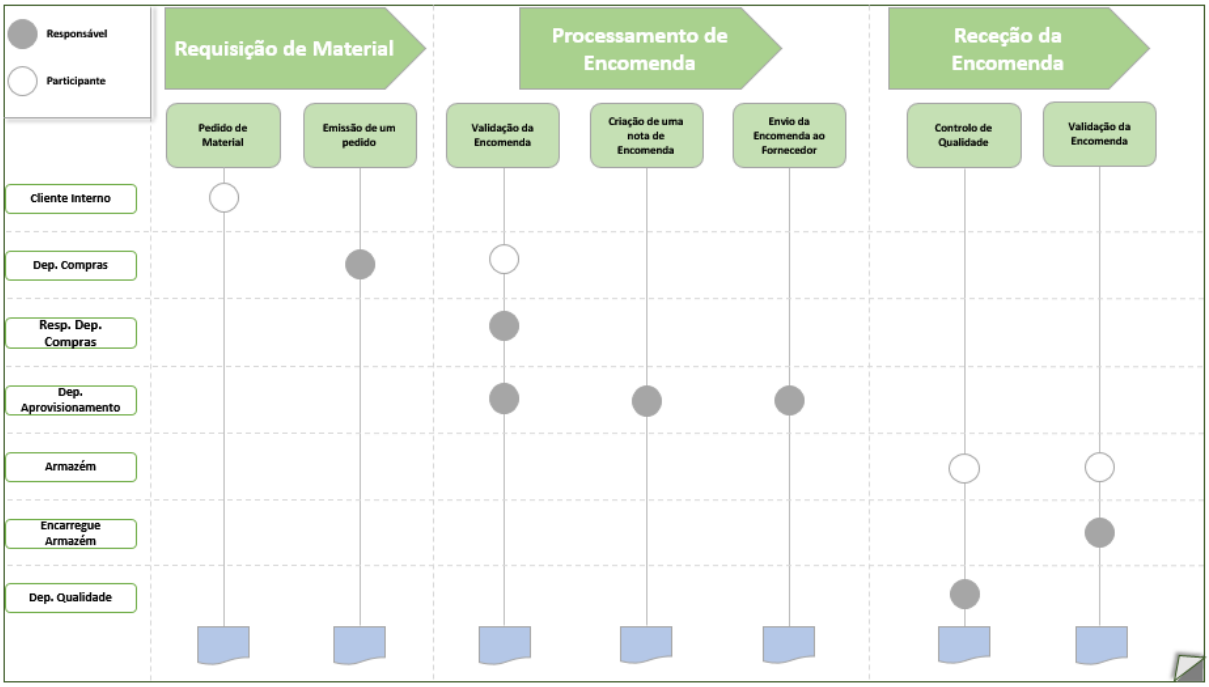


Figure 10 – Matrix of Responsabilities

In figure 10, it is presented that this is an internal request of material from and internal client (another business unit from the organization).

Associated to this internal client, there is a service level that should be achieved, but it is difficult when supplier lead time isn't precise and enough to fill this needs in time.

So this stock/inventory management is object of improvement, the focus of the project in the company, in order to increase all of this by predicting necessities and keeping track of the stock of other business units in real time, and anticipating the order requests decreasing the lead time of the suppliers and consequently increasing the internal service level.

Main problems concerning this process:

- Low Internal Service Level;
- Unpredictable Supplier Lead Time;
- Process not standardized;
- Lack of inventory tracking and perception of other business units (the internal clients).

3.2 Flux of Information Flow in Inventory Management

As mentioned previously, inventory management is done with several different tools, where the purchasing is done in the main system the AS400 and after the responsible has to input also in the SGPR (Sistema de Gestão de Produção de Rolhas) and Workflow in order to the billing occur.

Of course that, as this process contains a lot of different tools, the information is spread and sometimes lost or not used properly.

In the short term as the production plans don't meet the purchasing plans in the global management, the necessities are not clearly defined and the replenishment is also not done with enough time to be effective, leading to stock outs or excess buying.

This problems come from the fact that the inventory management is not correctly parameterized, which doesn't fit the requirements and demand of the market. It is necessary to step back, define the necessary inputs, identify the relevant information and define rules to operate correctly.

Other concerns with the current process based on several different tools, was that principles like the ordering quantities, the minimum lots, the fixed costs or holding costs were not analysed or thought properly. The real weight of the non-cork material in the business, increased a lot unnoticed, which led to the necessity to optimize its management.

The correct definition of the system will introduce real improvements on this kind of inventory management which will generate automatically an order request or replenishment refill, while the user will only need to access or readjust the need that was alerted by the system.

Main problems concerning the flux of information:

- Spread information;
- A lot of tools to work with;
- Outdated ERP;
- Lack of knowledge of the existent stock in other business units;
- Inexistent safety stock or previously defined quantities to order.

3.3 Warehouse Organization

In the figure bellow we can observe the current layout of the warehouse where non-cork material is kept. The central area is where the packages, boxes, and pallets are stored randomly without criteria, with no area defined for each category. The deliveries are made through the entrance area, and stored somewhere in the central area if it is a big product or large quantities since it provides a bigger area when compared to other corners of the warehouse.

This warehouse, also contains another area where they keep the defected material or material to be returned to the supplier.

The material/products are not differentiated by business units. Imagining a reception being made of X material, where the receptionist doesn't know if the material is to be used in this warehouse or to be transferred to another business unit, turns out to be complicated.

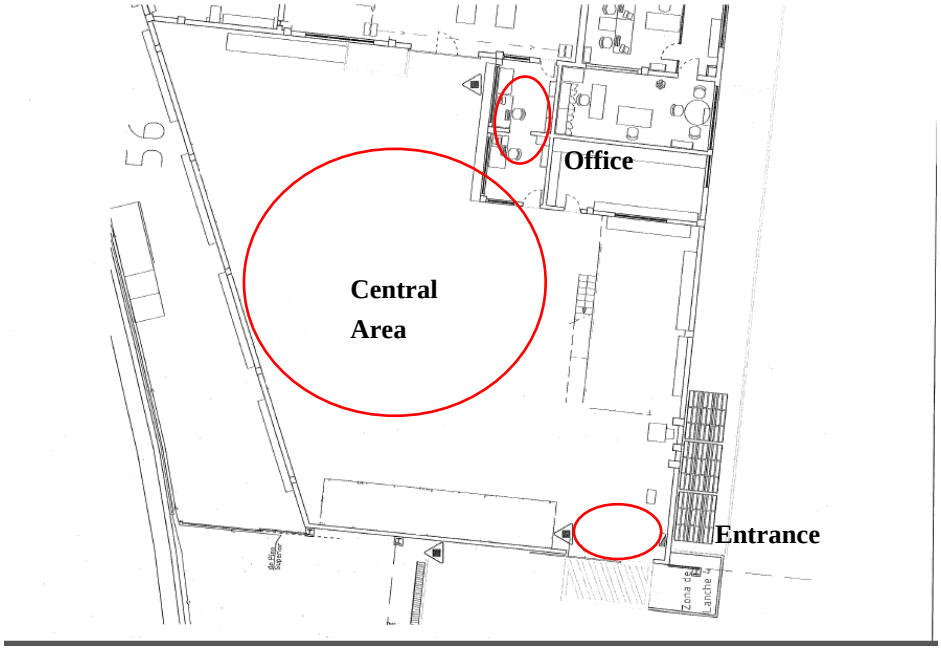


Figure 11 – Warehouse Layout

Also in the warehouse does not exist reference or any tool to point out material missing, stock-outs or reorder necessities. Since this matter is only treated once an internal request is placed, and only then checked if there is a need to order more or there is enough quantity to transfer to the other business unit.

All of this together, besides what was mentioned before in the AS IS situation, led to other problems specifically in the inventory management by the central purchasing department.

Main problems found in the warehouse:

- Disorganization in the storing of material;
- Lack of visual management;
- No reorder points or stock-out warnings;
- Misleading capacity without areas for each product;
- Unused space.

4 Methodology

A Kaizen A4 four steps (see appendix C) was developed to organize the information according to the problem and goals defined.

The structure that was used to develop the project was composed initially by identification and definition of the problem. This is an important phase, because it creates the goals that are needed to achieve and consequently dictates the success and outcome of the project. It is also necessary to have a notion of the situation AS IS in order to properly define the TO BE way of the project.

After the problem was identified and defined, convenient research had to be done to build theoretical background according to the theme, exploring several perspectives from different authors. Collecting pertinent scientific content, leads to build a successful and logical sequence to the practical work. As this is an intense and deep study of the subject matter, it can suggest and refer some problems that were not clear in the definition process. This serves then as a loop until the goals satisfy all parts involved in the project.

Following to the literature review and according to the same, models were chosen to be used as tools to build the prototype. All models and variations were evaluated according to the necessities, taking into account the advantages and disadvantages of each one.

After the basis was built, it was necessary to gather the tool's requirements, both functional and non-functional. This is probably the most important phase in the process of developing the tool. The wishes, imprecisions and needs of the potential users are translated into complete, precise and formal specifications. This has a positive impact to developing an effective tool, reducing potential errors at early stages of the project. It eases the description of the work scope and provides necessary references to the users.

Ending the idealization of the tool, with the models chosen and requirements gathered, it was developed and adapted a tool to the situation and context in the company. Lastly, it took place the measurement and consequences in the trial phase of the prototype, and which results turn out with the application of the tool.

4.1 ABC vs XYZ Classification

Have seen previously in the literature review that both of these analysis (ABC and XYZ) complement each one of it, making the analysis of the data (products) more complete and precise to analyse when looking at some dangerous variations that can occur in the demand, etc.

So, it is possible to obtain a general idea and vision about the demand that a certain product has, also its importance and weight to the organization.

From another point of view, this combination of the two types of analysis helps to achieve a balance point between levels of optimal inventories and a high service level.

Besides that, the criteria that was referred in both of the analysis can be adjusted according to the reality and context of the companies and their strategies defined.

