Process Improvement in Company A – Application of the *Lean* Methodology

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Abstract

In an era where the existing competitiveness in the industrial production is constantly growing, traditional strategic approaches have become insufficient for the high pressure of consumers, who increasingly demand innovation in supply. This trend is transversal to all industries and in order to maintain or increase their position in the market, they must be flexible to change. With this reality, there is a strong need to improve processes within organizations. In this sense, and with the objective of continuously reducing waste and leveraging the success of a company, the lean methodology emerges.
Company A, belonging to dairy industry, has been established on the market for five years and in 2018 transferred its activities to a new factory. Based on this context, and in order to strengthen its image in the face of competition, the company wants to o find solutions that positively impact its operational efficiency and service level. The document intends to explore how the Lean methodologies and tools can be applied to the case study described. This work presents a review of the state of the art on these themes, choosing those considered relevant as a set of solutions for the identified opportunities for improvement. Finally, the implementation and results of the improvement project are presented.
After the implementation, the operational efficiency increased by an average of 38% per target line of production and the accumulated service level grew by approximately 3 p.p., through an 88% reduction in mistakes committed in the order processing.

Keywords: lean methodology, lean tools, kaizen, dairy industry, operational efficiency, service level.

1. Introduction

The dairy industry, belonging to the agri-food sector, is in a continuous growth due to globalization. In Portugal, from 2010 to 2018 the milk production increased. These data translate into approximately 2 billion liters of milk sold per year.In this context, Company A (a name used in terms of confidentiality), belonging to the national agri-food industry (more specifically, in the dairy sector), felt the need to invest in improving the processes used to increase its low production line efficiency and the decreasing service level. Despite Company A being a subsidiary of an international group, whose sales volume exceeds 17 million euros annually, the factory only started its activity in early 2018.
The remainder of this paper is as follows: section 2 characterizes the problem presented by Company A, section 3 presents the state of the art regarding the methodologies and tools used in the implementation phase of the project, section 4 presents the problems observed and their respective solution development, section 5 presents the project implementation and reflects the results obtained and lastly section 6 gives the final conclusions of the paper.

2. Problem

After a thorough and detailed analysis carried out at Company A, it was concluded that, for a first approach, the pilot areas of the continuous improvement project are the production of milk in cartons and the shipping process.
The Company A improvement project aims to improve the production process, namely the efficiency and the service level of delivery.
The slow production start-up contributes to this low efficiency. To resume the production process, every Monday morning the aseptic tanks that will supply the lines must be heated and sterilized, which without interruption lasts at least two hours per tank. Consequently, there is an urge of changing this process, and adapt it into the Company A current needs.
The order shipping process has several flaws during its execution (such as overcrowding of the shipping pier, no priorities structured, variability in

the order processing, etc.) succumbing into processing errors that directly affect the company's service level, which has been going down since the factory's activity started in 2018. Therefore, an analysis must be made to the procedures, and changes need to be designed, to combat the aforementioned problems.

3. Literature Review

3.1 Lean Thinking Methodologies and Tools

For J. Womack (1990), lean production is an innovative production system that combines the advantages of mass and artisanal production, thus managing to avoid the lack of flexibility of the first and the high costs of the second. In this way, the entire system is designed to achieve seemingly contradictory objectives: to meet the customer's needs by offering a wide variety of products and at the same time reducing costs. The solution to this is to find a method of producing smaller quantities without increasing the associated costs, and this is only possible by reducing human effort and investments in tools, applying stock reduction policies and employing multi-qualified teams at all levels of the company. organization (J. Womack et al., 1990).

Lean production evolved into a philosophy of management and thinking whose focus is on eliminating waste at all stages of the production process (J. Womack & Jones, 1996).

The implementation of lean thinking consists of a set of tools that aim to support the fundamental lean principles through the identification of the concept value for the customer (Ohno, 1988).

According to Taj and Berro (2006), most companies present between 70% to 90% of changes in their available resources. For these authors, even in organizations where lean is applied daily, waste can represent up to 30% of their operations. While looking for and trying to reduce the seedlings, Taiichi Ohno categorized them into 7 types: (1) over production; (2) motion; (3) moving; (4) Transportation; (5) inventory; (6) over processing; (7) defects and errors.

