Implementation of Kaizen Lean methodologies - industrial planning and increased efficiency of production lines

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Abstract

The current market is marked by constant technological changes and large changes in the profile of the final consumer, making it increasingly difficult to meet these demands while maintaining a high level of service.

The present dissertation presents the case study of *Empresa X*, inserted in the pharmaceutical market, which requested the services of Kaizen Institute. The problem, addressed in this project, is due to the low service level derived from a low efficiency of the production lines and a high production lead time compared to the lead time presented to customers.

In this context, Lean Kaizen tools are explored and presented as part of production planning and overall efficiency of production lines. These are tools that aim to increase the added value for the final customer by reducing waste in production processes.

The following is a methodology to solve the problems presented. In this presentation the design of the solutions and the way they were implemented is demonstrated. Finally, a general synthesis of the project is made with the main conclusions and the presentation of future steps.

In this dissertation it was possible to implement the tools presented achieving a growth of 28 percentage points in the service level and 4 percentage points in relation to the efficiency of the packers with higher output of the *Empresa X*

Keywords: Kaizen Lean Methodology, Pull System, SMED, Industrial Planning

1 Introduction

The current market is marked by constant technological changes and major changes in the profile of the end consumer, making it increasingly difficult to meet these requirements while maintaining a high service level. (Shabaninejad et al., 2014). The pharmaceutical industry is a rigid industry and the production process inherent to this industry is quite complex with tight quality controls and rigorous SLA. Thus, being able to have a rigorous design of the entire production process and at the same time being able to reconcile it with a rigid and robust planning, are considered to be key to success. (Moniz et al., 2015)

This is the case of *Empresa X* (called *Empresa X* for confidentiality purposes) which wants to reduce the lead times of the entire production process in order to meet the agreed deadlines in order to obtain a high service level. With this objective in mind, it hires Instituto Kaizen (henceforth IK), a leading company in the field of continuous improvement consultancy and application of Kaizen management methodology, to be effective and sustainable in the production planning.

2 Case Study

2.1 *Empresa X* Introduction

The group, where *Empresa X* is inserted, is a pharmaceutical group with 100% Portuguese capital and is specialised in research and development, manufacture of pharmaceutical products, dermocosmetics and supplements.

In addition to its own brands, it produces and sells licensed products in partnership with many of the world's largest pharmaceutical companies. In response to the challenge of internationalisation and globalisation, the group, in which *Empresa X* is involved, is now present in over 50 countries. The industrial and commercial activity of *Empresa X* encompasses the manufacture of pharmaceutical products, cosmetics and food supplements for a diverse universe of institutional clients, both national and international. *EMPRESA X* produces, packages and delivers high quality products and services, within agreed deadlines and at competitive prices. The industrial unit has an annual gross capacity of 50 million units divided between solid, liquid and pasty non-sterile formulations (*Empresa X*, 2020)

2.2 Problem Description

Empresa X is one of the leading pharmaceutical companies in Portugal with some very important products in its portfolio. Given the current pandemic situation causing an increase in the demand, and consequently in production, the company is challenged to respond to this challenge with a higher service level and an even more challenging lead-time. In this sense, there is a need to reduce the current lead-time of *Empresa X*, trying to explore opportunities to improve the suppliers' lead-time, the visibility of the total capacity of the plant before accepting an order and to increase the overall efficiency of the production lines by focusing more sharply on the solid formations and more specifically on the packaging phase. To this end, *Empresa X* contracted IK to develop a project with Lean Kaizen methodologies in order to meet these challenges.

3 Lean Methodology for Production Planning

3.1 Contextualization and Evolution of Lean Methodology

This methodology is known to be a very effective methodology for continuous improvement. Its inherent tools are associated with increased productivity, increased product quality and "on time delivery" to end customers. (Chen et al., 2010a) Lean manufacturing initially focused mainly on reducing variations and unnecessary steps in the work, eliminating the existing muda in the production process. Today, it not only has a strong focus on the above, but also addresses the production process as a whole, starting at the initial stage of the product life cycle, through the purchasing, planning and manufacturing departments, to its distribution to the end customer. (Mrugalska & Wyrwicka, 2017) Following this paradigm shift in the process industry with the introduction of Lean, a new form of leadership is beginning to take shape based on the same philosophy. Lean philosophy is then split into two, Lean Production and Lean Thinking. (Salehi & Yaghtin, 2015) These two terms, according to Womack & Jones, 1992, were born when the book "The machine that changed the world" was launched, extending all Lean methodologies, not only to other industries and services, but also within the organisation, starting from the top to the line operators.