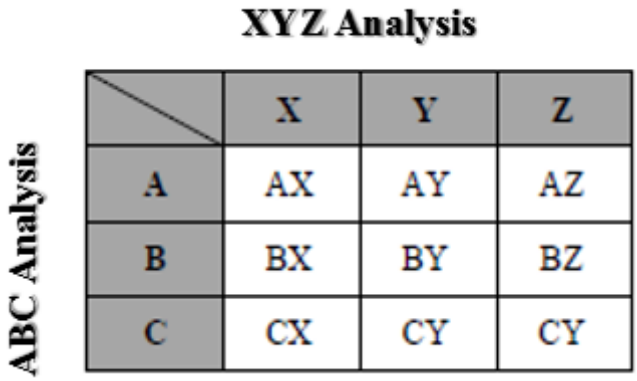


Figure 12 – ABC and XYZ combinations

a) ABC Analysis

So, the ABC analysis, according to what was said in the literature review, determines somehow the importance of certain products and therefore allows different levels of controlling based on the relative importance that is attributed to different products.

This analysis is then based on the observation that a small amount of products often/always dominate the results achieved in any situation or context, according to the pareto's law.

The main objectives are:

- Separation of the essential and unessential, defining an importance for the inventory products;
- Identification of the starting points for improvement, while implementing rationalization measures;
- Identify uneconomical measures and build foundations for supported inventory and material management decisions.

Based on the literature review and the authors, the approach to this analysis should briefly pass through determine the annual usage for each product and then multiply the annual usage of each product by the unit cost to get the total annual usage. Then, there should be listed the products according to their annual consumption in descending order. Finally, calculate the cumulative annual consumption and percentage to distribute according to the percentages the classifications A, B and C.

Advantages when using this analysis:

- It seems easy to use and understand/interpret;
- Very clear and graphical representation of the results and contents;
- No qualitative factors considered when using this method;

Likely disadvantages:

- Rough division into three classes for complexity reduction, which may not represent the real context of each product.
- ABC classification is based on historical numbers, which may change from one year to another.

b) XYZ Analysis

On another hand, the XYZ analysis objective is to classify products according to their variation in the demand and arrange products according to their consumption to derive an optimal inventory strategy.

The procedure should be based on determine relevant products, calculate the variation coefficients of each product, sort them by increasing variation coefficient.

In conclusion, many organizations use the classification of stocks divided on the basis of ABC analysis, while it turns out that the products are not differentiated enough. It only assesses the products according to their share in the company's sales. However, this inventory management and turnover rates should always be considered being also relevant aspects.

So, when using both of the analysis seems the most suitable option to this project.

4.2 Periodic Review vs Continuous Review

The reason for the calculation method in managing inventory management system is because high values of inventory management system can cause losses for the company, while not only defective products are wasted but also financial benefits of diminishing returns.

Both methods, periodic and continuous reviews provide different solutions, even for the same purpose, adapting appropriate storage techniques.

Tracking the inventory is one of the things that is important for a business that sells and uses tangible goods. Continuous and periodic review policies, according to literature review are two common methods for tracking inventory that includes accounting and ordering. Both have own advantages and disadvantages. Calculation and documentation of the periodic review made during a certain period, while the continuous review involves the calculation and documentation of each product in each time when the product needs updating.

The advantage for continuous review method is to allow updating inventory counts in real time so it will be easier to know when to reorder products in future. Lowering inventories is also a priority for the company, even if it diminishes the scaling and increases the transport costs.

Furthermore, it can facilitate an accurate accounting calculation because of the costs in real time.

Nevertheless, in this context continuous review method can be vulnerable to errors due to phantom inventory, which was already mentioned as the inventory that physically is in another warehouse. Also it can have a gap because of eventual understatements (missing inventory) due to scanning errors or untracked inventory movements, which could consequently lead to errors in replenishment. Following what was said, continuous review also requires more complexity than periodic review, while more people is needed in the transaction system, increasing the risk of mistakes made due to human error.

The advantages of periodic review is the reduction of time concerning the analysis of the amount of inventory, giving it time to structure the management decisions. Another relevant advantage is that the transport are optimized and costs are lowered because the categories of units can be aggregated in the orders.

The disadvantage is the inaccuracies in determining the amount of inventory if the business has a high sales volume, which is the case and making it harder to ascertain when reordering products is necessary. As the inventory level is not monitored at all during the time interval between orders, there is less direct control of inventory levels. A consequence of this kind of system is also higher levels of inventories that represent the safety stock needed to prevent unexpected stockouts or changes in the demand.

Bearing this in mind and after a brief discussion with the company, it was decided to use the continuous review model. The continual record of the inventory level of each item is maintained, which is an indispensable argument for the company.

The reasons to work with this model are synthesized as following:

- **Allows accurate restocking**. Changes in inventory levels are recorded in real time. Whenever the inventory on hand decreases to a predetermined level, referred to as reorder point, a new order is placed to balance the level. This order is placed for a fixed amount that minimizes total inventory costs (EOQ).
- **Lowering inventories level**. As mentioned above, the continual recording of the inventory level provides a continuous close monitoring. Which, consequently will affect the quantity of safety stock needed to prevent unexpected situations.
- **Uncovers shrinkage.** For the company this is very important, as we are leading with big quantities of material. Shrinkages and count errors adjustments are transferred to cost of goods sold. So in this system is possible to compare the inventory balance with the year-end count and allow to evaluate closely any discrepancies.
- **Accurate financial statements.** As the company has objectives throughout the semesters, which include financial ratios levels to be accomplished. This system allows to have a close keep up and more accurate financial statements throughout the periods.
- **Closer management of inventory levels.** Inventory level vs Sales. This model prevents a build-up inventory that is not selling and incur in highly costs to the company. As the inventory levels are most of the times corrects, the turnover can be correctly calculated.

4.3 Tool Requirements Gathering

It is important to take into account the different users that are involved in the use of the tool to be developed.

This gathering phase is important for the involved part, which are allowed to know exactly what is expected from the system to be developed, what it will do and will not do. The requirements of the system are data and information that are gathered to “serve as north” for the specification and creation of the project. Part of the objective of these requirements gathering then, is to understand the problem the same way the current users see it, and consequently translate the main goal of the system equally to the user’s intentions.

The focus here is mainly to automatize the process, with the aim to decrease the execution time of it and provide an effective system to serve as basis tool.

For this purpose inputs were gathered through observation and interview to focus on requirements to fill this gaps:

- Need to organize and implement optimization methods in the packaging warehouse of the company;
- Outdated system (AS400) and too hard to understand;

- Purchasing process not centralized.
- Categorization of the main products;
- Creation of Safety Stock and Reorder Points;
- User-friendly system;
- Centralized system that is linked to the main IS (AS400);
- Increase the internal service level.

5 Product Data Gathering and Analysis

To build the solution, it is necessary a study and a good comprehension of the functioning of the organization. Furthermore, it was studied the planning and purchasing process, according to the necessities and problems presented. Also, it was considered the available tools for the job, bearing always in mind all the users involved in it.

For the process, it was traced all over since the beginning until the end, using flowcharts and swimlanes, as well as the matrix of responsibilities which is already included in the AS IS situation.

In order to simplify the analysis of the products, it was used a file which contains all the historic of consumptions by category and the costs that those items represent in the end of the year.

From there, as we can see in the figure 11 bellow it was analysed the main products and the others, which contain maintenance material and health and safety at work material.

The increase in consumption the material consumption in the years of 2015 and 2016 (except for the others category which is not directly linked to the production activity) reflect the evolution in the cork stoppers market, which it is expected for the year of 2017.

Was we can check in figure 13, the chemicals represent a considerable number of units consumed for the company, when comparing to the other kind of products.

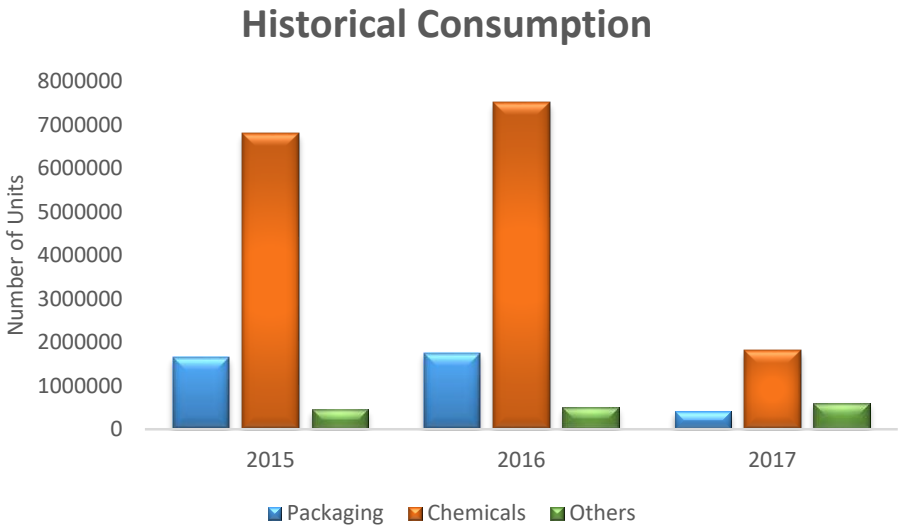


Figure 13 – Historical Consumption by Category

In this analysis we can understand that, as space is also a cost for the company, referred to as the holding costs, it was necessary to address this category of product.

Although in the end it was also decided to include the packaging materials also in the tool.

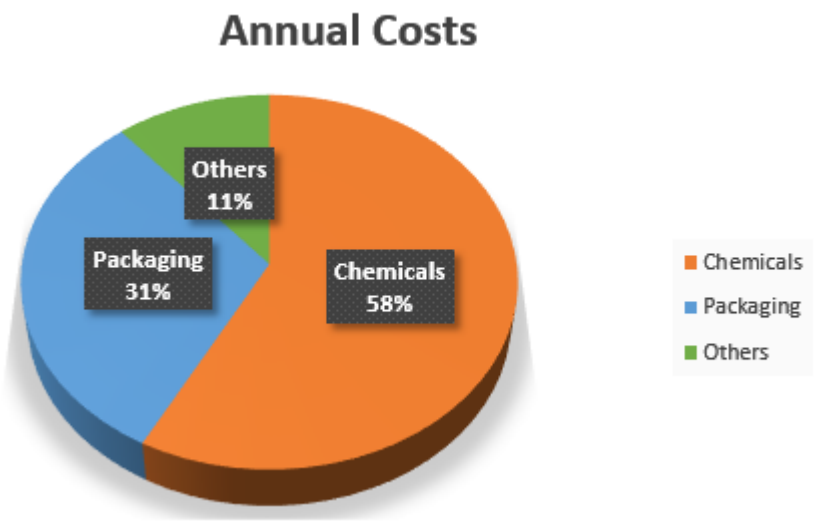


Figure 14 – Annual costs by product category

Observing the figure above, where the slice of each product of the total costs (approximately 22,5 ML) is represented. The chemicals represent 58% and the packaging material 31%, both presenting 89% of the total costs.