3.1.1 Value Stream Mapping

The Value Stream Mapping (VSM) is a collection of all actions, whether they add value, necessary for the product design through the main flows, from raw material to the final customer (Rother & Shook, 1999). These actions consider and make visual both the flow of material and information throughout the supply chain. The main objective of a VSM is to improve the performance of the production process by identifying all types of waste in the value chain and creating measures to eliminate them. This methodology is usually composed by five steps: i) select the product to be mapped, ii) map the "as-is" value chain, iii) identify critical points, iv) design future value chain, v) implement the new value chain designed.

For Abdulmalek & Rajgopal (2007), the VSM is the best lean thinking tool to visualize the nature of information and material flows by covering the entire supply chain through a diagram, since all the other optimization tools are only concentrated in the individual operations.

3.1.2 5 Whys

The 5-why analysis is commonly used in lean manufacturing. The 5-whys analysis emerged because of Taiichi Ohno's observation in his days in Toyota that when mistakes happen in the production environment people would always blame one another. He realized that mistakes are inevitable and the best approach towards mistakes is to identify its root causes of the and act upon them (Ohno, 1988).

In this regard, this analysis consists on questioning "Why?" for five times until the root cause becomes evident and then be able to identify the right solution to adopt (Imai, Masaaki; Bildhauser, 1986).

3.1.3 Visual Management

Currently, among organizations, operations have become more complex processes and information is disseminated through an infinite series of channels. The availability of information is not a problem, but the way in which it is communicated appears to be inefficient (Parry & Turner, 2006). Every day and constantly, employees receive data from their environment that they do not need, that are not relevant or that they do not understand (McKeown, 2013). The development of this management practice is not recent, it started in Toyota. The goal was for supervisors to be able to see immediately whether employees followed the standards of each operation (Ohno, 1988).

In order to make information more appealing and simple, many manufacturing and service organizations have increasingly used cognitively effective visual tools to provide relevant and easy-to-understand information so that their employees can use it on a daily basis (Tezel et al., 2010).

Regardless of the existence of different definitions for visual management in the literature, all agree that it is a tool for visualizing information. For Eaidgah (2016), visual management is the "practice of viewing information or exposing requirements to define directions". Liker (2004), refers to this method as "any communication device that provides just-in-time information, in

order to quickly inform how the work should be done and if it is deviating from the standard".
In short, visual management is characterized by making all the necessary tools, production activities or performance indicators accessible. For this method to be consistently applied, it must be related to continuous improvement initiatives, in order to promote continuous performance (Tezel et al., 2010).

3.1.4 Standard Work

For Koenigsaecker (2012), it is well known that tools that aim to improve quality and flow, also tend to improve productivity and costs. There is, for it, a key tool that is the primary source of productivity gains, both in production and management processes: the standard work. This tool gives strong emphasis to the added value steps and allows them to be analyzed.
Standard Work is a methodology oriented to observation and simplification of tasks (Osada, 1991). This tool aims to improve working methods through direct and uninterrupted observation of employees in the execution of their tasks, enabling the perception of difficulties and opportunities faced by operators. Therefore, this tool must be applied on the *gemba* (workplace).
The implementation of the standard work provides a structured method of sharing good practices among the employees. With knowledge of the best work method and subsequent organization alignment, execution times are reduced, eliminating *muda* (unnecessary; waste) tasks without affecting quality. After identifying the most appropriate way of working, it must be standardized and used by all operators who perform the task, to ensure that best practices known prevail.
The standardization process consists of 5 steps:
1. Definition of objectives SMART (specific, measurable, attainable, relevant and time bound);
2. Gemba observation;
3. Planning and implementing improvements;
4. Standardization of work;
5. Consolidation of standards.
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3.1.5 Daily Kaizen

The Daily kaizen tool appears as a solution for people development and sustaining results. Thus, the main objective is found in the creation and development of natural teams, so they can become autonomous and capable of maintaining and improving, daily, their processes and working area. This tool aims to change mentalities and behaviors, for which it is necessary that all employees are involved, every day and everywhere.

