Evaluation of logistics processes and Lean tools application to increase the productivity of SONAE MC's Fish Distribution Centre

Sonae MC

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Abstract

The intensification of internalization, coupled with the increasing competitive pressure of today's markets, forces companies to be in a process of continuous improvement, in order to make their resources more profitable and to deliver high quality products, in the right quantity and in the right place for increasingly demanding consumers. In order to keep up with this trend, companies have adopted the *Lean* philosophy, which is focused on reducing waste and creating value for the customer. As a result, this article presents Sonae MC, the current market leading company in the retail sector, which seeks to increase the productivity of its Fish Distribution Centre (FDC) in Santarém.

This paper presents a variety of *Lean* tools which allowed a solution to be designed for the problem presented. Tools such as SMED, 5S, One Point Lessons (OPL) and Visual Management enabled FDC to improve its internal logistics. The improvements implemented allowed SONAE's Fish Distribution Centre to increase its efficiency of the production lines in 54%, the productivity of the bivalve process in 40% and the time per pallet in the intake area was decreased from 7min/pallet to approximately 3min/pallet.

Key words: *Lean*, Continuous Improvement, *Lean* Methodologies, Standardized Work, Continuous Flow, *SMED, 5S.*

1. Introduction

Given the current economic climate and the increasing globalization of the economy, there is a growing competition between companies. As a result, companies have to deal with shorter product life cycles, higher product complexity and more product variants. The reaction of many companies to these changes results in the implementation of *Lean* production systems. Lean systems offer an approach that eliminates waste and increases customer value across all processes (Dombrowski et al., 2016).

The continuous improvement that some companies are adopting in order to achieve operational and service excellence is a consequence of this increased competition. Consequently, companies feel the need to adjust their management strategies and continually improve performance through all processes, to keep up with their competitors or, if possible, to overcome them (Nunes, 2016). It is in this context of innovation that the present dissertation arises, in a critical area of SONAE MC that deals with fresh fish, namely in the Fish Distribution Centre (FDC), in Santarém. This dissertation is part of SONAE's Call for Solutions program of four-month internship and was aimed to help FDC to improve its processes through the application of Lean tools and methodologies in order to achieve substantial and cost-effective improvements. The Lean methodology was chosen because it focuses precisely on the optimization of the flow of materials inside the warehouse, increasing the efficiency and productivity of the processes, without necessarily increasing the facilities, since that the small size of the FDC is one of its biggest limitations.

In order to achieve the general objective of this thesis and increase the productivity of this centre, there are several goals to be accomplished in three different areas of the FDC:

- **Intake**
  - ✓ Guarantee 3min/pallet on the intake materials flow;
  - ✓ Creation of checklist to control the process over time;
  - ✓ Supplier scheduling levelling.
- **Production**
  - ✓ Monitoring the installation of the new production lines and standardization of processes;
  - ✓ Creation of a checklist to control the process over time;
  - ✓ Increase the efficiency of the bivalve process.
- **FDC crates system**
  - ✓ Ensure higher control over the number of crates to be sent to suppliers.

2. Literature review

In this section there will be presented the *Lean* concept evolution (3.1), the Lean thinking (3.2), *Lean* production (3.3), *Lean* methodologies (3.4) and the *Lean* tools (3.5).

2.1 *Lean* Concept Evolution

Just mention "*Lean*" and most *Lean* thinkers will immediately associate it to the *Lean* production approach implemented by Toyota in 1940 and the main topic of "The Machine that Changed the World" (Womack et al., 1990). The first book to ever approach Japanese production methods in contrast to the traditional mass production methods in Europe (Melton, 2005).

The first major change in the industrial paradigm was made by Henry Ford, who created a systematic and standardized type of production, creating Ford Motor Company's famous assembly lines that would start the mass-production system. This change brought a considerable improvement in productivity and worked as inspiration for several other production methods in the rest of the world (Womack et al., 1990). However, it was only after the II World War in Japan, in the middle of an economic crisis and in a challenging environment for the Japanese economy that Shoichiro Toyoda and Taiichi Ohno, employees of the Toyota Motor Company (TMC), transformed the production system into a *Lean* production system called the *Toyota Production System* (TPS). Since then, the *Lean* production system has become a worldwide benchmark for success in several economic sectors and continues to expand (Abreu et al., 2017).