Following the gathering of information necessary to start the screening of data through the use of ABC and XYZ analysis.

So, in order to analyse this products after gathering the information, they were transferred to a spreadsheet for a subsequent treatment.

In conclusion there are 412 different items (corresponding to chemicals and packaging material) which correspond to a total of approximately 50% of the total items that exist in the company, and 80% of the costs of units.

5.1 ABC Analysis

This is a new approach to the analysis of this kind of non-cork material, in order to focus on these items that weight in the final accounting, which will be analysed starting now every trimestral meeting in the company.

To this analysis the last 52 weeks approximately of consumption were considered and tested the parameters of the principle which in terms of % per items represent 20/30/50 and by % of costs which represent 80/20/10 has presented in the tables bellow for both categories of items.

a) Packaging Material

Packaging		
Class	**% Item**	**% Cost**
A	9%	**80%**
B	22%	**15%**
C	69%	**5%**

Table 1 – **ABC analysis according to % of costs**

Packaging		
Class	**% Item**	**% Cost**
A	**20%**	92%
B	**30%**	7%
C	**50%**	1%

Table 2 – **ABC analysis according to % of items**

As mentioned in the literature review, some authors do not agree with the criteria presented by the paretos' law because it can be adjusted to companies reality. Nevertheless, it was decided that the analysis according to the % of costs was adapted to the necessities of the context which the project was developed.

So, observing the tables 1 and 2, and the figure 15 presented the classification for the packaging items stand like this:

- Items of A classification represent 80% of the costs and 9% of the items;
- Items of B classification represent 15% of the costs and 22% of the items;
- Lastly the C classification items represent the last 5% of the costs and 69% of the number of items.

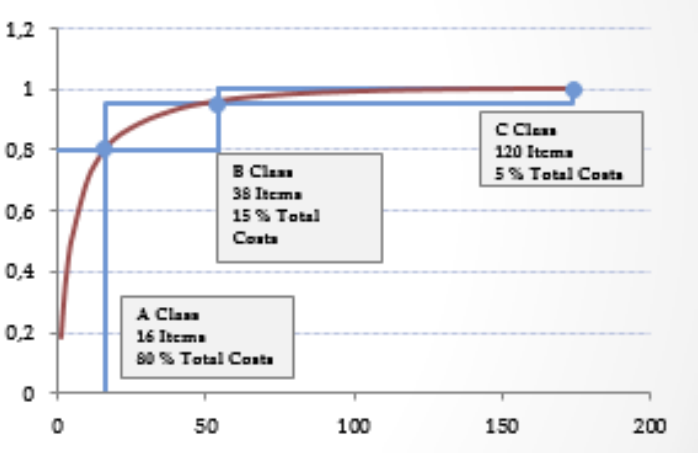


Figure 15 – ABC final classification for packaging material

b) Chemical Material

Considering the chemicals we can observe the tables and figure bellow for the classification of the items.

Chemicals		
Class	**% Item**	**% Cost**
A	8%	**80%**
B	11%	**15%**
C	81%	**5%**

Table 3 - **ABC analysis according to % of costs**

Chemicals		
Class	**% Item**	**% Cost**
A	**20%**	95%
B	**30%**	4,5%
C	**50%**	0,5%

Table 4 - **ABC analysis according to % of items**

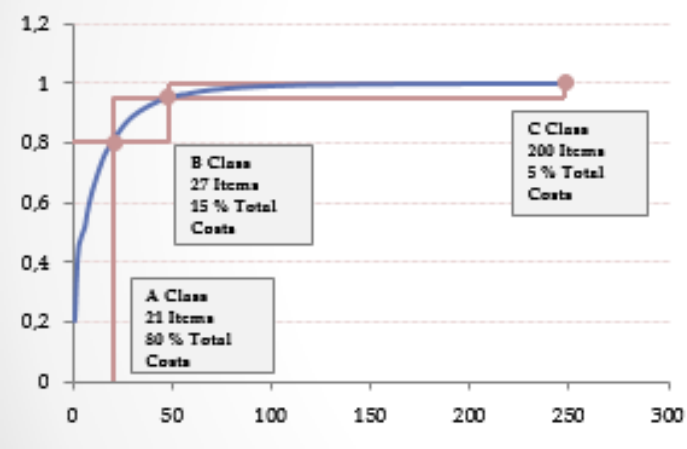


Figure 16 – ABC final classification for chemical material

The same happened in the chemicals, where the % costs was thought to fit the needs of the context of the company.

The final classification according to the figure is the following one:

- Regarding the A classification items, represented by 80% of the costs and 8% of items;
- B classification items are denoted by 15% of the costs and 11% of the items;
- Finally the C classification items are represented by 5% of the costs and 81% of the total number of items.

In this specific case of both categories of items and as expected big part of the costs are represented by a small quantity of units.

5.2 XYZ Analysis

This analysis turn off to be of great value when classifying items. As mentioned in the literature review this kind of analysis according to their fluctuation in demand.

In this phase, when joining both analysis the total costs change as well as the ABC classification.

As the XYZ analysis to the non-cork material was not done yet by the company, the method was tested according to the parameters defined and described earlier in the literature review in page 6.

Class	Packaging	Chemicals
X	*6%*	*7%*
Y	*22%*	*19%*
Z	*52%*	*74%*

Table 5 – **XYZ classification result**

In the table 5 and according to the criteria defined for the project we can observe the results of the XYZ analysis for the new model of classification.

Analysing the data, it is verified that in both categories of products, the X items are under 10% of the total number of items. While the Y items are under 25% of the total number of items and the Z classification is above 50% of the total items.

5.3 ABC/XYZ Analysis

Using both methods, ABC and XYZ would complement the analysis and provide a clear and more precise point of view when managing items.

Following that, we can check according to the table below the percentage of each item when joining both classifications into one single classification.

With this, it was possible to surpass the irrational process and all of the perspectives that generate technical, financial and human inefficiencies, using a file to serve as a guide for the purchasing planning and process.

Class	Packaging	Chemicals
AX	3%	2%
AY	5%	3%
AZ	1%	2%
BX	2%	3%
BY	10%	5%
BZ	9%	3%
CX	1%	2%
CY	7%	10%
CZ	42%	67%

Table 6 – **ABC/XYZ resume of final classifications**

In a general way the results prove that the analysis ABC and the XYZ analysis are essential to be done, and to filter the management decisions only to the items that are needed to.

The analysis was done to filter the products of each categories, in order to consider only part of the total units. The objective is to focus the efforts only in the items that are classified from AX to BX, while only those items are included in the tool and followed according to the continuous review system.

The decision was based on the fact that in both categories the A classification items where 9% of the items represent 80% of the costs in the packaging and 8% of the items represent 80% of the total costs. And the B classification case, in the packaging material 22% of the items represent 15% of the total costs and 11% of the items representing 15% of the costs. From that, it was added the regularity of demand including only the X and Y items.

The remaining items, kept with the traditional way of management, since it required less effort and costs associated with it.

6 Stock Management Tool

In order to understand the system that was developed, it will be presented the architecture of the system, the functionalities as well as the reports and possible analysis to be done from the system and the roll-out the intended user of the system.

6.1 Architecture and Design

After the analysis of the collected information explained in the previous chapter, it was necessary to design the necessary procedures and data to introduce in the system. For that, the interface and functionalities assume a crucial part and thus it should be developed in the help of the future users of the tool.

This phase, allows the transformation of abstract models to the conception of utility model for a long term. This is the reason why all the users should be involved in the development of the tool, in a way to project the mechanisms of interaction with the data and database in terms of inputs and outputs of information bearing in mind the real necessities of the company/users.

It is also necessary to understand that this tool is a prototype, so it is always subject of changes in the future, either of inputs as outputs.

The tool chosen to work with the database and information, was the excel, also concerning the outdated database used by the company the options were limited. Microsoft Excel, allows a certain interaction and personalization, if necessary by the user, allowing to change criteria of updating information from the database, allows inserting more information or changing/improve formulas to be more efficient and adapt to the necessities in real time. It is also possible to automatically update the files so the user doesn't have to worry and think about that.

The operational model developed, included five calculation sheets:

- The calculation spreadsheet for the system, which retrieves and uses the information coming from different tables from the database;
- The system spreadsheet, where the interface shows all the fields and criteria necessary for supporting the management decisions;
- The resume from the main system, which is allows the user to observe the items and its current status;
- The analysis spreadsheet which contains the analysis of the main sheet, including variations and fluctuations of consumptions and levels of stock of all items;
- Finally, an additional/optional spreadsheet is presented, where the user can manually insert information of the suppliers which will be reflected in a graphic of risk, allowing to make decisions concerning prices of lead time of suppliers.

Although in this chapter the spreadsheets will not be subject of deep analysis, because the concern is the architecture and design of the tool.

In the figure 17 we can observe the interaction between platforms and the flux of information that concerns the system context.

Figure 17 – System Interaction and Architecture

The inputs are introduced manually, by the people who receive the items, and by the people who make the purchasing and ordering of the material. From there, the excel file is fed from the database (AS400), which passes the current stock available, the orders and transactions in progress and the historical consumption.

The data is processed and treated in the calculation sheet which will pass the information to the main sheet which by its hand will retrieve data for the following sheets.

An important fact was that when involving the users in the development of the tool, the mental design of the final tool was easy to create and simultaneously minimizing the resistance to change.

6.2 Implementation and Test

In this subchapter the phase of the implementation of the tool will be described and illustrated with figures representing the spreadsheets previously enounced.

Concerning the organization of the database, it was not chosen to link to a single excel and integrate all the information there, a file that would pass the information to the main excel file, because it would occupy much space and it would be too heavy to handle. So as said before, the database would pass the information directly to the final excel file.

The implementation through the use of Microsoft Excel was done because most of the people are comfortable to use it and very used to handle excel files and to change the queries linking to the database. Also, as the tool is not to be used by several users at the same time, it wasn't present the risk of losing or duplicating information. A few visual basic routines were used in

order to ensure that the number of formulas would not exceed the maximum iterations that the computer usually supports.

The system developed, and as mentioned the previous phase, presents five spreadsheets with different purposes as shown in figure 18.

