Pull Planning System in the Wine Industry

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Abstract

In the last decades, the growth of competition between companies has been a norm, as well as the pressure to satisfy end customers. This increase is a result of globalization and changes' susceptibility that the markets require today. Additionally, the pandemic COVID-19 forced companies to adapt quickly, and most industries are facing a scenario of survival in these times of crisis. Taking that into consideration, companies lack methodologies and tools to increase productivity and eliminate waste. The Lean methodology is one of such examples that guarantees companies to achieve their process optimization objectives. Bearing this in mind, the main objective of this Dissertation is to identify opportunities to increase productivity through introductions in productive operations' planning of Company A, that belongs to the wine production sector. This case study carried out in the context of an internship at the Kaizen Institute Consulting Group, a consulting company in continuous improvement hired by company A, aims to solve his need in the organization's internal logistics by creating a more efficient production flow, reducing inventory, and associated costs. The application of methodologies and tools associated with Lean thinking, namely Pull Planning, Heijunka, VSM and SMED. A production planning system in pull adapted to the real demand of final consumers has been implemented to solve planning problems and to improve efficiency. At the end of the work carried out and implementation of the proposed initiatives, there was an improvement of 11% in the level of customer service in meeting the shipping and collection dates, an optimization of stocks of consumables with a coverage reduction by 27%, the increase in the capacity of the production lines and the average volume of daily litres produced, 23% respectively, and the global OEE of the production lines which increased by 39%. In short, Company A and all those belonging to the wine or process industry are recommended to maintain the sustainability of lean initiatives implemented through standardization of processes and maintaining a structured kaizen culture of measurement and continuous improvement, always involving all people.
Keywords: Lean; Kaizen; wine industry; pull planning; continuous improvement

1. Introduction

Following the economic crisis that started in 2008 and the increased demand by consumers in the last decade, companies have faced a great challenge to match the needs of the market without never losing their competitive edge. Nowadays the situation has worsened because of the pandemic Coronavirus Disease 2019 (COVID-19), and companies are now doing everything possible to "survive" to this crisis. It is now, more than ever, essential for companies to realise the importance of increasing efficiency and act daily by eliminating waste and increasing productivity.

Lean thinking emerged as a methodology used to address efficiency problems in companies through cost reduction. This cost reduction resulting from the elimination of waste is achieved with the participation of all employees, from top management to the plant operator. The Kaizen Institute (KI) presents itself as a multinational consulting company that provides an external support to different company sectors. In this specific case study, it is responsible for supporting the fulfilment of the objectives raised by Company A, a Portuguese company belonging to the wine production sector.

The main objective of the present work is to develop and implement a pull production planning system, adequate to the real demand of the final consumers, with the goal of optimising the production efficiency and improving the service to the customers of Company A.

2. Case Study

2.1. Description of Company A

Founded 30 years ago, Company A is a Portuguese wine industry, namely in the production, bottling and commercialisation of Portuguese wines. Although it shares market with other large competing companies, it is regionally one of the largest industrial companies in Lisbon, which in turn represents 15% of the national production [10]. Despite those, it operates mainly outside Portugal, in the international market (almost 50 countries), to which it exports 90% of its production.

Company A presents a multi-brand strategy, thus obtaining a diversified range of products of its own brand or associated with different partner varieties. It produces different red, white, rose, sparkling, semi-sparkling, light and late harvests, in the approximately 600 hectares of vineyards it has in Portugal. The organisational structure of the company includes vineyards and wineries in 5 regions spread across the country, one Wine Plant per region and each one with a vineyard, wine cellar and wine production plant. The Wine Plant located in the Lisbon region will be the case study in this work (Wine Plant 1), in which the company's main facilities are located. It has 7 main departments and 6 production lines: 2 automatic, 3 semi-automatic and an exclusive labelling.

Figure 1 shows the current flow of operations of the process of wine production under study.

Figure 1: Main operations of company A value chain.

Due to the growth in wine consumption in the last two decades in Portugal and in the World, of around 20% and 9%, respectively [10], investment in improvements at the production process has been crucial for the company. Actions were taken from the supply of raw materials to the dispatch of finished product (FP), in order to make the organisation more rigorous at a multidisciplinary level and thus being able to keep up with customer demand and exceed competition.