Therefore, the methodology described develops the teams through the introduction of daily routines, as a fundamental management concept, whose objectives are the monitoring and communication of performance indicators, skills development and employee motivation, acting on deviations through countermeasures and sharing of good practices among all.
The Daily Kaizen is divided into four principal phases and in one base level: level 0, teams definition; level 1, teams organizations; level 2, workspace organization; level 3, work standardization; level 4, process improvement.

4. Initial State Analysis

The current situation of the company is analyzed, and improvement opportunities identified, using the tools presented, namely the VSM. This tool will make possible to understand the behavior of the physical (material) and information flows in Company A and the critical points to be targeted by the improvement process. The "as-is" is analyzed, (the initial state of the factory), the improvement opportunities identified in this state are divided through the 7 *muda* model, developed and its root causes searched using the 5 Whys Analysis. Finally, proposals for solutions are presented with the goal of answering the mentioned problems.

4.1 Value Stream Mapping

Along with Company A's team, composed by the leaders of each process area, the Value Stream Mapping (Figure 1) was designed with the intention of having a full overview of the factory.

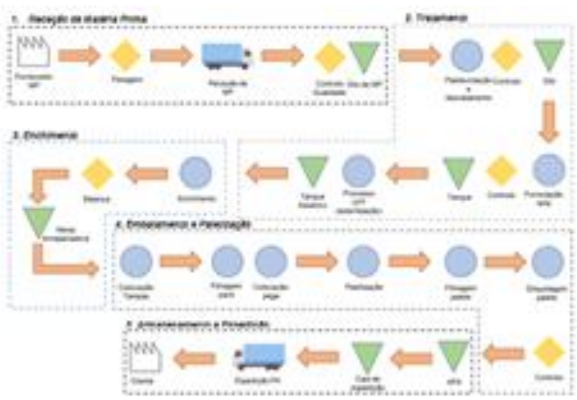

Figure 1 - Value Stream Map

As it is possible to see in Figure 1, the VSM divided the factory in five areas: raw material reception, milk processing, filling, packaging & palletization, and warehousing & expedition. These five areas include all of the value chain's operations.

The mapping process (VSM), and the several visits made in the g*emba*, made it possible to recognize and group the main waste existing in the value flow chain (Table 1), according to the seven *muda* model, where the areas of production and shipping process were analyzed separately.

Type of Waste	*Production*	*Warehouse & Shipping*
Over Production	Large lots	Finished product pallets removed from racks at the end of the day to be shipped the next day
Motion	**Long duration of weekly production start-up**	Waiting for information about the arrival of the transporters
Moving	Employees move in excess to carry out their duties due to the disorganization	Employees move in excess to carry out their duties due to the disorganization and ergonomics of the workspaces
Transportation	Subsidiary material warehouse away from the production line	Finished product pallets are placed in the warehouse aisles and only then stored in the racks
Inventory	Large lots	Long dwell time of good on the shipping dock
Over Processing	Non-complete pallets of finished product must be unpacked at the beginning of a new production, and the packaging replaced in the filming line	Lack of priority management in orders to be dispatched, resulting in overcrowding of the shipping dock and excessive handling of pallets
Defects and Errors	Defective packaging	**Significant number of errors in orders shipped**

Table 1 - Waste identified in the areas of production and warehouse & shipping.

Table 1 summarizes the main improvement opportunities present in the areas of production and shipping of Company A. Through this analysis and within the scope of this paper, it was possible to conclude that the biggest sources of waste are the duration of the weekly start of production and the number of errors in the orders shipped, resulting, respectively, in an inefficient production and a low service level.

Once the main sources of waste were identified, the analysis of the 5 Whys (Sakichi Toyoda, 2012) was used. It was carried out in two workshops with those responsible for the production and shipping areas of Company A.

From this analysis and regardless of the area of activity, the absence of structured processes, based on standards created and implemented, is shown to be the root cause of the difficulties observed during the construction of the VSM, causing a decreasing service level and production efficiency.