Even the best results obtained by companies that have adopted this *Lean* philosophy do not convince the most skeptical. The main criticisms are that it is a practice that requires too much information, money and time. With so many studies and articles stating that the implementation of this system is one of the main reasons for providing successful manufacturing operations and keeping companies in a competitive environment, it seems only a matter of time until a large adoption of the *Lean* concept is made by most of the companies. (Abreu et al., 2017).

2.2. *Lean* Thinking

Lean thinking begins with the customer and the definition of value. Therefore, since a production process is the transport vehicle of value (the product) to the customer, *Lean* thinking principles must be applied and shaped to the Industrial Processes of each type of industry (Melton, 2005).

For more than two decades *Lean* thinking was the business strategy that ensured the competitiveness and sustainability of companies by focusing on eliminating activities that do not add value to the costumer. Since resources and energy are limited, it is essential to find alternatives to produce more with less and focus only on activities that add value (Mourtzis et al., 2016). It was in this purpose that Toyota engineers developed the TPS so that fewer and fewer resources were needed to deliver the right products at the right time and in the right place. (Abreu et al., 2017).

For Melton (2005), to achieve a good implementation of a *Lean* culture, it is essential to have a rational and well-structured reasoning according to five fundamental steps: data collection, data analysis, planning change, implementing change and measure the benefits of this change (Figure 1).

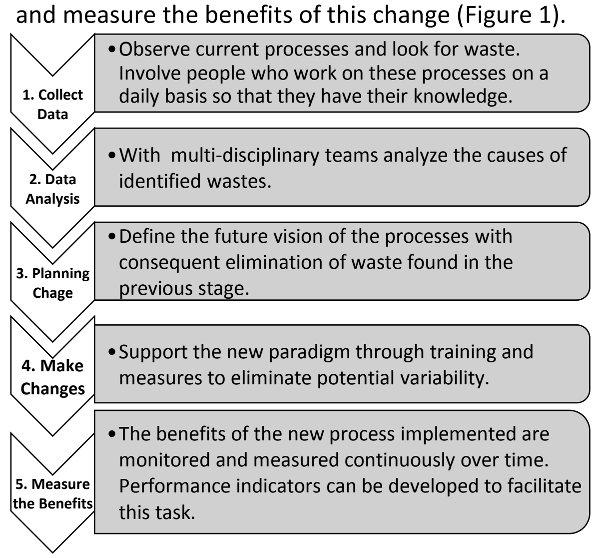

Figure 1 - *Lean* thinking implementation structure (Melton, 2005).

2.3 Lean Production

The origins of *Lean* production date to the year 1940, when the limitation of the Mass Production System to offer a greater variety of product to its consumers motivated Eiji Kiichiro and Taiichi Ohno, both TMC engineers, to visit the Ford plant in Detroit several times in order to understand failures of the mass production process and from there to elaborate a new system more efficient and dynamic. (Womack et al., 1990). This new system would have great advantages compared to its predecessor, requiring a continuous resolution of the company's problems by all employees, making the production system more robust and efficient. (Melton, 2005). There were several positive effects on productivity, product quality and response to changes in market demand that the TPS installation brought to many companies, making them more independent and sustainable in their development and improvement process (Womack et al., 1990).

2.4. *Lean* Methodologies

Lean methodologies are essential for the correct implementation and management of the *Lean* philosophy in a company. The most relevant *Lean* methodologies for the study in question are presented below.

2.4.1. *Kaizen*

Globalization has undoubtedly affected production processes worldwide. To face this reality, companies have to implement changes in their structure in order to remain competitive in the market. One of the strategies implemented by several companies to increase their competitiveness is based on a philosophy of continuous improvement or *Kaizen* philosophy. The *Kaizen* philosophy is based on the perspective that our life requires constant improvement. It is in this way that companies need to respond to this globalization, implementing habits and practices of continuous improvement with the aim of reducing waste throughout all processes (Maarof and Mahmud, 2016).