Lean thinking is described as a form of leadership based on the reduction of waste, the creation of value as the basis for strategic decisions by companies, the centre in people within the organisation itself and the optimisation of the entire value chain. (Poppendieck, 2011)

3.2 Principles and Tools of Lean Methodology

3.2.1 Value Stream Mapping (VSM)

According to Grewal, 2008 the Lean VSM tool makes it possible to explain and analyse the entire flow of information and materials from the entire value chain, showing an overview of the process. Through this analysis, it is also possible to identify and analyse opportunities for improvement, facilitating strategic decisions, with the aim of obtaining optimised solutions, but with a focus on added value activities. These understandings in the flow of the value chain are very relevant to this case study because the planning activity is a flow of information with various stakeholders and associated intermediate tasks.

There is a step by step implementation in this tool suggested by Tapping D., Luyster T. (2002) that allows better structuring decision making, in the optimisation of information and material flows. The step by step is: Mapping the Current Situation; Analysing and Identifying

Opportunities for Improvement of the Previous Step and Mapping the Future Situation

3.2.2 Value Added and Waste Activities Definition

As Hicks, 2007 states, the Lean methodology aims to eliminate waste from a production process in order to be able to give maximum added value to the customer. Any industrial or service task can be divided into 2 groups of tasks: tasks that add value and tasks that do not add value. (Bartoli & Silva, 2015)

J. P. Womack & Jones (1997) define the same concept with a definition of value not driven by companies, but by the client. For the author, value is "all that the client is willing to pay" and it is therefore crucial that all productive tasks defined by the company be ruled by this premise, all these activities expressing the needs and demands made by the clients. The concept of waste, or also known as muda, is defined by every activity that does not add value for the end customer. (Chen et al., 2010b) These authors further argue that reducing all activities that do not add value for the end customer, not only increases production efficiency but is also the best way to increase competitive advantage over the market competition. According to the same authors, the muda is divided into 7 categories: Rework, Overproduction, Over Processing, Waiting for Materials, Waiting for People, and Movement of Materials. (Tapping D., Luyster T., 2002)

These three concepts of Lean, added value and muda, are very important concepts for using the tools associated with this methodology in a structured way.

3.2.3 Lean Kaizen Tools to Support the Production Planning Strategy

In the literature studied for this project, the Push and Pull production systems were the two systems found to respond to a production planning activity. (Wu, 2019)

Push System

According to the authors Puchkova et al., 2016, the Push system is the most conventional production approach. In the push system, the production sequence is made as fast as possible in order to use as much capacity as possible on existing machines. In the case of production planning, this is based on order forecasts. The characteristics of this system allow the reduction of lead times for delivery to the customer as the intermediate product stock throughout the system and the finished product stock are high. Possible variations in demand for this type of system may not be a problem due to the amount of stock that exists throughout the process. (Puchkova et al., 2016) However, according to the same authors, the disadvantages of the Push system may be high stock value, high risk of stock obsolescence and low turnover. This system can be described in a generic way as drawn in figure above.

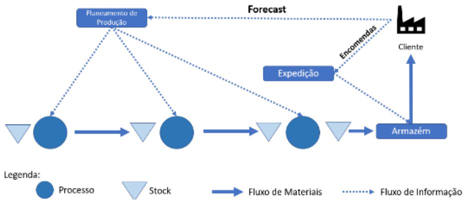


Figure 1 - Push System

Pull System

On the other hand, pull systems, also associated with Just-in-Time. (Puchkova et al., 2016) do not operate on the basis of demand forecasting models but on the basis of orders from customers. In this case, the various tasks of the production process are activated according to a need downstream of the task so as to be able to replenish them by means of a signal normally represented by cards. In this context, these production signals are generally known as Kanban (Bonney et al., 1999) (Puchkova et al., 2016) Before defining and analysing the proposed literature for the combined pull strategies with MTS and MTO, it is important to define the concepts of MTO and MTS. For the MTS strategy, the authors Fernandes et al., 2014 argue that production only starts before demand occurs. The system in this case produces on forecasts and not on firm orders placed by the customer. On the other hand, the same authors argue that the MTO strategy only starts production after a firm order from the customer. In this case the system produces on firm orders and not on the basis of forecasts, and the stock of the finished product is substantially reduced.