2.2. Problem Definition

The wine industry in this case study is in turn a process industry. These industries are characterised by the complexity of their processes and large lead times (time intervals between certain operations) along the value chain. These operational constraints are some of the problems identified in these industries that represent, respectively, opportunities for improvement.

The main goal of this work is the improvement through the identification of symptoms and respective causes in company A. Productive problems are defined and analysed by going to *Gemba*, the place where value is added, in this case the areas of planning and wine production. Some critical points identified were a planning system considered inadequate for the desired optimisation, and after going to *Gemba*, and interacting with employees of various levels, it was possible to specify some critical points in terms of productive inefficiency.

The Overall Equipment Effectiveness (OEE) is the indicator used to measure the productive efficiency of the lines. This indicator measures the efficiency of an equipment or production line and relates the effective production time to the available time for production.

This production inefficiency contributes to the Company's low level of service and makes it difficult to optimise the planning (Figure 2). Several reasons were identified for causing the loss of efficiency on the lines. Losses in quality when defects, breaks and rework are generated. Losses in availability due to breakdowns, reference changes, breaks and other line stops. Finally, speed losses are due to micro-stops and reductions in line speed.

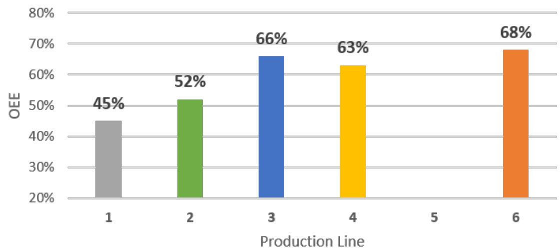

Figure 2: Efficiency of Production Lines in 2019 (Company A, 2020).

3. State of the Art

3.1. Lean Concept

The lean production system like the one currently known, emerged after the Second World War at Toyota, in response to the economic crisis across Japan. In 1988, Toyota introduced a descriptive system of the manufacturing process and all its operations. With this so-called Toyota production system (TPS), created by Shoichiro Toyoda and Taiichi Ohno, the company was able to reach minimum inventory levels, to reduce costs and increase quality control [18]. This variability in production processes and volumes in different companies gave rise to the creation of a new comprehensive ideology for all industries with different sizes and productive diversification, called Lean Thinking [16]. According to Womack et al. [24], the integration of lean thinking is divided into 5 fundamental pillars: 1 - Definition of the value to the final consumer; 2 - Identification of the value chain and segmentation of the activities necessary for the operation, which may or may not represent added value; 3 - Establishing a continuous flow of materials, people and information; 4 - Development of a pull system with production orders correlated with consumer orders; 5 - Pursuit of perfection through continuous process improvement and elimination of remaining waste.

Moreover, the lean and kaizen relationship emerges: in order to achieve production goals based on lean thinking, a culture of kaizen continuous improvement would be needed, which encompasses all areas and involves all people, every day [3].

One of the basic tools is to identify the 7 types of *Muda* (wastes) in *Gemba*, which are classified as [14]: Overproduction; Materials transport; Stopped materials (inventory); Movement of people; People Standing (waiting); Over-processing and Defective products.

3.2. Strategic Production Planning

For the Strategic Production Planning two approaches are usually considered: pull and push While the first is based on the real needs of the consumer, the second one is planned in advance through historical demand forecasts and order groupings [2]. The push mass production system based on forecasts, purchase orders for materials and production are issued by centralised planning and the material follows the supply chain to the FP and this is "pushed" to the customer or stored, this and, awaits the order to be shipped [21]. The most used strategy in this push system is the Material Requirements Planning (MRP), an inventory control with the purpose to maintain stock levels to ensure the availability of materials when there is a need for these. Although it has a reverse production control, this is, from the FPs to development of raw materials required [11].

Contrary to what happens in a push system, in a pull planning it is the customers who dictate the rules(Figure 3). The production process of this system starts at the "end" of the chain at customers and goes back to the raw material suppliers. Throughout the production and at the right moment, that is, only when necessary the right quantities of components or product are produced by the actors of the process [22].

Historically the pull planning system was developed, with the denomination JIT (supply of exact quantity at the right time, just-in-time), at Toyota around the 50's and, came to contradict the system push by giving priority to customer needs. In a simplified way, this system is currently a pillar of support of the lean philosophy, it is based on a successive consumption and re-positioning of the exact quantities consumed. The production orders are generated by orders made by the customer and thus successively in all the operations of the chain with orders of exact quantities of demand in the operation successor until component supply orders arrive [4] [13].