However, it is important to highlight the remaining opportunities for improvement arising from the analysis of the 5 Whys, such as the lack of structured communication, the lack of indicators and objectives in operations and the poor organization of workspaces. Therefore, using the tools presented a solution proposal is developed:

- The long dwell time of good on the shipping dock, errors in the order processing, and the duration of the start of production reveal the malfunction of these operations and the absence of standardized work. To this end, new procedures that fit the current scenario of Company A, must be created, and implemented to achieve greater efficiency in the operation: **Standard Work**
- The lack of communication and analysis of indicators made visible the need for an implementation of the Kaizen culture in Company A. The word kaizen is presented as a philosophy that systematically seeks to improve, in which it is believed that it is possible to do better with the involvement of all. To promote a culture of continuous improvement, through communication, analysis of indicators and setting goals, the **daily kaizen** must be implemented.
- The poor organization of the shipping pier creates confusion and complications during the goods shipping process. To this end, information visualization practices, in order to guide the work of employees, should be promoted: **visual management**.

5. Implementation of Designed Solutions

5.1 Standards Work Implementation

The main problem identified was the lack of standardization of the processes performed by the responsible teams throughout the production flow. The fact that there are no written procedures of the best practices to perform specific tasks, creates variability and errors in the executed processes contributes to a low production efficiency (OEE = 33%) and decreasing service level (95%). These indicators contribute negatively to the profitability and image of Company A.

5.1.1 Production Area

Initial State

Knowing that Company A is in operation 24 hours a day for five days, it is necessary to understand the real time in which the machines are effectively available to produce reference units.

The results shown in Figure 2 represent the average time available for filling (without planned stops), in hours, for each day of the week during three months of analysis. Through this analysis a pattern becomes noticeable: Monday, Wednesday and Friday are the days when milk production is lower, in addition to the fact that, on Monday, from the 24 hours of opening, the filling is only available in average 15 hours.

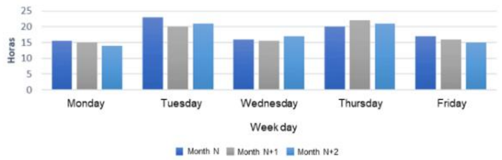

Figure 2 - Average time available for filling machines in Line 1, 2 and 3.

For further clarification, a Pareto diagram (column chart that ranks the frequencies of occurrences from highest to lowest, allowing the identification of the importance of the problems) of the causes of availability losses was performed for the day with the lowest yield. The waiting time for production start-up corresponds to more than 44% of the availability losses of the filling machines at the beginning of each week.

In the current situation, the sterilization of equipment is carried out sequentially and with the support of only one steam boiler, taking an average of 210 minutes to start per line. When only the value-added activities are timed the duration changes to approximately 180 minutes per line.

The execution times of each task were measured without considering the changes activities to ensure that later they are not included in the new standard. The data were collected over several weeks in order to obtain greater accuracy. When observed, for half of the startup production process, the operators allocated to the filling and palletizing areas are waiting for the sterilization process to end and the production to start. This happens because the start of the first shift, for the different stages of the process, is at 6 am, with only 2 FTE (Full Time Equivalent - full time employee) assigned to each of these.

To mitigate this problem, a different process was developed to change the current system of the weekly start-up production, where the goal is to balance the workload and to increase the production efficiency.

Implemented State

This scenario aims at the sterilization of milk and aseptic tanks, of the three filling lines, simultaneously. For this to be feasible, it is necessary to use the two steam boilers available, and thus ensure that the amount of steam supplied to the sterilization of the equipment and product is sufficient for the entire process.

Therefore, the goal outlined for the start of filling is set for three hours after the start of sterilization, starting the production of all lines until 8 am on Monday.

To align the work performed by the employees of the first shift of the week with the new process, the entry times have to change: at 5 am only one employee will enter the control room (to start sterilizing the equipment), and one in the filling zone (in order to prepare the equipment); the rest of the team will start their shift one hour later, following the order of the current standard.