Pull MTO

In the combined pull system with an MTO strategy, production only starts after an order from a customer has been placed. The customer will receive his order as soon as production is completed. In this strategy, there will be no inventory along the value chain as production will only start after the customer's order, thus completely eliminating the intermediate product stock. As the product is delivered to the customer after it has been produced, there will also be no finished product stock. (Yano et al., 2019)

This can be shown in the above figure

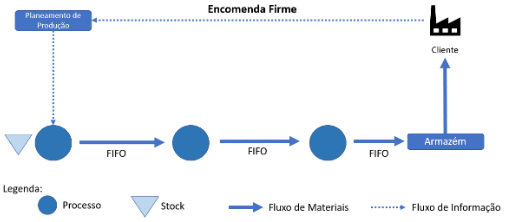


Figure 2 - Pull MTO System

Pull MTS

Unlike the previous system, there is inventory along the supply chain in the form of a finished product, intermediate product or both, building a replacement system along the chain in the form of a supermarket. This supermarket is sized according to demand so that there is no stock shortage while another reference in the chain is being produced. (King, 2009)

This system is exemplified in the above figure:

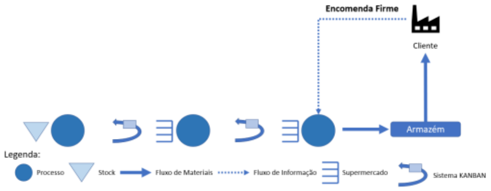


Figure 3 - Pull MTS System

Pull MTS-MTO

The pull system with a hybrid MTS-MTO strategy is used when the finished product and end consumer profile vary. On the one hand, this system satisfies a production of standardised finished products where demand not only requires large quantities but is also regular, thus producing for stock in supermarkets. On the other hand, if the product portfolio is varied and there are highly customised references where demand is irregular and in small quantities, then the MTO strategy will be used where a firm order will trigger production at the beginning of the value chain. (Beemsterboer et al., 2016) (Nagib et al., 2016) In this hybrid system, the value chain is able to absorb the advantages of both systems because while using the MTO strategy, it is taking advantage of not increasing the stock of finished and intermediate products, and the risk in this product profile is that they may become obsolete, on the other hand, it is taking advantage of having a well sized stock along the value chain for products with a high turnover profile and which are ordered in large quantities.

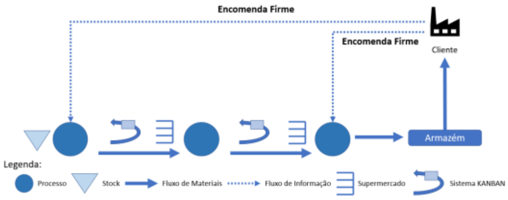


Figure 4 - Pull MTS-MTO System

Production Leveling

In this first stage, the quantity and type of product to be produced in one shift will be specified. The calculation starts with the monthly order for each product variation. The quantity for a certain leveling horizon for each product variation is divided by the total number of shifts available for production. This results in the leveling for each product variation and the cycle time for all the products found.

Leveling Product Mix

In this second phase, the production sequence of the orders per shift is determined which leads to a finer levelling and sequencing of the product mix. The result of levelling is a production sequence with a continuous flow adjusted to customer demand and a balanced use in the various stages of the process.

After levelling, a supermarket-sized box is then created (concept described above) which will be managed by a "mailbox" with Kanban cards which when removed in the correct order will trigger a productive activity. (Lippolt & Furmans, 2008)

ABC-XYZ Methodology

The ABC-XYZ analysis is divided into two distinct analyses: volume analysis and frequency analysis. For the volume analysis the letters ABC are used. This analysis is governed by the Pareto rule, i.e., it is observed that a rather small amount of the references produced has a considerable impact on the company's strategic and financial goals. (Stojanović & Regodić, 2017) The XYZ classification is derived from the ABC methodology and is based on the classification of products according to a sales ratio and therefore plays a key role in stock management. (Buliński et al., 2013) This division has the intuition to not only classify our products according to a percentage of sales, but also to take into account the frequency with which the product is sold. (Buliński et al., 2013)