Figure 18 – Skeleton of the Tool

As the number of users was not high, since only one main user was to interact with the system, which allowed to adapt and implement some improvements in the trial phase of the tool.

In what it concerns to linking the excel file to the database was not complicated, only the development of the query was difficult because of the outdated AS400 database and complex names of tables in it.

Once all the necessary data was collected and treated, as all the files linked, the user could start testing it. Throughout the testing phase, minor changes were made to the tool in the main spreadsheet, where the items were divided by warehouse and only the items AX to BX were used in the analysis.

The testing and evaluation were made during the interaction by the user and feedback was given about it. After stabilizing with the changes and feedback, two meetings were done in order to present it and to clarify possible doubts about the system and its rollout. Also, an instruction manual was left for possible new users.

6.3 Functionalities

The stock management has a role in the improvement and service level delivered to the client, and these benefits can be translated into decision making with the right tools and methods.

In what it concerns to the replenishment and ordering, all fields were calculated accordingly to what was mentioned in the literature review. Also equations and algorithms based on the continuous review model, were calculated in order to determine the safety stock level and reorder points.

It was necessary in this project context needs, to define a minimum quantity to each item, which would correspond to the safety stock available on hand.

Once the pertinent observations were presented for each model to follow, and as mentioned before it was the continuous review. The main reason was to each time an item passes the safety stock level it should immediately ordered again. This fits better the purpose of the company in terms of inventory management.

So, the tool supports the management and control of inventory in the company. The decision making process can be adapted in the calculation spreadsheet, which contain the parameters to be calculated and the items to be inserted in the main sheet. Nevertheless everything happens

in the main sheet, where the safety stock is presented and can be followed from there. Visual warnings appear in the sheet, when some item goes pass the safety stock level or reorder point. This doesn't mean that is imperative to order once the level is passed, but it serve as a guide to the management to keep up with stock levels, both minimum and maximum. Neither the EOQ has to be followed closely, because for example in August, maybe it doesn't make sense to order that much, since the production is stopped for almost all the month and it is not worthy to fill the warehouse with material.

For the main user, the person in charge of ordering and making the purchases, it is important to have an idea of the right stock level to maintain, the existing stock in the other business units, cover levels of stock in terms of weeks and maximum stock to have considering all the costs and rotation of inventory. Since the user only responds to internal requests and is not in the other warehouses to evaluate the necessity of ordering or not, it is important to have all that information complied in one file.

The excel file contains a resume sheets, which is easier and cleaner for the user to check, with only the important information of low stock levels, insufficient cover of stocks, stock-outs (in this case question other units if it is not needed to order). The analysis sheet, contains the variation of items that show low levels and other important analysis, and it is done automatically every day, when the user opens the file. It presents the evolution day by day of the number of items and its status, and the variation when comparing with other days. Also a final lookup is done month by month, and at the end of the year with the average of items, for example that had stock-outs.

Mês	Semana Ano	Dia Semana	Stockouts	Variação	Abaixo Nível SS	Variação	Possíveis Rupturas	Variação	Cobertura Insuficiente	Variação	Sem Resposição	Variação
4	16	5	9	-	23	-	3	-	6	-	16	-
4	16	6	9	0%	24	4%	3	0%	6	0%	14	-13%
4	17	4	10	11%	24	0%	1	-67%	5	-17%	15	7%
4	17	5	10	0%	23	-4%	2	100%	6	20%	15	0%
4	17	6	11	10%	24	4%	1	-50%	5	-17%	15	0%
4	Balanço Mês		9,8	-	23,6	-	2	-	5,6	-	15	-
5	18	3	8	-27%	21	-13%	1	0%	5	0%	14	-7%
5	18	4	9	13%	23	10%	3	200%	6	20%	16	14%
5	18	5	9	0%	24	4%	3	0%	6	0%	14	-13%
5	18	6	10	11%	24	0%	1	-67%	5	-17%	15	7%
5	19	2	10	0%	23	-4%	2	100%	6	20%	15	0%
5	19	3	11	10%	24	4%	1	-50%	5	-17%	15	0%
5	19	4	11	0%	22	-8%	1	0%	4	-20%	14	-7%
5	19	5	10	-9%	17	-23%	2	100%	3	-25%	14	0%
5	19	6	8	-20%	16	-6%	2	0%	3	0%	13	-7%
5	20	2	4	-50%	12	-25%	2	0%	3	0%	12	-8%
5	20	3	4	0%	12	0%	2	0%	2	-33%	9	-25%
5	20	4	3	-25%	11	-8%	2	0%	3	50%	9	0%
5	20	5	3	0%	11	0%	2	0%	3	0%	8	-11%
5	20	6	2	-33%	10	-9%	1	-50%	3	0%	7	-13%
5	21	2	5	150%	13	30%	3	200%	3	0%	7	0%
5	21	3	6	20%	14	8%	3	0%	4	33%	7	0%
5	21	4	6	0%	14	0%	2	-33%	2	-50%	8	14%
5	21	5	6	0%	15	7%	2	0%	2	0%	6	-25%
5	21	6	6	0%	16	7%	2	0%	2	0%	6	0%
5	22	2	4	-33%	11	-31%	1	-50%	2	0%	6	0%
5	22	3	3	-25%	10	-9%	2	100%	1	-50%	6	0%

Figure 19 – Analysis spreadsheet illustration

As we can see by the figure presented above, which illustrates an example of the final month of April (and first of the testing) and the month of May. We can observe the variation that was mentioned before, day by day and the total quantity of items that are inserted in each parameter. It is important to notice that one item may be contemplated in more than one field. This is more a macro support tool for management decisions, in order to avoid increasing stocks levels or low level stocks, and therefore decreasing service level. This serves to support the analysis of the inventory that is done monthly by the industrial direction.

Artigo	Armazém	Condição	Descrição	Semana do Ar	Dia da Semar	Estado
COLA BIOCOL BS-28 (IBC) "DS"	H4	OK		20	5	
COLA BIOCOL BS-3010 (IBC) "AG"	S5	OK		20	5	
COLA BIOCOL BS-32 (IBC)"AG"	H4	OK		20	5	
COLA BIOCOL BS-32 (IBC)"AG"	E4	NOK	*StockOut*	20	5	Encomendar Urgente
COLA COL HYDROKOLCORK CR8009 Q13 IBC	A4	OK		20	5	
COLA COLM. LORFLEX 8655/A "BS"	A4	NOK	*Abaixo Nível SS*	20	5	Verificar Stock
COLA COLM. LORFLEX 8655/A "BS"	A9	OK		20	5	
CX CARTAO GA 571X371X447(Nº1.0)C/PEG	24			20	5	
CX CARTAO GA 571X371X447(Nº1.0)C/PEG	E4	OK		20	5	
CX CARTAO GA 571X371X447(Nº1.0)C/PEG	R4	OK		20	5	
CX CARTAO GA 586X386X822(Nº3.0)C/PEG	E4	OK		20	5	
CX CARTAO GA 586X386X822(Nº3.0)C/PEG	24			20	5	
CX CARTAO GA 586X386X822(Nº3.0)C/PEG	H4	OK		20	5	
CX CARTAO GA 586X486X647(Nº4.0)C/PEG	H4	OK		20	5	
CX CARTAO GA 586X486X647(Nº4.0)C/PEG	E4	NOK	*Possível Ruptura*	20	5	Verificar Stock
CX CARTAO GA 586X486X647(Nº4.0)C/PEG	24			20	5	
CX CARTAO GA 586X486X647(Nº4.0)C/PEG	A4	OK		20	5	
CX CARTAO PK 586X486X647(Nº4.2)C/PEG	H4	OK		20	5	

Figure 20 – Resume spreadsheet illustration

In the figure 20 we can observe the resume spreadsheet illustration, where the detail is presented about the item, the warehouse that it is currently occupying, the condition only being “ok” or “nok”, the description that is passed from the main sheet. Also it is represented the week of the year and the day of the week. Also a status is presented to the user, with an advice for different conditions that are currently applied for each item. In this case, the user can act for each item in real time, allowing the decision making to be supported by this tool, and following closely the current stock status of each warehouse of the business units.

01/06/2017					jun/17								
Grupo	Artigo	Classe	UN	Arm.	SS	Lead Time	Stock Atual	Encomend	Cobertura	Cob. Virtua	Ponto de Encomend	Consumo Médi	EOQ	Nível Stock
Caixas de Cartão	CX CARTAO GA 586X386X822(Nº3.0)C/PEG	A|X	UN	E4	1473	2,00	1670	800	5,77	6,53	2739	290	2401	88%
Caixas de Cartão	CX CARTAO GA 586X386X822(Nº3.0)C/PEG	A|X	UN	H4	912	0,60	960	1000	1,53	2,52	1342	630	1988	95%
Caixas de Cartão	CX CARTAO GA 586X486X647(Nº4.0)C/PEG	A|X	UN	H4	2893	0,70	3760	8640	1,27	3,49	4365	2963	5006	77%
Caixas de Cartão	CX CARTAO GA 586X486X647(Nº4.0)C/PEG	A|X	UN	E4	2502	0,70	2063	2000	1,26	1,78	3774	1643	4965	REORDER
Caixas de Cartão	CX CARTAO GA 586X486X647(Nº4.0)C/PEG	A|X	UN	A4	26	0,70	2723	0	142,28		61	19	6666	1%
Caixas de Cartão	CX CARTAO PK 586X486X647(Nº4.2)C/PEG	A|X	UN	H4	339	0,60	560	0	3,09		499	181	536	61%
Caixas de Cartão	CX CARTAO PK 586X486X647(Nº4.2)C/PEG	A|X	UN	K4	817	1,00	1002	640	2,82	3,62	1314	355	2202	82%
Colas e Aglomerantes	DISAQUA PU 1001	A|Y	KG	H4	5849	0,60	4990	1500	2,74	2,96	8604	1825	4989	REORDER
Filmes	FILME EXTENSIVEL DE ALTO RENDIMENTO	A|Y	KG	A4	408	0,60	621	6879	3,47	41,26	600	179	1816	66%
Filmes	FILME EXTENSIVEL DE ALTO RENDIMENTO	A|Y	KG	E4	709	0,60	1090	614,5	3,46	4,81	1042	316	2075	65%
Filmes	FILME EXTENSIVEL DE ALTO RENDIMENTO	A|Y	KG	H4	212	0,60	806	0	3,34		312	242	1563	26%
Filmes	FILME EXTENSIVEL DE ALTO RENDIMENTO	A|Y	KG	K4	93	0,60	613,5	0	15,36		138	40	988	15%
Filmes	FILME EXTENSIVEL DE ALTO RENDIMENTO	A|Y	KG	R4	397	0,60	350	680	4,5	12,63	585	78	738	REORDER
Colas e Aglomerantes	FLEXPUR 240 "AG"	A|Y	KG	AI	30363	0,60	0	66150	STOCKOUT		44661	9090	18911	REORDER
Colas e Aglomerantes	FLEXPUR 280-A "AG"	A|Y	KG	S5	55107	0,60	37000	150000	1,42	6,54	81059	26225	11133	REORDER
Produtos de Lavação	HYDROTOPCORK NEUTRO 8009 M3DL (IBC)	A|X	KG	K4	172	0,60	900	0	13,85		253	65	941	19%
Produtos de Lavação	HYDROTOPCORK NEUTRO 8009 M3DL (IBC)	A|X	KG	V4	697	0,60	700	300	1,43	1,44	1026	490	2104	100%
Produtos de Lavação	HYDROTOPCORK NEUTRO 8009 M3DL (IBC)	A|X	KG	A4	2635	0,60	2100	0	0,91		3876	2310	5612	REORDER
Parafinas, Óleos e Emulsõe	OLEO PARAFINICO (IBC KG)	A|X	KG	E4	9415	1,30	8764	2595	2,44	1,86	15942	3598	7346	REORDER