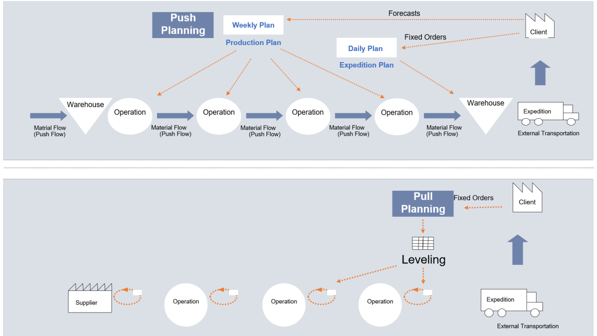

Figure 3: Push and Pull Systems (Kaizen Institute, 2020).

The pull planning system is divided into three implementation steps: (1) Strategic Planning; (2) Capacity Planning and (3) Execution Planning [9].

Based on demand Strategic Planning determines the replenishment policy of the references according to its typology and is supported by 3 distinct strategies:

- Make-to-Order (MTO) replenishment strategy: replenishment strategy: Order of production and placed immediately after the customer order has been received. The FP is delivered to the customer right after the conclusion production and without the need for storage along the supply chain [19] [20];

- Make-to-Stock (MTS) replenishment strategy: The customer order generates an order to supply the supermarket (the term "supermarket" represents a separate storage from push storage systems because they have order points that generate reposition when the minimum pre-established amount is reached) [6];

- MTO-MTS replenishment strategy: Hybrid strategy that joins the two previous ones in a way to nullify their disadvantages, when used exclusively, and to ensure the best decision for each type of product. An advantage of this strategy and the high degree of adaptation to each product specification [5].

In the Strategic Planning phase there are also two classic analyses of product references that can be realised and that support in the choice of the best strategy to use: ABC and XYZ. The analysis ABC is an approach used since 1950 in inventory management and categorises product references by business volume, considering the history of previous sales according to the Pareto principle of that 80% of revenues are generated by 20% of references [23]. Since the ABC analysis does not analyse the demand behaviour in each product, there is a need to of a XYZ analysis that does the same reasoning as the previous analysis but directed to the frequency of orders. It is created a rule of prioritisation of order frequency and then the references are categorised by X, Y, Z in order of highest order regularity and high predictability of demand (X) for occasional orders and some variations in demand (Y) and by large fluctuations in demand and low predictability (Z) [17] [23].

The Capacity Planning, where planning is optimised of the production lines. An analysis of the loads and production capacities of the equipment and lines is carried out. It is also made an anticipation of the demand and seasonality.

Finally, the Planning of Execution is the phase where the client's order is executed in replenishment, production or delivery orders to the customer according to the analyses made previously. This planning is realised through decisions of quantities to produce and better timing to do so [12].

In the wine industry the pull system must be suitable for the type of manufacturing process that exists, usually dependent on the filling phase in production (as is normal in a beverage process industry), therefore a capacity planning stage must consider the number of full bottles filled in a given period of time.

A study conducted in Australia shows the advantages of implementing a lean system including pull planning methodology, has in the companies and farms of the Australian wine industry. The authors propose a Lean Production model of the respective four phases of implementation. The pull strategy belonging to the fourth phase, which represents the greatest difficulty of implementation, but brings results with greater impact [1].

3.3. Lean Strategic Planning Support Tools

The application of strategic planning tools in certain cases may not be successful due to initial constraints related to inputs required to solve the method correctly or constraints during implementation. It will be fundamental to maximise the capacity of the production lines and make them as efficient as possible, but complimentary reduce changeover times which are associated with high costs and opportunities of production wasted.

The Value Stream Mapping (VSM) tool is a visual presentation technique, it is usually a presentation of the whole flux of processes, materials, people and information along the supply chain and value, from the suppliers, presented on the left side of the table, the delivery of the product or service to nays consumers, represented on the right side [7].

The Single Minute Exchange of Die (SMED) is a tool that can be translated into a quick, simple and easy change of production series (setup time), in which the words "single minutes" symbolise the optimal goal of reducing time to less than 10 minutes [8]. This tool was developed by the industrial engineer Shigeo Shingo, in 1950 at Toyota, after being observed that for lack of a single screw the change of paint in a factory of company took more than one hour.