BTS-BTO

The BTS (Buy-to-Stock) concept refers to products that due to their predictable characteristics in relation to demand, high order volumes and high lead-time delivery, it is necessary to buy for stock. On the other hand, in the BTO (Buy-to-Order) concept the products are characterized by being very customized, by having a low lead-time and a high variety in demand and that it becomes necessary to buy according to a firm customer order. (Grabež & Vranje³Baričić, 2014)

3.2.4 Lean Kaizen Tools to Support Production Line Efficiency

OEE

The OEE is a quantitative measure of productivity that arises through the concept of TPM introduced by Nakajima in 1988 and is defined as the total performance measurement of an equipment. (Horenbeek et al., 2014) The OEE is a measure that can be applied at several different levels within internal operations to increase productivity. OEE measurement is divided into three main groups: Availability, Performance and Quality. Availability is calculated by the ratio of the time the machine was actually available for production and the opening time. Here all efficiency losses due to planned and unplanned downtime are measured. Performance is calculated by the ratio of actual production time, quantity produced divided by speed, and available time. In this parameter all performance losses during the period under review are taken into account. These performance losses can be losses of production speed and micro-stops. In the quality parameter losses, are characterized whenever the equipment is actually producing, but the final production is not considered good for the final customer. This parameter is calculated by the ratio between the time the equipment has been producing quality products and the time it has been producing all products, with quality and without quality.

Ishikawa Diagram

The Ishikawa diagram, or fish bone diagram, is a diagram that helps to understand the cause and effect relationship in order to better identify the root cause of the problem in question. This diagram is also known as the 6M's diagram because it puts in its bones 6 groups: Method, Man-Work; Environment; Machine, Materials and Measurement. (Caswito & Hidayat Sutawijaya, 2019; Nusraningrum & Arifin, 2018)

4 Methodology

4.1 Planning Phase

At this stage of planning, the initial problem will be further developed. Here the VSM tool will be used, which makes an analysis of the current situation through an exhaustive data collection as well as a mapping of the information flow and logistics, in order to describe the problem in more detail. This tool requires a multidisciplinary team, in order to have as much information as possible, hence the description of the problem in chapter 2 is relevant, but not in the required detail. From this planning phase came the greatest opportunities for project improvement.

4.1.1 Value Stream Mapping

The Value Stream Mapping tool was used in the planning phase

By using this tool and combining it with a multidisciplinary team with the participation of the Chief Executive Officer (CEO), the Chief Operations Officer (COO), the industrial director, responsible for purchasing, responsible for planning, responsible for management control, responsible for logistics, responsible for production and responsible for quality, it was possible to map in as much detail as possible the information and material flows of the initial situation in order to identify the main focuses of improvement. The mapping of the material flow that emerged is shown in the figure below:

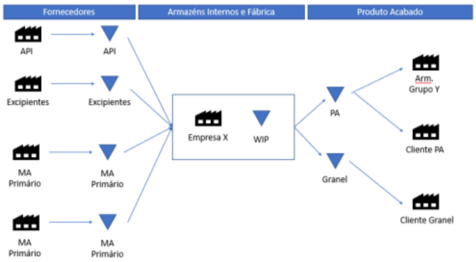


Figure 5 - Value Stream Mapping Flow

From the figure above, it was possible to see that the flow of materials starts at the suppliers, through the supply of API and Excipients. These materials form the tablet or liquid substance of the drug, and the primary and secondary packaging material for the formation of packaging. This supply will create moving stock that will go to *Empresa X*'s warehouse.

Once the stock in movement enters the factory of *Empresa X*, it is transformed into a finished product and may leave as an intermediate product which in the figure is described as bulk. In this mapping of the material flow, in a macro view, it was possible to conclude, with the multidisciplinary team, that the lead-time of suppliers was high and that the raw materials and packaging material were only bought on firm orders from the customer. Having said this and after the analysis made through the VSM tool we were able to conclude that *Empresa X* works in a MTO system, where all the orders it produces are closed on a firm order by a customer. Points of improvement have been identified in both the material flow and the information flow and production efficiency, which will be summarised below.