Figure 21 – Main spreadsheet illustration

In the figure 21, we can observe the main spreadsheet functionalities, which will be mentioned bellow. With this tool and in what it concerns the person who is in charge of the inventory management, he can support his decisions in a pertinent way considering what the tool presents about the items in real time.

The tool is presented by the family group of each item followed by the item type. The ABC/XYZ analysis is inserted for each item, according to what was previously analysed, easing and filtering the items needed to be focused. Also the items are presented by warehouse, which was a gap upon the traditional inventory management, without the prototype.

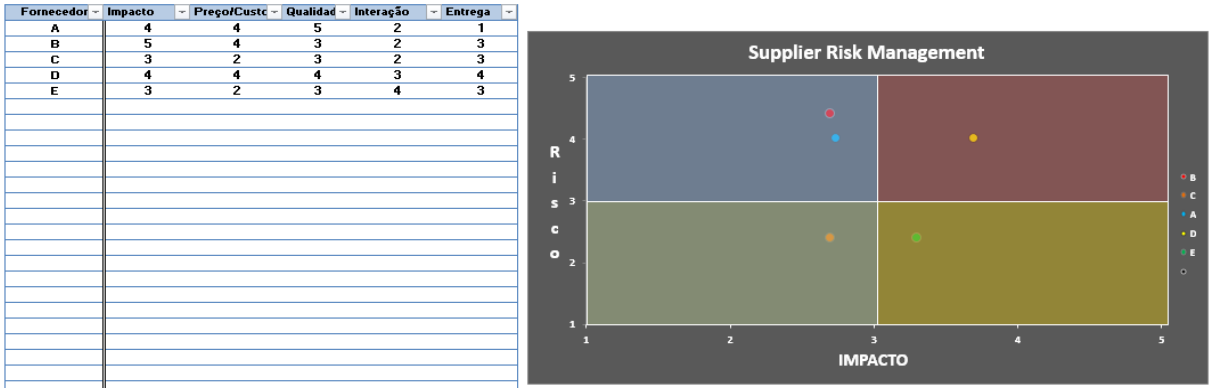
The kind of report that can be done from this tool, resides in the ideal quantity to order which determined individually for each item. Also the safety stock is illustrated as well as the reorder point. An additional feature was added besides the main objectives of the continuous review, which was the cover level and the virtual cover level. Both represent the capacity to cover the

necessities of the demand with the inventory on hand in the case of the cover level and with the ordered quantities in the case of virtual cover level.

At the end of the tool there is a visual management support to represent the current stock level with the percentage that the inventory on hand represent from the predetermined maximum stock to keep.

The user can now anticipate necessities from other business units and control the stock level, and consequently keep the costs low and space on warehouses unoccupied. Also, his decisions, have a low chance of damaging the company with increased costs of quantities when comparing to the non-existing tool before the development of this excel file.

Regarding the last spreadsheet in the excel file that is presented by the figure 22, it must be filled manually. Although, this tool can be important because of the roll that the supplier takes in the business. Since the company has a high impact in the supplier's market, it is important also to keep the service level from them to the company high.



Fornecedor	Impacto	Preço/Custo	Qualidad	Interação	Entrega
A	4	4	5	2	1
B	5	4	3	2	3
C	3	2	3	2	3
D	4	4	4	3	4
E	3	2	3	4	3

Figure 22 – Supplier risk management tool

Concerning the usage of this tool, the user is obliged to input a value from one to five in order to effectively evaluate the supplier according to certain criteria and parameters.

This is suitable for using in the mensal meeting to analyse the current inventory and the costs, and therefore check if it is necessary to develop actions or strategies concerning the supplier's price or lead time.

6.4 Implementation Results and Benefits

Considering the results, it is important to notice first that there was not any tool used before, so this is a relevant change in terms of inventory management for non-cork material. And second, the period of testing and evaluation was short, with only the last part of April and the month of May.

The user, checks the status of the items two times a day or more in case he has an internal request for ordering. This is an improvement because the user can have a "chopper" view of the inventory levels and thus support better his decision and quantities to order.

Also the flux of information between the database and the excel file, provides a better, cleaner and more precise/filtered data for the user, instead of consulting the complex database.

Although the system only considers items with low variation in the demand, even a minor change in the kind of inventory management, supporting the decisions with the tool, can bring benefits to the company, as we can observe according to the figure 23.

Nevertheless, as presented in the figure bellow we can see some improvements in the stock level, and changes in the number of items with costly conditions for the company.

The graphic that is presented in figure 23 is contemplated in the analysis spreadsheet and automatically updated every end of the month with the information about the inventory.

Figure 23 – Month variation of stock level

According to the figure, there was a decrease in stockouts and inventory that is lower than the safety stock level from April to May, while possible ruptures stays practically the same in both months presented. Also, the insufficient cover of inventory and the stock without reposition decrease from April to May.

Considering the time that was attributed to the trial phase, the results represent significant changes in stock levels and consequently decrease in the costs incurred by the company, associated to the inventories. This decrease in stock levels translate an easier understanding of current inventory, allowing better decisions applied to it, when purchasing and replenish.

This decrease does not represent higher level of stocks but yes, better management and options associated to reordering timings and quantities provided by the tool.

With the evolution of the project throughout its development, the company collected concrete benefits from the analysis done, testing and implementation of corrective solutions.

The planning tool was simplified by the automatic calculation of the necessary quantities to order according to the necessities of material according to a predefined service level, where the user only had to check for the intended item the optimal inventory level, both minimum and maximum.

With a much lower time required to plan the purchases, giving the user more time to analyse technical advantages between products and negotiate with suppliers for example.

Benefits can simplified as the following:

- Exact knowledge about which items are classified as A and B, and where to aim the focus of the management. Knowledge about the XYZ variation of those items;
- Clear and reliable outputs as safety stocks, service levels intended for the items and order quantities;
- Impacts on the purchasing process by the automation of the inventory management;
- Safety stock tuned to avoid unnecessary and over needs;
- Keep affordable and optimized inventory levels.

7 Complementary Project

Besides the main project presented, and as mentioned previously in the early chapters there was another project that was initiated described in the AS IS model, where we observed that the central warehouse was not organized or optimized.

Bearing this in mind, it was necessary not only to act on the information system to support the inventory management, but also to act on the shop floor in order to organize the inventory and space, and link the information between the system and the warehouse.

This warehouse stores packaging material as well as hygiene and safety materials, and other consumables like cleaning material.

As presented in the figure 23, a design was made from the original layout. The purpose was to organize the replenishment of the stock and to organize according to capacity and quantities. Also to apply standards to reduce de workflow and ease the processes.

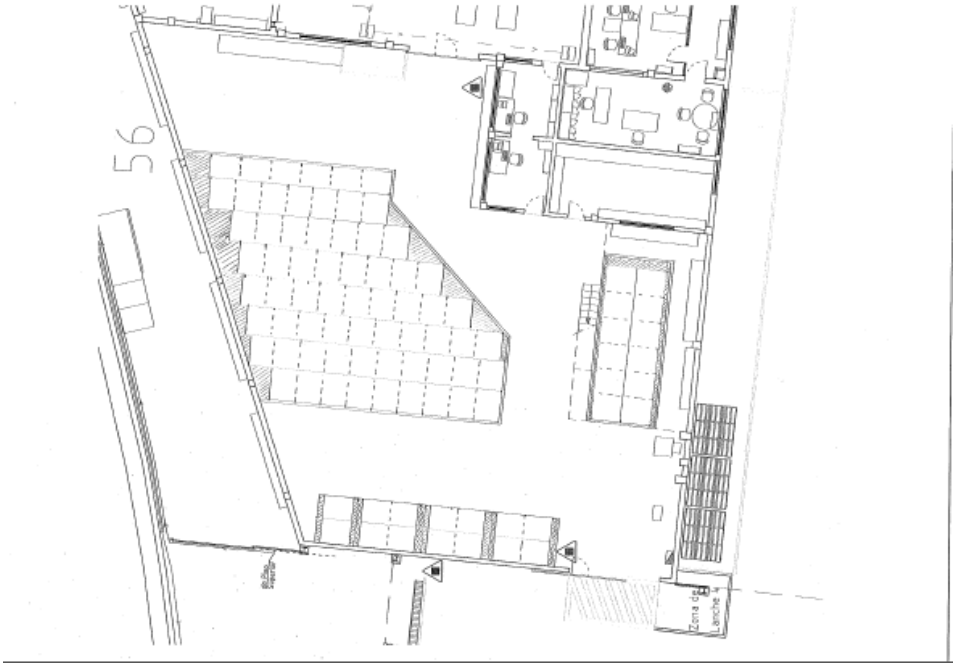


Figure 24 – Layout proposal

7.1 Development of the project

Starting the analysis, a gathering and collection of past items categories that were part of the inventory in the warehouse was done. This data collection also was important to categorize the products to divide them in the warehouse, according to size, weight and variation in historical consumption.