Before the implementation of the SMED tool it is fundamental to defined "change time" (setup). This is usually denounced as the time interval since the completion of the last component or product of the previous batch until the completion of the first product of the next batch according to the stable science of production. All the activities such as disassembly of species from the previous batch, preparation of the change, cleaning, assembly and operation for the next batch, necessary documentation and start-up are included [15].

4. Company A's Initial State Analysis and Production Planning Proposal

4.1. Initial Value Stream Mapping

At the beginning of this work in company A, visits were made to the plant to collect data and identify the existing processes on site with the parties involved in them (*Gemba* Walks). A survey on "Wine Plant 1" was made of the processes that involved the areas of the Production, Logistics, Planning and other complementary departments.

Figure 4 presents the production area of the visited installations and the location of the respective wine filling lines. In Figure 4 the identification of the production lines is in the first process, that is, at the beginning of the respective line, the depalletization process in the automatic lines (1 and 6) and placing of bottles on semi-automatic lines (2, 3 and 4).

The material flow was the first to be designed. Figure 5 shows that the process was divided into 3 zones (one of them has 3 sub-areas): the logistic centre (warehouse), the winery and the production

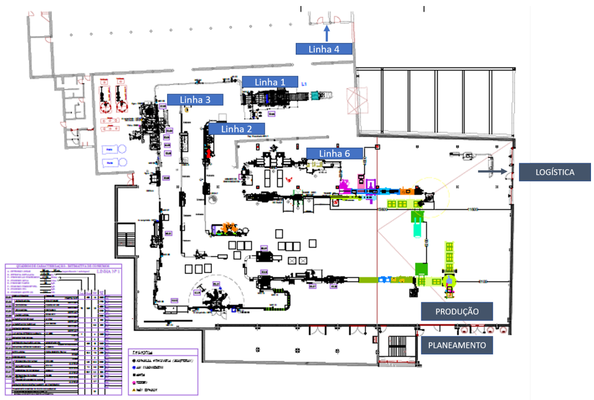

Figure 4: Bottling Lines' Area Layout.

area:

Logistic Centre: this warehouse has 3 sub-areas (floors): the floor 0, dedicated to the storage of bottles, WIP (Work-in-Progress) and FP, the floor -1 dedicated to the storage of labels, capsules and boxes and the floor 1 where is the store of the used labels and back labels.

Winery: in this place the wine from Wine Plant 1 is prepared and stored in tanks. They also received wines from the other company A's " Wine Plants" in Lisbon, Alentejo and Vila Verde. The tanks the wine goes into containers, used to transport and temporarily store the wine (vats), which can hold 2500 litres and are located near the production area.

Production Area: in this area there are the 5 lines, automatic or semi-automatic of the company. The process is started after the bottles are recycled from the logistic center by a forklift that transports them to next to the line (buffer of 3 pallets).

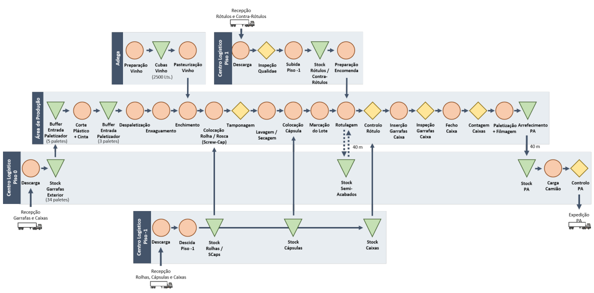

Figure 5: Wine Plant 1's Material Flow.

A similar exercise was done to map the information flux of the different areas, as it is possible to observe in Figure 6, with opposite direction from the flux of materials. This is represented from right to left, from the order of the customers to the orders in the different areas. The areas that are involved in the information processes are the following: Customers, Commercial, Quality, Purchasing, Planning and Production.

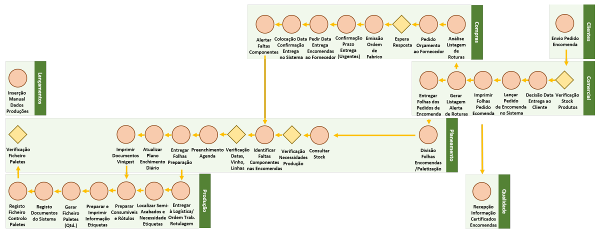

Figure 6: Wine Plant 1's Information Flux.