It is relevant to note that some of the proposed improvements have not only been raised through the analyses mentioned above using the VSM tool, but have also been identified in intensive field observation work. The main points of improvement observed are: high lead-time processes, loss of information during processes, due to the fact that they are done manually, complex and bureaucratic processes, high variability in process outputs, customer needs not reflected in production plans, high effort in operational planning, lack of levelling out of production, material breakages justifying loss of service level, high intermediate stock levels, need to reduce the effort of some more bureaucratic tasks to increase productivity, long equipment set-up times, many adjustment and tuning problems after the equipment set-up.

4.1.2 Solution Design

The two major topics, which underpin this continuous improvement project, are the optimization of the overall and industrial planning process of *Empresa X* and increasing the overall efficiencies of the plant by using the line with the highest output as a pilot. It is relevant to note that both solutions complement each other. In order to understand the proposed solutions and to understand them as a whole, it is important to define the value unit of the material and information flow. The unit of value in this case is the batch of a customer order. In order to optimise both the material flow and the information flow, it is relevant to understand that all proposed decisions and activities have to be seen as added value to the previously defined value unit. That said, for a process to be optimised, flows must first be optimised, even if resource inefficiencies exist. Guaranteed flow efficiency also guarantees that when the value unit, in this case the batch order placed by the customer, enters the system there are no waiting times during the various processes even if these processes are not optimised. After the first phase of flow optimisation, resource optimisation begins so that a robust process can be achieved that is as optimised as possible from the point of view of the value unit. This ensures that the organisation is designed to add value to the order lot placed by the customer.

For the **optimisation of flows** the strategy for intermediate product references in MTS and MTO and the strategy for supplier references in BTS and BTO were first defined. Then capacity planning was carried out. Finally, a more micro analysis was made with the construction of the levelling box and with the definition of the production sequence through a production urgency score. For the **optimization of resources**, first an analysis of the structured problem is performed through the Ishikawa diagram. This tool allows to understand what are the main causes for efficiency losses so that it is possible to find solutions that respond to these same causes.

When the root causes are identified and the solutions to the problems are proposed, an impact and effort matrix analysis is initiated in order to be able to prioritise the solutions found. After the impact and effort analysis, priority is given to those solutions that have the greatest impact with the least possible effort.

4.1.3 Definition of the KPI's for the Improvement Project

Within the proposed improvement project, and after mapping the current situation using the VSM tool and designing the solutions with the multidisciplinary team mentioned above, the main indicators were defined, not only to measure the company's performance during the project in question, but also to evaluate the proposed solutions. The main indicator to be improved is the service level for the customer. To calculate the service level, the following equation is presented:

$$Service\ Level = \frac{\sum_i Statisfied\ Orders}{\sum_i All\ Placed\ Orders} \qquad (1)$$

Another indicator defined with the multidisciplinary team is the efficiency of the lines with the highest output.
The following equation was used for the calculation of the OEE that gives the efficiency for the production lines:

$$OEE = Availability\ x\ Perform.x\ Quality \qquad (2)$$

Having explained the formulas to calculate the Key Performance Indicators, then it is possible to confirm in the table below, the summary of the two global indicators of the project, its baseline and the objective value.

Tabela 1 - KPI Summary

Indicador	Baseline	Objetivo
Nível de Serviço	32%	77%
OEE	48%	58%

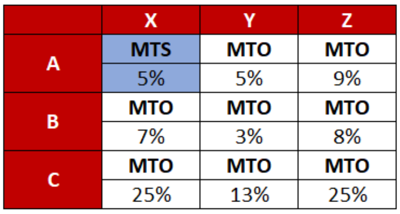
4.2 Development and Implementation of the Proposed Solutions

4.2.1 Implementation of Flow Optimization Solutions

To implement a flow optimization system, as explained in the solution design, a hybrid MTS-MTO pull strategy was used. For this system to be implemented, it was necessary to resort to the strategic steps listed below, culminating in planning support software developed in Microsoft Excel.