Spending some time with the workers in the area while collecting data and analysing the space, allowed me to start to implement some contents and concepts about lean in manufacturing. Preparing and train the people would be an important step to turn them autonomous for the continuous improvement culture, leaving to them the task of effectively improve their work.

Following and according to the figure above, the boxes for the pallets are possible to see. Also it was taken advantage of a space at the right below a deck to store temporary material or in transaction. Also the limits drawn outside the boxes represent the area where the forklift should pass through.

The shelves were optimized in order to stock the lighter and smaller material. The method chosen to replenish and consume for all the material was the LIFO. The decision was based on the fact that all the material comes in pallets, so even if the material is small it comes in big quantities keeping it difficult to manage and move. Also the materials are not perishable.

In order to act on the warehouse, a strategy to apply 5S on the space was developed, because the warehouse was lacking organization and cleaning.

To reduce the workflow and waste some visual aids were outlined to be implemented in the warehouse. With the use of different colours in the boxes it would be classified according to the ABC/XYZ analysis previously done. It was also designed to be applied to the safety stock boxes and the reorder point to serve as a visual warning.

Status board translating the information of the tool and the inventory level wold stand in the warehouse for the daily Kaizen. The board would also denote the consumption evolution and variation and some important ratios to keep up with.

It was designed also, the labels for most of the items that would be provisioned in the shelves and drawers.

Lastly it was outlined to apply a kanban system for replenishment of material necessary for the day to day work. This kanban would be standing in the entrance of the warehouse, for the person in charge of material movement to deliver the intended in the Kanban.

The simplified strategy to be developed, in order to eliminate the problems was:

- Collect Data;
- Prepare and instruct people throughout the project;
- Implement 5S;
- Target the standards;
- Create visual aids for the standards;
- Create template for internal audits;
- Build and implement the standards for all the processes;
- Detect the errors and wastes;
- Eliminate all the source of those errors and waste.

The project had to be put in stand by and was not possible, to initiate the implementation of the changes designed and developed. Nevertheless, all the work and strategies developed were left to the continuous improvement person in charge in the internal Logistics of that warehouse.

8 Recommendations

In this chapter some recommendations will be presented, focusing on information system, the tool developed and the physical warehouse, which were mainly the themes that surrounded the project and were focused in order to achieve the main goals of the tool developed.

Concerning the current tool that was built based in excel, the centralized system that currently is used does not fit the needs of the company from my point of view. It is necessary to filter accordingly to business units warehouse (for example A4 for Amorim & Irmãos packaging warehouse), and decentralize it to the other business units. As the process of purchasing is standardized, as well should the tool used be the same across all the business units.

Decentralizing the tool and the process, will reduce the errors of miscalculations or understatements from the central purchasing department (which would not be anymore a central department, but spread to all business units).

If the database actually changes, it is necessary to adapt this tool to the new one, because it could turn obsolete without connections to the current database to extract information about the stock levels and orders in progress.

Finally, and as showed in the process swimlane (see appendix A and B), I agree that the purchasing process should be updated to a more suitable strategy for the company, since is far to length for the purpose, and too many participants are involved in it, increasing the possibility of compromising the process.

Regarding the physical warehouse in the Amorim & Irmãos and since the complementary project was not implemented, I personally recommend that it should go on. The physical warehouse is very important, since it holds most of the material used in the business unit. Its lack of organization and space optimized constitute most of holding costs of the non-cork material, perhaps leading to the proposal of the project that was developed here in the company.

Also it is very important to keep the warehousing linked to what is being done in with the excel file to support the decision making process concerning the stock levels and reorder points, that can be drawn in the physical warehouse according to the lots of the items.

Finally, leading and implementing the kind of culture of change and continuous improvement, which is hardly focused there, doesn’t seem to reach the warehouse in question. So, as mentioned in the initial situation, it would be important to apply the 5S rules and address the present Muda’s in the warehouse.

9 Conclusion

Currently the strategy of the companies should rest on the waste reduction, value creation throughout the supply chain and consequently increase the level of competitiveness and a more favourable positioning in the market share.

When the problems and necessities are identified, improvement opportunities appear and the probability of success is higher when facing other organizations.

The project focused in the creation of a tool to support the inventory management, managing the flux of information between all the platforms, and centralizing all the convenient data for the stock management. The main goal was to improve the inventory management developing useful tools to optimize the process and support the decision making in the field.

Although the benefits of implementing such tool are clear, it is necessary to have present the necessity of implementing a culture of change and keep on with the work that was done, improving continuously and therefore create value offering a high service level.

Due to the variety of non-cork items it is necessary that the replenishment is done without damaging the company and originate ruptures in stocks as well as balancing the cost and resources used in it. Considering this ABC and XYZ analysis were done in order to adjust the items to the clear necessities of the project.

In the follow up, the project, as mentioned before focused on the development and implementation of a system to manage the inventory, and therefore the tool chosen as the Excel. Following that, methods such as continuous Review as it appeared to fit better the needs of the company in the context, with equations to calculate safety stocks, and reorder points were used. Also tools like business process management were used to trace the purchasing and replenishment process.

The system was developed with success according to the necessities presented, being transferred for an autonomous user. The trial phase of the prototype presented significant improvements and benefits, as it was shown in the results by the month of May changes in the inventory levels already had occurred.

I can only add that this four month experience was in fact an increase of value, contributing widely for my personal and professional development. A place where I could actually put in practice some important academic contents and learn another more in the company.

9.1 Limitations and Future Work

Concerning the limitations implied in the project, most of the proposal improvements were somehow barriers to the development of the project, either the AS400 or the warehouse organization. Nevertheless and at the same time, they contributed the same way to the achievement of the project, because without it, there wouldn’t exist any purpose of improving and evolving in the direction of organizational excellence.

The work that was developed including supporting the decisions concerning the purchasing and replenishment of the non-cork material, constitute an opportunity for future work and an opening to continuously improve in that specific field.

It necessary then to encourage the organizations to review their processes of flux of information and decision management, in order to implement optimized and efficient systems suitable to the organization’s reality.

Regarding the complementary project, in the warehouse it is necessary to understand that the elimination of waste transformed into value creation is very important, in order to achieve the organizational excellence. Investing time and resources focusing only in the development of the information system it's not enough, because it is necessary to integrate all processes and contexts involved to achieve the excellence plenitude. Tools, like the 5S and the Muda were taken into account when addressing this project. Also, the lots level and reorder points were considering when designing the space for the units.

In a future perspective the tool developed should be address many more times in order to improve and integrate maybe some more fields and areas of the company.