In the VSM of Figure 7 it is possible to see the last added value operations for the company: the filling and labelling. All the others that do not complement these two are considered *Muda* (waste).

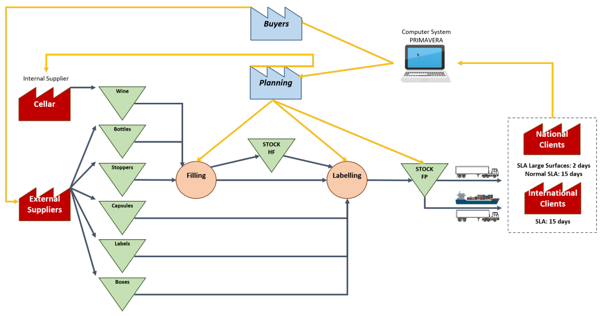

Figure 7: Company A's Initial VSM.

By completing the previous mappings it was possible to better interpret the flux of joint activities of the company and identify possible constraints between operations, departments and their use of resources. With the exercise of the "hunting" to the *Muda* (activity of raising of operational waste in the *Gemba*) it was possible to conclude that a large part of the waste found during the process had origin in the existing productive inception and inadequate planning system. Through a Diagram of *Ishikawa* (name of the creator of the Herringbone Diagram) was possible to identify the root causes of some of these constraints in Planning(Figure 8).

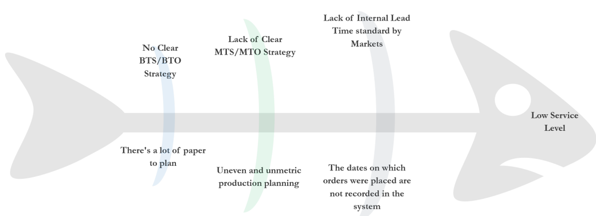

Figure 8: Ishikawa Diagram.

4.2. Future Value Stream Mapping and KPIs

This future strategic vision of company A has as main objectives to improve the profitability of the company by maximise the use of the necessary resources and available capacity, increase the level of customer service, reduce the level of inventories, and create a productive flux. With In the new VSM presented in Figure 9 the orders that arrive from customers are directly redirected in the information system that prioritises them according to collection dates and type of reference. Then the Purchasing department check the necessary components/consumption to the production and order the that are missing. In a logbook box the products are then allocated to a production order according to the best strategy. The production lines are sequenced based on the orders and depending on the availability and their capacity. In addition, it is intended to restructure the teams to obtain a more organised production, by chains of value to the investment of functional organisation, and an optimised communication between areas, namely the areas of Purchasing and Planning.

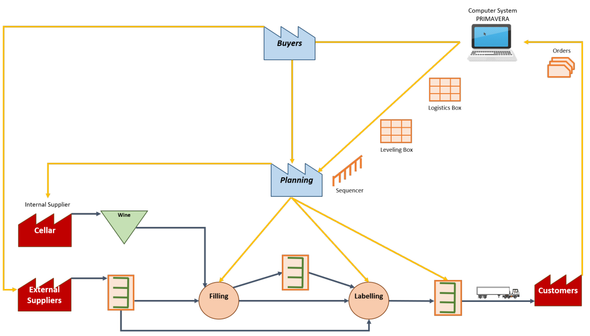

Figure 9: Company A's Future VSM.

To assess the system performance throughout the implementation of the improvement plan of the proposals of four Key Performance Indicator (KPI) were introduced:

On-Time-Delivery - Percentage of orders ready at pick-up date requested by the client and validated by the commercial area; The calculation is obtained by equation 2, for a certain period in analysis, in which the number of orders ready at the date of collection represents those that were produced and stored prior to its collection (or delivery, date to the customer).

$$Level\ of\ Service = \frac{Number\ of\ Orders\ on\ Collection\ Date}{Total\ Number\ of\ Orders} \tag{1}$$

During the last four months of 2019 a collection of all sales data and readiness dates was made of production and actual collection from the client The baseline obtained for the level of service overall company was 66.5%.

Stock Coverage Consumables - Average number of months that the components available remain in inventory until they are used in production. This KPI is calculated by the equation (3) .

$$Stock\ Coverage = \frac{Stock\ Existing\ Components}{Average\ Monthly\ Consumption} \tag{2}$$

In the case of stock coverage, the baseline value of 3.91 months was calculated with the existing stock at the last day of the year (12/31/2019) and the average monthly consumption of 2019. After the team work, the goal for this year was denounced indicator of reducing the baseline by 15%, which translates into a 3.37 month component coverage.