MTS-MTO

In order to implement this strategy, a strategic planning study should be carried out for all intermediate product references. As in this industry there are holding times between processes making the study more limited. Holding times means maximum waiting times between processes before the product loses quality and has to be destroyed or re-evaluated by quality control.
In this case, the study of intermediate product references before packaging was considered and after selecting the planning strategy for each reference the individual holding teams of each reference will have to be validated in order to understand whether this strategy can be implemented or not. For the references to be classified as MTS and MTO, the analysis tool described in chapter 3, ABC-XYZ, was used. The output of this analysis can be found in the following image:

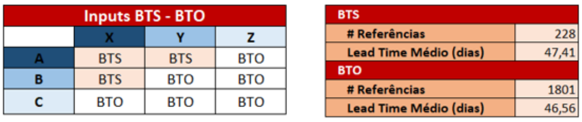


	X	Y	Z
A	MTS	MTO	MTO
	5%	5%	9%
B	MTO	MTO	MTO
	7%	3%	8%
C	MTO	MTO	MTO
	25%	13%	25%

Figure 6 - MTS-MTO Analysis Output

BTS-BTO

For this case study, row materials and packaging materials are classified internally as ZA, ZB, ZC and ZD. The materials belonging to the ZD category are the recorded materials that were disregarded from the study in question due to the possibility of becoming a product with obsolete information.
In this strategic classification of the planning of each reference supplied, the same tool used to define the MTS and MTO references was used, the ABC-XYZ tool.
The result of this analysis was as shown in the figure below:



Inputs BTS - BTO			
	X	Y	Z
A	BTS	BTS	BTO
B	BTS	BTO	BTO
C	BTO	BTO	BTO

BTS	
# Referências	228
Lead Time Médio (dias)	47,41
BTO	
# Referências	1801
Lead Time Médio (dias)	46,56

Figure 7 - BTS-BTO Analysis Summary

Capacity Planning

In order to be able to carry out a conclusive study in this step, it is important to have a list with all the orders already placed by the customer for the finished product and the routes associated with each product. A route means the speed, set-up time, the performance component of the OEE and the number of operators required at each work centre per finished product. With both of the information mentioned, it is possible to calculate the number of hours required per work centre to meet the customer's demand. The following equations have been used to determine the total occupancy of the work centres:

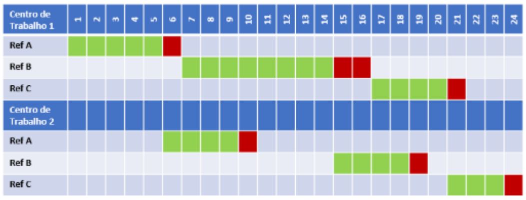
$$Shifts_{i\ ct} = \frac{Total\ time\ per\ month_{i\ ct}}{8h} \tag{3}$$

$$\%\ capacity\ _{i\ ct} = \frac{Shifts_{i\ ct}}{Monthly\ working\ dayss\ _{i}\ x\ \frac{24h}{8h}} \tag{4}$$

This analysis should be done on a monthly basis with the orders loaded for the next 4 months. With this routine it is possible to predict variations in demand and stipulate whether it is necessary to adjust the team of operators to the load requested by the customer. At this stage it is important to close with the production the total number of shifts opened per month.

Levelling and Sequencing Box

The study of strategic and capacity planning is necessary to build an implementation plan. However, the implementation plan does not answer questions such as "when" and "how much" to produce and for this it is necessary to carry out a study of the implementation planning. In order for such a study to be carried out, a levelling box is built with a specific sequencing order determined according to the specificities of the company.The leveling box is a planning aid tool that is divided by time slots and by reference. The construction of this tool is usually physical and for this reason it is called the leveling box. In order to fill the hourly space in the leveling box, it is necessary to calculate the total production time of the reference, the time of entry into the work centre and consequently the time of departure. It is also relevant to know the set-up time so that it is possible to estimate the entry of the next product at the work centre. In the following figure it is possible to illustrate a leveling box with random references. In green you can see the production times and in red you can see the set-up times.



Centro de Trabalho 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Ref A	🟩	🟩	🟩	🟩	🟩	🟥																		
Ref B							🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥								
Ref C																	🟩	🟩	🟩	🟩	🟥			
Centro de Trabalho 2																								
Ref A						🟩	🟩	🟩	🟩	🟥														
Ref B															🟩	🟩	🟩	🟩	🟥					
Ref C																					🟩	🟩	🟩	🟥

Figure 8 - Sequencing Output

For the sorting of the orders, an urgency score of production of the order was defined. This score is obtained through the following equation:

$$Score = demanded\ date - lead\ time - today \tag{5}$$

As mentioned above, the focus of this score cannot be 100% service level because if it is, a lot is lost in line efficiency through loss of availability by performing more set-ups. To meet this requirement, orders were grouped by intermediate product code before packing.