5.1.2 Shipping Process

The order processing begins with the execution, in system, of the order placed by the customer. This processing is done in two different information systems.

The problem lies in the method currently used by Company A, as it has two FTE for processing, but each performs only part of the process: each FTE manages one system. Thus, they are dependent on each other's work. If one of them cannot work, the process is suspended, causing delays in the processing and shipping of orders placed by customers, which will directly impact the service level. Additionally, the fact that the processing of a particular order is not centralized in a single responsible person, triggers errors.

With the collaboration of the responsible collaborators, it was developed the order processing manual, where all activities inherent to the process, in both systems, were contemplated and transcribed.

In this sequence, a four-hour training session was held with the intention of making employees independent in the execution of the process and thus promoting work in lagged shifts. With full knowledge of the two Systems, it is possible for the employee to work autonomously, and thus support an entire shift allowing the creation of a second shift, doubling the time for processing orders in system.

Another one of the problems during order processing is the time the goods stay on the shipping dock: since they have been ready to ship until they are shipped takes, in average, 10 hours.

The long dwell time the goods remain on the expedition dock comes from an ill-defined process and a lack of a properly structured standard. Due to these improvement opportunities, and after defining together with the team the objective for this indicator, 5 hours, the solution proposal was: work management framework and a timetable of the transporters.

Work management framework: structured method of priority management, which allows the picker (cargo allocation worker) to collect the delivery note in a table already organized by the employee who processed the order, with the priorities properly defined (Figure 3).

Figure 3 - Pickers' work management framework.

Transporters timetable: the need of establishing a time for the arrival of each carrier was identified, where each warehouse of destination is allocated to a certain time interval and all its carriers must comply with it. After identifying the trend of orders by destination warehouse (Figure 4), and considering this for the creation of the timetable, the time slots were defined to each warehouse and their respective carriers.

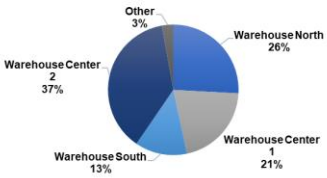

Figure 4 – Trend of destinations for shipping orders.

With this, all time slots must be respected, and carriers must only pick their orders in the defined hours (Table 2). In this way, it is possible to organize the priorities of the orders to be shipped and prevent overcrowding of the shipping dock.

Arrival	Departure	Warehouse
00:00	02:00	Warehouse Center 1
02:00	04:00	
04:00	06:00	
06:00	08:00	Warehouse South
08:00	10:00	
10:00	12:00	Warehouse North
12:00	14:00	
14:00	16:00	
16:00	18:00	Others
18:00	20:00	Warehouse Center 2
20:00	22:00	
22:00	00:00	

Table 2 – Transporters Timetable.

5.2. Daily Kaizen Implementation

5.2.1 Palletizing Team

The criteria used to choose the pilot production area was the ease of collecting indicators. Thus, the chosen area was palletizing, whose team is responsible for lines 1, 2 and 3, after filling the packages. Together with this team, the following indicators were established:

1. Line efficiency: considering the theoretical cadence of the line (12.000 units per hour), record the quantity produced per day. The stipulated objective was an increase of 20%, per line, compared to the OEE baseline;

$$OEE = \frac{Daily\ Production}{Theoretical\ Production\ Capacity * Hours\ planned} \quad (1)$$

2. Unscheduled downtime: sum of the total time the line has stopped due to malfunctions or waiting for information for each shift;
3. Rejection: sum of the total number of packages produced, how many were rejected, per shift, and why they were rejected;
4. Planning: according to the planning carried out for the day, confirm whether production has been completed.

To assist the daily meetings implemented, a team table was developed with all the information considered relevant to be discussed and analyzed. The table (Figure 5), using Visual Management, contains the meeting agenda, the indicators established for the area, the team's daily work plan and the PDCA, where suggestions for improvement are discussed. The meeting must take place at the beginning of each shift and the performance of the previous day must be analyzed.

Figure 5 – Daily Kaizen meetings board.