Average Daily Volume - Number of daily litres produced in average; The average daily volume allows to give a vision of the evolution of the produced quantity and the contribution that a system in pull gave through the optimisation and levelling of production lines and consequent maximisation of production. The KPI is calculated by the monthly average of the total daily volume (in litres).

$$Average\ Daily\ Volume = \sum \frac{No\ of\ Litres\ Filled\ on\ Line\ i}{Days\ worked\ on\ Line\ i} \tag{3}$$

With the records from September to December, the baseline of 83,253 Litres for this indicator was calculated and it was denounced a workshop team target of 100,000 for the work cycle in 2020.

Global OEE - Percentage of efficiency of production lines; The Global OEE and calculated by OEE of each line with the percentage of its volume in relation to the total volume. The OEE of each line and calculated by dividing the number of units conforming by the line capacity at an opening time defined by equation (5).

$$Global\ OEE = \frac{Productive\ Time\text{ - }Quality\ Losses}{Open\text{-}ended\ Time} \tag{4}$$

In the case of company A the opening time is 8.5 hours. Denounced so in workshop starting from the principle that the stop time for lunch and a time when the line could be working if the conditions to allow it. The recording of OEE data weighted by line volume in the last four months of 2019 resulted in an average baseline of 50.1%.

4.3. Proposed Implementation Plan for the Production Planning

The last phase of planning in which the implementation phase in the company is denounced under study. To create an implementation plan with the strategy and initiatives to perform during the work, initiatives be aligned with the vision of solutions and objectives of the work previously denounced. In this context and designed a Gantt Chart (mapping schedule) with the stages of the work to be done in the workshop. Prioritisation of initiatives to be included in the Implementation Plan has been included in the following topics:

1. Characterisation of the Current Situation;
2. Implementation of Planning Communication Dynamics;
3. Definition of the Strategic Plan for the Finished Products and Components;
4. Implementation of the New Planning Process;
5. Creation of Metrics, Support Tools and Planning Dashboards;

The main part of this implementation is to solve the largest constraints, of the poorly levelled production sequence of the lines, and by promoting a high rotation with zero breakage, through an improvement in stock management. At planning model view is intended to denote the type of order considering the lead time of delivery (MTS/MTO), defined a standard of the SLA of the suppliers, dimension the supermarket of the MTS orders, build a visible and integrated logistic box for all departments, guarantee the production plan closed for week S+1 in the middle of week S and create a tension resolution meeting at the beginning of the week S (with permanent and optional attendances). Additionally, create routine communication dynamics between teams and optimise processes through the development of models to support Planning and Purchasing.

5. Implementation of the Production Planning

5.1. Pull Planning System

The first major decision made in a workshop session with the Planning team was to define a standard, which previously did not exist for the Customer Delivery Lead Times, i.e. the available time interval for the production to place a customer order and put it in storage ready for collection by the customer. Considering that this lead time has a direct relationship with the Commercial area, some elements of this department were included in the decision-making process. Being the collection date calculated by the difference between the reception date and the lead time internal for order preparation (lead time delivery).

$$Pickup\ Date = Delivery\ Lead\ Time \tag{5}$$

The number of lead time days would be the same as the SLA (Service Level Agreement), i.e. the level of service agreed between each client and company A, depending on the respective target market.

Each FP is associated with a specific order for a particular customer. This customer may belong to the international market or the national market. If it belongs to the national market, the Lead Time Delivery is defined as 15 working days.

Some rules were developed to support the construction of the analysis of the FPs rotation considering the frequency of orders (XYZ analysis). The following rules were determined for the construction of the analysis of the volume of sales associated to the FPs (ABC analysis). The classic FPs as reference A are the best sellers that total 80% of the total volume of sales; B products represent the following 15% of sales volume; and lastly all C Pas were considered as those with the lowest weight in sales volume, i.e. only 5%.

For the specific case of Company A, taking into account the Delivery Lead Times and XYZ and ABC Analyses previously defined, the decision rules of the MTS/MTO strategy, represented by the next decision tree (Figure 10):

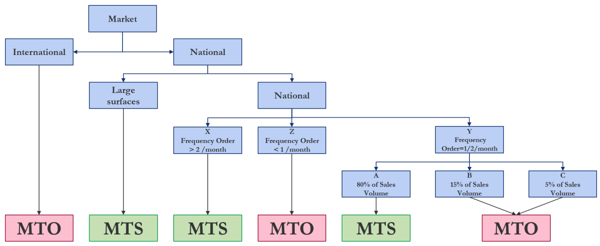

Figure 10: Supermarket Rules for MTS Vs. MTO.