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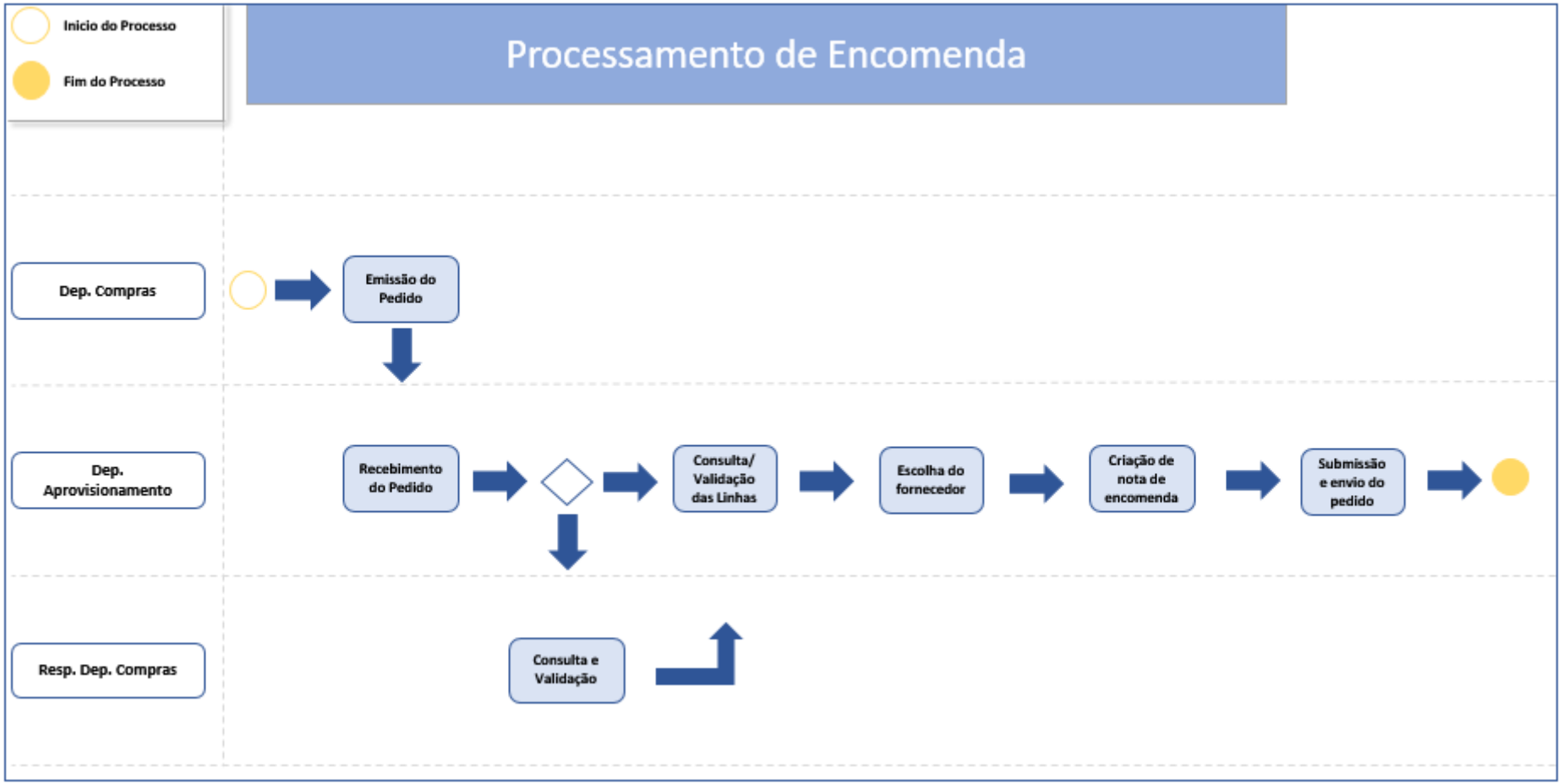
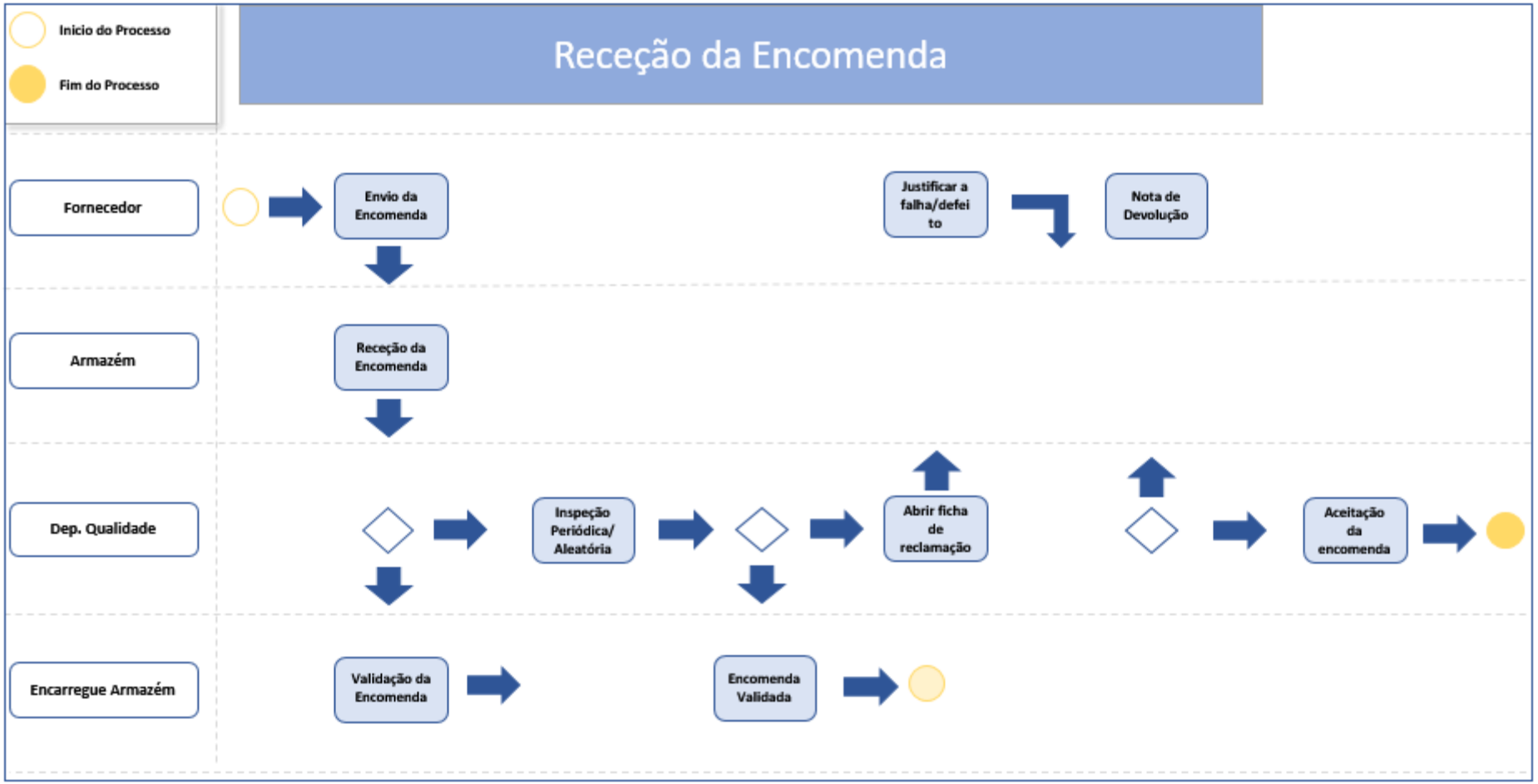
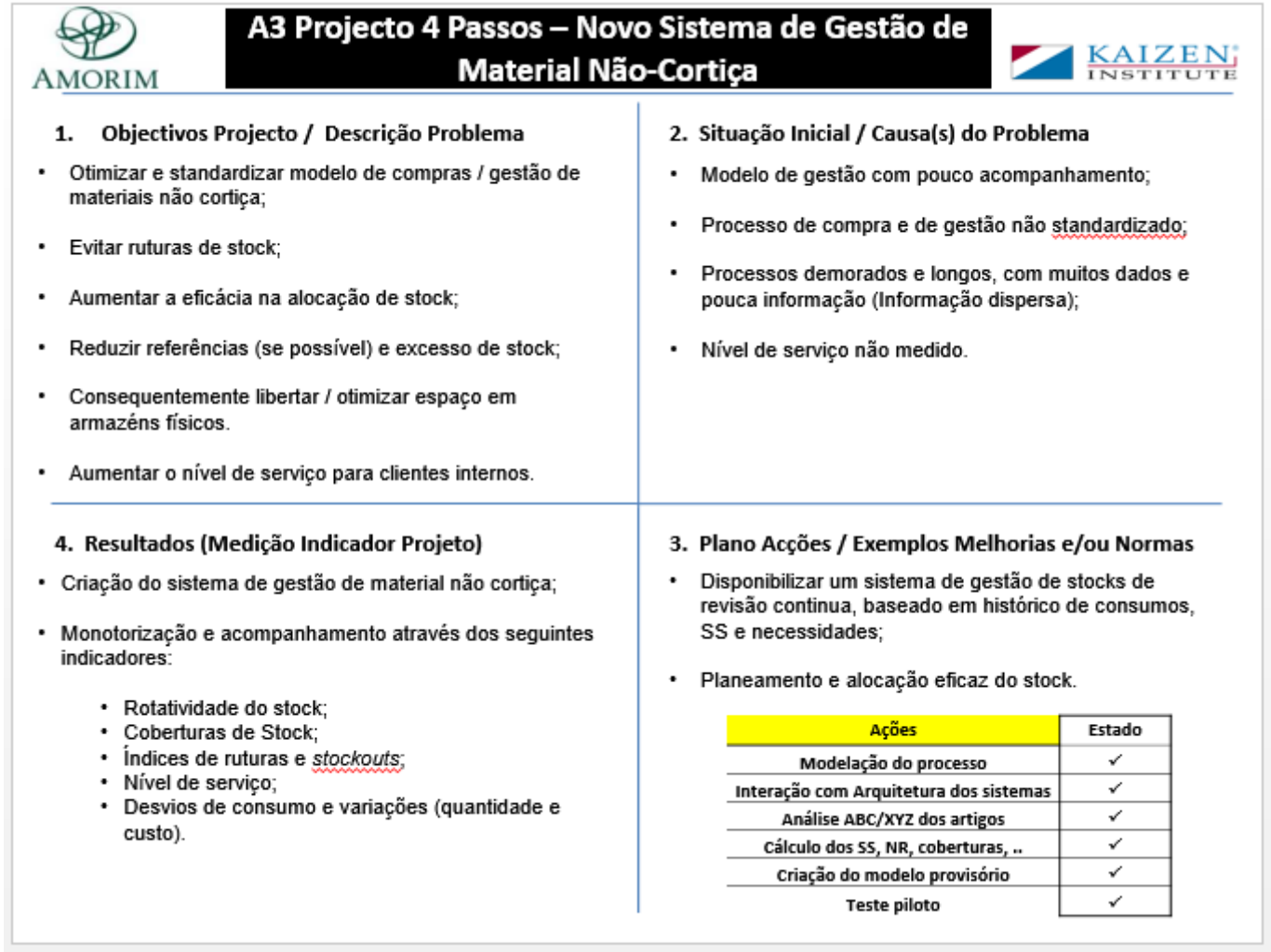
APPENDIX A: Order Processing



APPENDIX B: Order Reception



APPENDIX C: A4 Four Steps



AMORIM

A3 Projecto 4 Passos – Novo Sistema de Gestão de Material Não-Cortiça

KAIZEN INSTITUTE

1. Objectivos Projecto / Descrição Problema

- Otimizar e standardizar modelo de compras / gestão de materiais não cortiça;
- Evitar ruturas de stock;
- Aumentar a eficácia na alocação de stock;
- Reduzir referências (se possível) e excesso de stock;
- Consequentemente libertar / otimizar espaço em armazéns físicos.
- Aumentar o nível de serviço para clientes internos.

2. Situação Inicial / Causa(s) do Problema

- Modelo de gestão com pouco acompanhamento;
- Processo de compra e de gestão não standardizado;
- Processos demorados e longos, com muitos dados e pouca informação (Informação dispersa);
- Nível de serviço não medido.