5.2.2. Warehouse & Expedition Team

The development of this tool in the logistics team followed the same pattern as the production team: setting up a routine of daily meetings with the help of a board (Figure 6), whose content will be information considered relevant by the team. Thus, the performance of the process under study (through chosen indicators), daily division of labor and improvement plan (PDCA) will be mirrored.
In this case, the indicators chosen together with the team were:

1. Service level: percentage result that summarizes the efficiency of the service provided, in the correct quantity and specification. This indicator will be calculated for each day of service and in its accumulated total;

$$Service\ Level = \frac{\#Satisfied\ Orders}{\#Placed\ Orders} \qquad (2)$$

2. Number of errors (detected by the customer): sum of the number of errors (one box, one error), and their causes, in orders shipped that will directly affect the service level;
3. Number of errors (detected at the conference): sum of the number of errors found per order during the internal check of orders.

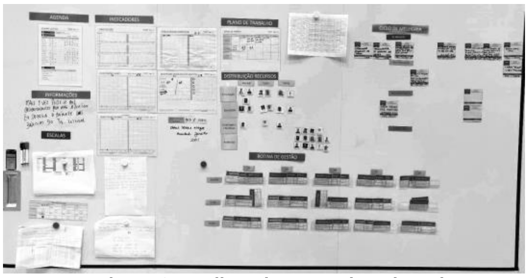

Figure 6 – Daily Kaizen meetings board.

5.3 Visual Management

There are no defined zones (within the shipping zone) for the allocation of pallets by order, and it is at the discretion of the employee responsible for picking, the organization of the goods at the pier. In this way, and taking into account the problems of the pier overcrowding, which causes loading errors - due to the difficulty in understanding where the pallets corresponding to each order start and end - and sometimes making it impossible to load two trucks simultaneously when only one of the dock doors is cleared for this, the entire area mentioned was reorganized.
According to the pier area, it was calculated that its maximum capacity is around 260 pallets. However, it is recommended that at every moment there are always two dock doors available for expedition. Therefore, and with the knowledge that every order has on average 30 pallets, the maximum capacity recommended is around 210 pallets allocated on the expedition dock. The Figure 7 shows the new layout, where every blue number represents a dock door and every green number represents the corridors of pallets (one corridors = 10 pallets allocated).

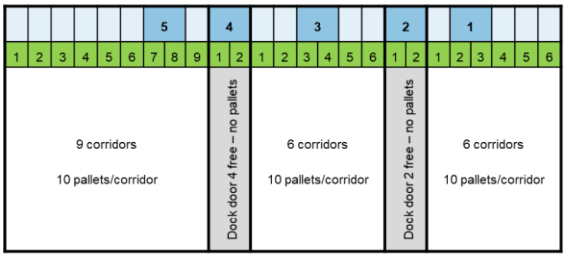

Figure 7 – New shipping dock layout.

To mitigate the errors caused by the difficult perception between the beginning and the end of the pallets of a respective order, and once again using Visual Management, posters in an A4 size were developed (Figure 8). After the allocation of all pallets of a certain order on the shipping dock, they must be identified with the new standard.

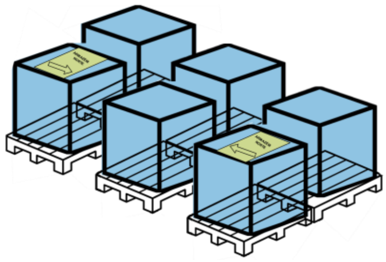

Figure 8 - Example scheme for the application of Visual Management posters.

6.Results Analysis and Conclusions

Production

The application of the methodologies and tools described in the third chapter of the paper to the case of Company A revealed significant improvement on the KPI's defined for the project (production efficiency and service level).
Regarding the production lines efficiency, as previously mentioned, Lines 1, 2, and 3 had an average OEE of 33%. During the 2 months of the pilot phase – with the daily kaizen and new startup production process – the gains obtained are visible: increased by an average of 38%, reaching a result of 53% for Line 1 (Figure 9), 49% for Line 2 (Figure 10) and 36% for Line 3 (Figure 11).