All production components have been BTS certified right from the start, if at least one of the associated FPs follows an MTS strategy. That is, if a FP exists in permanent stock, because it has a huge rotation, then the components it consumes must have a similar strategy and already be stored in time for the production. Additionally, all components associated with a MTO in case they have a lead purchasing team greater than the difference between SLA and Production Time, i.e. no time to be ordered within the time of customer orders will also be BTS if their frequency of consumption in FPs and less than 6 months. All components should have a replacement level, which when reached, of a purchase order alert. In cases where the purchase time is longer than the time for production and delivery to the customer the components only see a BTO strategy if had the last consumption in FPs more than 6 months ago. From the dense hybrid strategy for the components resulted 2,286 BTS and 4,867 BTO, representatives of an average weekly potential stock value of 1,195 k€ compared to 2,037 k€ of the average value in 2019.

To calculate the different production speeds, the semi-finished wines (without label) were divided in families. Each wine was categorised into a family represented by the type of unit (bottle), the dimension, the type of wine, the gas, and the inhibition. All combinations of these subcategories resulted in 58 different types of wines, which are currently produced in one of the six existing lines. This way the maximum speeds collected in the *Gemba* for a specific product of a family were adapted to all the products of the same family. Due to the high number of references and the great variability of typologies was completed the data of the speeds with inputs given by the production director, coordinators and line managers. The values were calculated through of the weighted average of the theoretical speed of each semi-finished wine in each line with the full amount of the 2019 stuffing history. The simulator created in spreadsheet (Excel) therefore allows testing scenarios of changes for time available for production on a certain day that we want to analyse. The data to be put in the simulator are quantity and type of changes to analyse for that day. The output, and the truth to be made, are the maximum capacities for this scenario of changes in this line (in bottles and in litres), considering its average rate and the times of changes in analysis. Figure 11 shows an example of usage of the simulator to analyse a change of 1 wine in the different production lines.

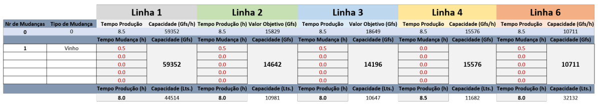

Figure 11: Production Rates Simulator.

The logistic box is a file created as where the various order tracking dates are recorded and generated the priorities in order of collection date. The information has been incorporated to the system information, i.e. the data placed in the spreadsheet (Excel) is fed directly into the system and the order status information is updated.

Previously the allocation of orders the production lines remained a heuristic decision by the Planning team, based on their experience with the history of each reference in the production and the volumes that each line normally fills, using a basic calculator to assist in this calculation. These quantities to be filled in each line were usually reviewed and adjusted with the director's view production that ended up giving a comfortable safety margin and thus avoiding embarrassment larger on the lines during the day.

A visual tool (Sequencing Calculator) was also created for consulting the load and capacities of the lines and with the detail of allocation of products sequence. All missing data was additionally collected to the times already gathered of non-productivity, of reference changes and of the line's theoretical cadences. Incorporation of all the information of the planned production orders of the computer system, the specifics of the products and components and their association (e.g. dimensions and shape of the bottles, number of components consumed in a PA for each subfamily, type of wine, internal codes components, line capacity for each product, among others). The output of the Sequencing Tool presents 8 query pages and is divided into 3 analyses: (1) Weekly Summary in Litres; (2) Daily Summary (Figure 12); (3) Detail per line (of the six existing lines).

Figure 12: Sequencing Simulator.

5.2. Communication and Planning Support Models

An important step in supporting the Pull Planning system was to provide all the means necessary for success of the same. An essential support to the plan implementation is the communication within the team, between areas and with superiors.