4. Resultados (Medição Indicador Projeto)

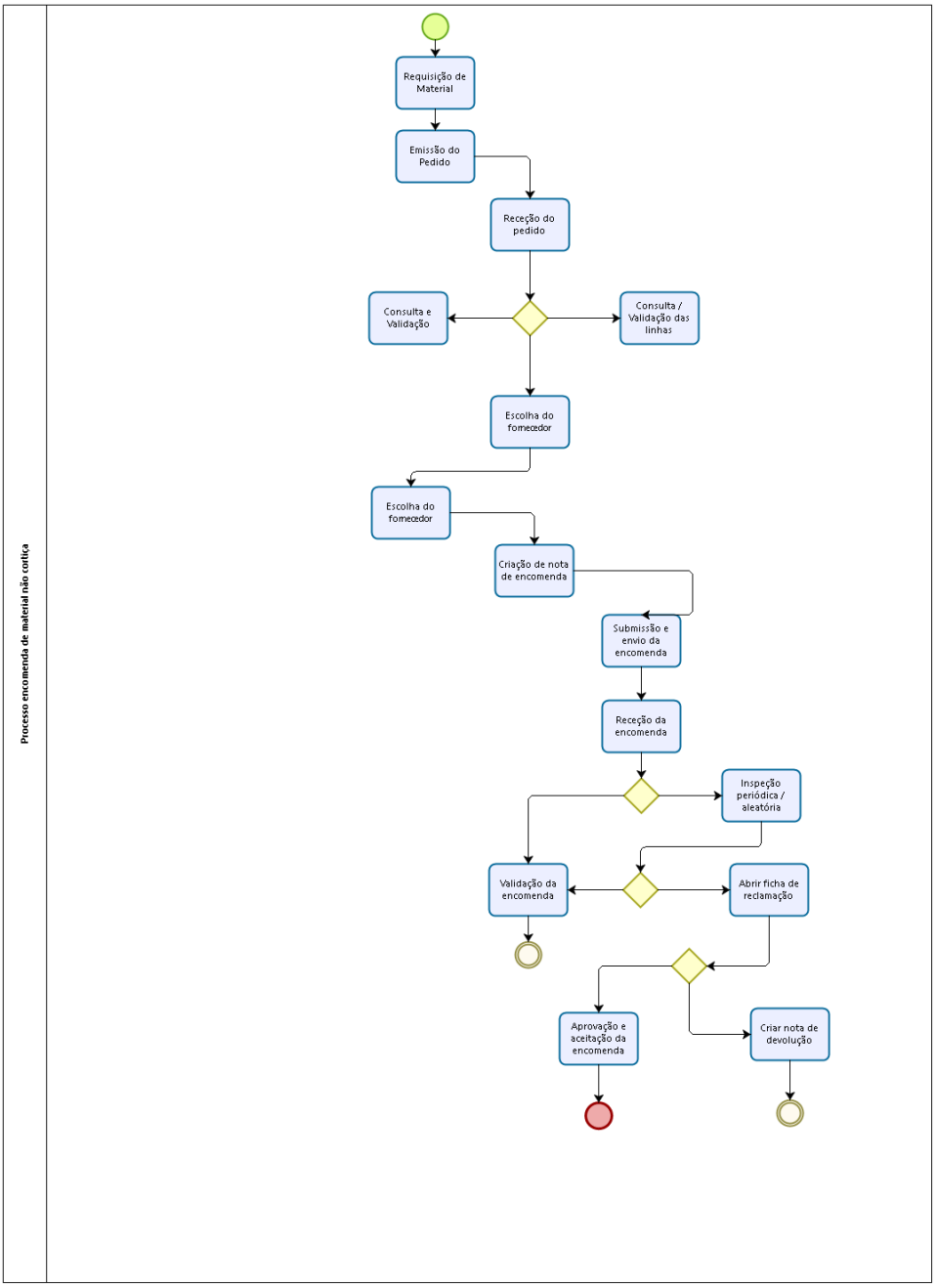
- Criação do sistema de gestão de material não cortiça;
- Monotorização e acompanhamento através dos seguintes indicadores:
  - Rotatividade do stock;
  - Coberturas de Stock;
  - Índices de ruturas e *stockouts*;
  - Nível de serviço;
  - Desvios de consumo e variações (quantidade e custo).

3. Plano Acções / Exemplos Melhorias e/ou Normas

- Disponibilizar um sistema de gestão de stocks de revisão continua, baseado em histórico de consumos, SS e necessidades;
- Planeamento e alocação eficaz do stock.

Ações	Estado
Modelação do processo	✓
Interação com Arquitetura dos sistemas	✓
Análise ABC/XYZ dos artigos	✓
Cálculo dos SS, NR, coberturas, ..	✓
Criação do modelo provisório	✓
Teste piloto	✓

APPENDIX D: Complete Process



APPENDIX E: Tool created for consumption consulting by catergoy

Embalagens

Armazém	(All)
Unidade	(All)

Mês: 1 2 3 4 5 6 7 8 9 10 11 12

Consumo Artigo	Ano 2015	2016	2017
SACOS RÁFIA BG 1,10x1,35MT C/RAREIRA	519306	493696	120900
CX CARTAO GA 586X486X647(Nº4.0)C/PEG	269392	278499	70344
CX CARTAO GA 571X371X447(Nº1.0)C/PEG	80401	87568	22348
ETIQUETAS PRODUÇÃO RA.IND.008.1	70504	97442	5503,5
PALETE MADEIRA 1200X1000MM(6 TAB)"TE	53429	55968	14848
FILME EXTENSIVEL 500MMX23MY P/MA	51209,93	304	0
FITA POLIPROCINTA 12X0,55 D.280 VD	50000	57500	10000
CX CARTAO GA 586X386X822(Nº3.0)C/PEG	49300	53727	13261
FILME POLIET NAT 1 COR 1070X0,110 MM	39714	42871	11728
SACOS PLÁS.530x(60+60)x840x0,12 LISO	37088	37451	10096
FILME POLIET NAT 1 COR 1090X0,110 MM	29089	28343	9789
CX CARTAO GA 586X486X547(Nº2.0)C/PEG	27933	28134	8185
CX CARTAO PK 586X486X647(Nº4.2)C/PEG	25301	24215	4731
PLACA CARTÃO 400X300 MM	20965	3000	
SC MGRIP Rª 20212 c/CUR 80X120 s/IMP	20000		

Químicos

Armazém	(All)
Unidade	(All)

Mês: 1 2 3 4 5 6 7 8 9 10 11 12

Consumo Artigo	Ano 2015	2016	2017
PERÓXIDO HIDROGENIO 35% (CONTENTOR)	1136650	1169350	266500
COLA BIOCOL BS-32 (IBC)"AG"	991500	1242780	487200
COLA BIOCOL BS-3010 (IBC) "AG"	903165	241825	227150
COLA BIOCOL BS-32-E (IBC) "AG"	526050	588000	0
OLEO PARAFINICO (IBC KG)	305905	326105	88500
FLEXPUR 280-A "AG"	291000	1050000	140000
COLA FABRICOL AG-202(IBC) "AG"	272000	10000	
COLA BIOCOL BS-28 (IBC) "DS"	206800	139145	33000
Soda Caustica Liquida a 50%	176750	172800	42970
COLA COL HYDROKOLCORK CR8009 Q13 IBC	165900	144400	31000
HYDROTOPCORK NEUTRO 8009 M3DL (IBC)	136700	120900	26000
POLIESTIRENO CRISTAL LACQRENE 1540 T	131575	85675	24750
PERÓXIDO HIDROGENIO 50% (CONTENTOR)	123700	118000	30000
POLIESTIRENO A/C LACQRENE 7240 TOTAL	121861	138950	50
COLA FABRICOL EC-505 (IBC) "DS"	113000	99000	25000

APPENDIX F: Tool created for external service level consulting by supplier

Químicos

Ano: 2015 | 2016 | 2017

Fornecedor	Encomendas	Atrasos	Nível Serviço
MIKROQUIMICA-PRODUTOS QUIMICOS, LDA	394	87	70,44%
RESIBRAS, S.A.	370	41	76,30%
LORCOL-IND. COLAS PROD. QUIM., LDA	252	36	90,50%
ERPÍDIO FERNANDO ALVES COUTO, LDA	238	25	87,83%
RNM - PRODUTOS QUÍMICOS, LDA.	226	44	80,13%
LUSOCOPLA-FAB.COLAS INDUSTR., LDA.	144	27	76,48%
FABRIRES - PRODUTOS QUIMICOS, S.A.	118	19	84,06%
LAMEIRAS - PIGM. E PREPARAçÕES, LDA	112	26	84,26%
FLEXPUR-POLÍMEROS DE POLIURETANO,SA	111	10	74,79%
BLUESTAR SILICONAS ESPANA, S.A.	94	43	68,21%
MANUEL VIEIRA & Cª(IRMAO),SUCRS,LDA	62	15	52,22%
QUIMITEJO - PRODUTOS QUÍMICOS, LDA	61	4	97,04%
C2M AUROCHS Industrie SAS	57	25	58,86%
TIAGO PAIS UNIPESSOAL, LDA	50	21	58,01%
MANUAL-SOC. ARTIGOS GRÁFICOS, LDA	48	29	39,39%
FERRAI-FERRAMENTAS INDUSTRIAIS,SA.	47	38	45,27%
FLUPOL, LDA	35	28	44,91%
SONAE INDUSTRIA - P.C.D.M., SA	34	7	85,93%
AMORIM & IRMÃOS, S.A.	32	16	72,41%
H.B. FULLER ISAR-RAKOLL, SA	24	7	72,50%
ANGELO COIMBRA & CA.,LDA	22	5	84,26%
ELIAN SAS	22	21	7,14%
BRENNTAG PORTUGAL, LDA	21	6	71,43%
SOC.COM.PLASTICOS CHEMIEURO, LDA	20	11	50,00%
CROMITAP-PROD. PARA PLÁSTICOS, LDA	19	12	54,17%

Embalagens

Ano: 2014 | 2015 | 2016 | 2017

Fornecedor	Nº Encomendas	Atraso	Nível Serviço
SMURFIT KAPPA PORTUGAL, SA.	525	233	56,08%
AMORIM FLORESTAL, S.A.	358	266	20,13%
AJI - INDÚSTRIA DE MADEIRAS, S.A.	234	47	86,11%
PLASTEUROPA - EMBALAGENS, S.A.	167	119	52,34%
ETIPORT-ETIQUETAS ARTES GRAFICAS,Lª	122	52	39,07%
GOPACA FÁBRICA PAPEL E CARTÃO, SA	119	61	26,02%
POLIVOUGA-IND.PLÁSTICOS, S.A.	92	40	70,04%
GRANAZ GRANUL. CORTIÇA AZARUJA, LDA	85	25	89,96%
PLASGAL- PRODUÇÃO DE EMBALAGENS,LDA	76	16	86,67%
RODRIGUES & BOAVENTURA, LDA.	57	27	68,11%
CARMASIL-INDÚSTRIA GRÁFICA, LDA	56	44	22,45%
EUROGRIP - PROD. EMBALAGENS, LDA	56	32	30,29%
TIPOGRAFIA J.O.L. IMPR., UNIP., LDA	55	20	65,00%
COTESI-Comp.Texteis Sintéticos, SA	53	26	35,96%
EUROPA&C EMBALAGEM, S.A.	43	33	18,61%
FRANCISCO OLLER, S.A.	41	6	85,14%
LIMA PACK - Unipessoal, Ldª	39	5	87,37%
TREFINOS, SL	32	4	84,62%
ZETES BURÓTICA, SA	32	15	37,54%
COMBIPACK-SIST. ART. EMBALAG., LDA	28	18	35,83%
PACK2000 - COM. PROD. EMB., LDA	28	10	61,99%
ENFIOS LDA	26	21	19,23%
DS SMITH PACKAGING CARTOGAL SAU	26	16	31,25%
TECTIL - PIASTICO RETRATIL, LDA	24	18	25,00%
VIEIRA DA SILVA & IRMÃOS, LDA.	24	13	58,48%