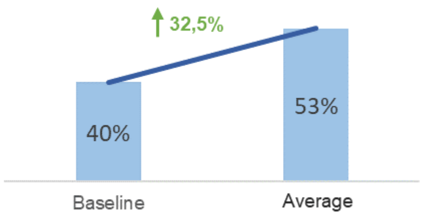

Figure 9 – OEE evolution in Line 1.

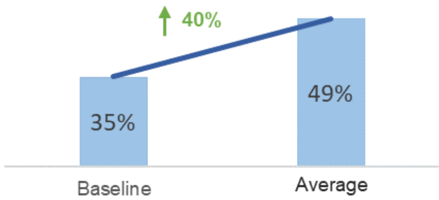

Figure 10 – OEE evolution in Line 2.

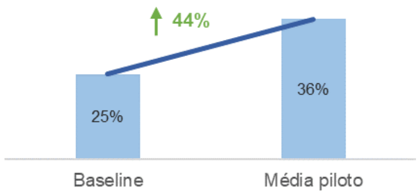

Figure 11 – OEE evolution in Line 3.

Warehouse & Expedition

Regarding the dwell time of goods at the shipping dock, it has been reduced by 60%, from 10 hours to 4 hours. In orders to be shipped, errors have decreased by 88%, which means an increase of 2,6 percentage points (Figure 12) in the accumulated service level; the January and February individual service levels of 98.8% and 99.4%, respectively, contributed to this increase.

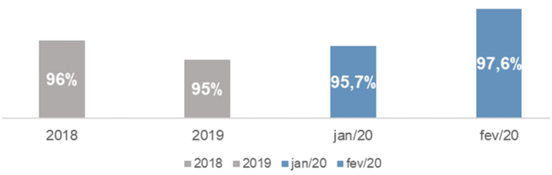

Figure 12 – Increasing service level.

In the development of this project, several significant obstacles were overcome that contributed to a greater or lesser speed and efficiency of implementation. From the outset, the human tissue composed of social and cultural diversity implied a change in language according to the recipient. Keeping the ideas and concepts to be transmitted, they had to be adapted to the respective interlocutor so that he could understand, recognize the message, feel part of the project and be motivated to continue with the proposed objectives. Change is usually synonymous with challenge and overtime which creates mistrust among countless employees. Now, the kaizen tools are supported in team interaction and proactivity as part of solving the problem. The human element is the basis for sustaining the success and effectiveness of any project.

7. Recommendations for Future Work

Due to the current pandemic situation (COVID-19), this project had a time limitation, therefore some of the initial proposals were not tested nor implemented. In this case, several proposals emerged for a future work in Company A to be implemented.

To continue the continuous improvement of operations, it is proposed for future work:

- Validation and implementation of a new developed process for the weekly start-up production, which will bring greater benefits, such as a gradual increase in the time available for production and, consequently, greater efficiency of the lines.
- Improvement in information systems: when observing the processes performed in system, opportunities arose to evaluate the possibility of creating transactions that allow to see processed orders versus orders to be processed and to change the picking gun system so that it is possible to view all order references at the same time, thus ensuring greater employee productivity. However, due to the time limitation of the continuous improvement project there was no opportunity to develop it, remaining as a suggestion for future work.
- Improvements in daily Kaizen: greater use of the work plan; hourly update of indicators and objectives, in order to understand if the production is according to plan (in the production area) and if the service level is being maintained (in the logistics area); improve the visual management of the framework; creation of a competencies matrix, promoting greater performance for each employee; unfolding of the daily kaizen dynamics for the different areas of the Company A, adapting the meeting and the respective indicators to the needs of each area. The remaining teams must be introduced to this concept and trained in their role. Although these are different areas, their implementation should not be done simultaneously, with the risk of losing their focus.
- Improvement in internal logistics: implementation of the *mizusumashi* methodology. It refers to an internal supply

operator whose function is to supply the necessary materials to the different production areas. Following standardized routes and transporting small quantities at previously defined times, this tool allows reducing the shift by preventing workers from having to leave their job to supply the lines (Monden, 1983).

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