A pull system only generates results when all areas are working in the same direction, that is, are aligned with the pull objective: to satisfy the client's needs in real time and to guarantee a productive flux. With this in mind the Planning Process Model was designed and implemented (Figura 13)

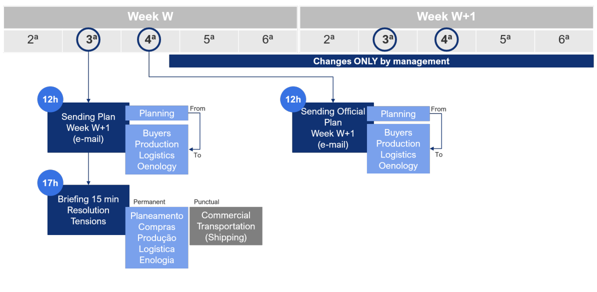

Figure 13: Planning Process Model.

6. Discussion of Results

The main discussion of the results is based on the performance indicators (KPIs) analysis of the case study identified in the section 4.2. The monthly behaviour of these four indicators is then considered representative of all the initiatives and tools implemented, since they had a direct influence on their results. Based on the work done is possible to support that the initiatives implemented had a great impact on the operations. The production is now levelled and sequentially planned according to the orders requested by clients and the stock´s strategies of the existing FPs. The components in the warehouse were released and used to the maximum in the consumption of these ordered products always guaranteeing a security stock of them. The optimisation of the use of the lines and the increase of the diary volume produced. Moreover, the quality of the produced products has also contributed to improving those indicators and the company is now more suitable for peak of the process industry.

The obtained quantitative results can be seen in Figure 14, where a positive increase is observe in 3 of the KPIs. The negative one is due to the pandemic environment and company change in the strategy.

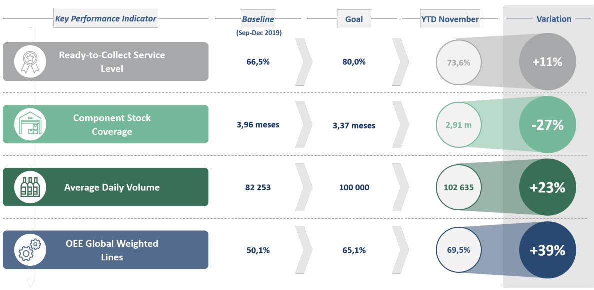

Figure 14: Final KPI Results.

A key point of success was the involvement that top management (management) had in decision making. Although it had a slower and less involved initial participation, it proved to be fundamental and decisive when proactive accompaniment was guaranteed, roughly from the middle of the work. Other constraints arose and had a relative influence in the results of the dissertation, such as, some difficulties of culture change in the field and limited access to the company for 3 consecutive months due to COVID-19 delaying the initiatives. Despite everything the initiatives were accomplished practically all with 100% success.

7. Conclusions and Future Work

The initial situation of company A was identified, as well all its value-added processes, operational problems, and opportunities for improvement. Depending on the opportunities encountered, the limitations of time and resources for the work, were pointed the tools and the initiatives of use during the implementation stage. An improvement proposal was validated by the teams and the implementation began after the planning system was considered the most suitable for company.

During the implementation of the proposed methodology several constraints had an impact and in operation, such as the restrictions caused by the COVID-19 pandemic, the lack of culture of change in the company and the reduced initial involvement of the administration. Throughout of the project multidisciplinary workshops were held, with several sessions of theoretical training of the concepts and of their implementation.

The initiatives to implement the future vision, proposals, the plan was successfully accomplished virtually total. Pull Planning was implemented with excitement in the stages of Strategic Planning and Planning of Capacity. In the execution planning stage, some unforeseen events have occurred that change the initial strategy. Concerning the communication and support models to the planning, all were fulfilled and had a greater impact on the results.

To assess the success of the work four performance indicators were defined: the Service Level; the Coverage of Consumable Stocks; the Daily Average Volumes and the Global OEE of the Lines. The results obtained at the end of November were compare the baseline determined in 2019 and its evolution between January and November of 2020. Comparing the 2019 baseline with each indicator, the Service Level increased by 11%, the Coverage of Consumable Stocks decreased 27%, the Average Daily Volume (in litres) increased 23% and the overall OEE of lines increased 39%.

This work was carried out in the areas of Production and Planning with the aim of improving the productive and satisfy the requirements of the clients of company A . There is a commitment to future work to maintain the good results obtained. The continuous success of the Pull Planning system implemented in company A depends on the internal work in keeping the initiatives active. Additionally, there are other lean tools that support the achievement of an optimised pull system, being of these, the most important to mention is a good execution of SMED and a good follow-up of OEE for increase the achievements of the production lines.

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