Thus the lead-time referred to in the equation is the total lead-time to carry out the intermediate product campaign. By subtracting this lead-time from the requested date, the score would be the date later the product could go into production without affecting the service level.

4.2.1.1 *Ferramenta em Pull de Apoio à Estratégia de Planeamento*

Due to the complexity of the pharmaceutical industry processes and the fact that there are several work centres in independent rooms, this tool has been used to ensure that the whole pull strategy is well implemented.

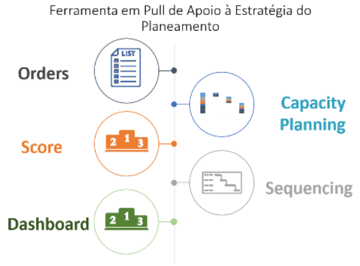


Figure 9 - FPAEP Diagram

In a first step it is necessary to put the most up-to-date order list on file. When the order list is uploaded you have to ensure that the product roadmap is up-to-date. In the next step it is possible to check the dynamic capacity planning with all previously raised specifications. When loading the orders, the tool automatically calculates the score of each order and sequences it through all the work centres giving as output the leveling box. In addition, it is also possible to monitor the expected service level using the expected completion dates of the orders, enabling the planning team to carry out a more rigorous production control.

4.2.2 Implementation of Resource Optimization Solutions

In the optimization of productive resources, an intensive data collection file was first built. The objective of this tool is to obtain OEE data with the various justifications for efficiency losses. In this file it is possible to obtain the values of availability, performance and quality. Then it is possible to divide these losses into the various associated reasons. After some months of data collection it was possible to verify that the biggest efficiency loss was the performance loss and within this parameter it was possible to divide it into several levels and to conclude that the biggest reason for efficiency loss was supply problems in the area of the primer in the packaging phase of the pills.

Then an analysis was carried out on an Ishikawa diagram where several causes were identified. The diagram can be confirmed in the image below:

Figure 10 - Ishikawa Exercise Output

After associating several causes to the root problem, several solutions were associated with the production team. To decide the priority of implementation, an impact effort matrix was made. In the end, 7 viable solutions were found where 3 have already been implemented, 1 under implementation and 3 awaiting budget approval. A summary of the solutions found can be found below:

Lack of management and monitoring of formats
- Officiate procedures and assign officers: Done

Variation in product quality
- Signalling defective containers: Done

Ramp exit / Alveolar entrance
- Quotation request for ramp replacement: Waiting

Non dedicated formats
- Request for replacement quote: Waiting

No format maintenance plan
- Implement after format management: Waiting

Lack of gauges in the set-up
- Blocking and written recording of gauges: In implementation

Technicians do not use set-up procedures
- SMED Training: Done

5 Análise e Discussão dos Resultados Obtidos

As explained during Chapter 3, two global indicators were defined to evaluate the company's performance during the project, which are the level of service and efficiency through the OEE. Starting with the service level, there was a baseline of 32%, which today stands at 60% and has grown by 28 percentage points. This indicator has not yet reached the target but it is expected that the impact of the FPAEP will be felt in early 2021. That said, the target is expected to be achieved by the end of the current project. For the OEE, the baseline was 48% and is now at 51% with an overall growth of 3 percentage points. This indicator did not meet the project's objective because it had two months in error, August and September, which had low efficiency results due to preventive maintenance carried out in August and which had a significant impact in those two months. In addition, there are 3 solutions awaiting approval that will also have a significant impact on this indicator and it is expected that the objective will be achieved by the end of the current project.

6 Future Work

This project had several limitations, the main one being the impact of the general confinement announced in March, which led to the project's timeline being dragged forward. As a result, it was not possible to implement all the tools to measure the impacts in a timely manner. It is expected that both indicators will achieve the objective as mentioned in the previous chapter and the end of the continuos improvement project. It is also suggested for both implementations that on the one hand the FPAEP be developed in a more robust software when it is 100% geared to the planning team as it has now been developed and on the other hand the SMED tool be implemented in the packaging machine setups to improve the OEE parameter of availability thus decreasing the efficiency losses of the indicator and then leveraging the overall OEE project indicator.

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