The word *Kaizen* derives from two Japanese words "Kai" meaning change and "Zen" meaning for the best (Palmer, 2001). It is a set of practices focused on small improvements achieved as a result of an ongoing effort across the organization. The key aspect of this philosophy is its rapid analysis, allowing it to detect a problem and quickly implement a solution in real time (Knechtges and Decker, 2014).

According to Maarof and Mahmud (2016), there are three main pillars to successfully implement a Kaizen methodology: standardization of processes, elimination of waste and maintenance of a clean and organized workplace. They also concluded that this revolutionary methodology, since its implementation at Toyota, has allowed numerous companies to increase their customers satisfaction, their productivity, the satisfaction of their workers, their own profits, and at the same time reach a top position worldwide.

2.4.2. Just-In-Time (JIT)

The JIT production methodology can be defined as a comprehensive management strategy that has a simple objective, to produce the required items, in the required quantities and in the required time (Baykoç and Erol, 1998). When JIT is applied to a production system, it is based on the flow of material, minimizing product stock. For this purpose, small batch production is used (Alcaraz et al., 2014).

The JIT, characterized by its Pull system, allows companies to reduce their inventory, a fact that is crucial in certain industries such as the retail industry, allowing higher financial results in a sustained way (Fawson et al., 2003).

2.4.3. First Expired First Out (FEFO)

One of the major challenges for companies operating in the retail industry is to determine the right quantities of the different types of products, each with a certain shelf life, in order to minimize the total costs of the system (Sazvar et al., 2016).

The inventory can be categorized into three main groups: 1) products with an indefinite expiration date, that is, infinite; 2) products that lose their value over time, due to the introduction of substitute products as a result of technological advances; 3) products that deteriorate over time, that is, lose their qualities over time (perishables). Based on a study by Lystad et al. (2006), approximately 15% of total inventory losses are due to product deterioration. For companies dealing with these perishable products it becomes essential to adopt a FEFO policy in order to avoid the generation of waste and out-of-date products that may have negative effects on the company's reputation (Bakker et al., 2012). According to the FEFO policy, the products with the shortest shelf life are the first to be shipped. When the variability of these perishable goods increases, the capacity of the warehouses can be a critical issue, and in this situation the decision has to be made taking into account various aspects of these goods such as the profitability of each product, its expiration date and the satisfaction of demand (Sazvar et al., 2016).

2.5. Lean Tools

Lean tools are responsible for implementing the Lean methodologies in organizations.

2.5.1 Single Minute Exchange OF DIE (SMED)

The SMED method was developed by Shigeo Shingo, a Japanese Industrial Engineer, and has as main objective the reduction of the Setup time of machines or production lines. The goal is to reduce the setup time to one digit (<10min) (Almomani et al., 2013). In this method, all activities can be divided into two categories: 1) internal activities, which are executed while the machine is offline; 2) external activities that are performed while the machine is operational (Shingo, 1989). Initially the model proposed by Shingo was composed of four phases: 1) creation of a Setup map, where it was possible to have a global image of all the activities; 2) classification of the internal and external activities; 3) transfer internal activities to external ones whenever possible, in order to increase the productivity of the process; 4) improve all machine operations, eliminating unnecessary operations and improving initial setup.

2.5.3. 5S

The 5S is a tool designed in Japan by Kaoru Ishikawa and functions as a checklist that aims to create work habits that provide better organization, cleanliness and discipline in the workplace. It is a method composed of five steps, as the name itself indicates, being: *Seiri* (sort), *Seiton* (tidy up), *Seiso* (clean), *Seiketsu* (standardize) and *Shituke* (institutionalize). (Imai, 1997).

2.5.4. Visual Management

In recent years, Visual Management has assumed an extremely important role within organizations, as a system that through visualization allows employees to better understand their role in the company, while perceiving the company's values and needs of their consumers (Janni and Petra, 2015).

2.5.5. Process Standardization

Standardization is one of the tools that can be used to continuously improve an organization. By documenting current best practices, standardized work is the starting point for possible future improvements and is one of the key pieces of the Kaizen methodology. (Míkva et al., 2016).

A standard should have the following characteristics whenever possible (Imai, 1997):

- Must be clear, efficient, easy to perform and the best way to perform a task;
- Must provide a way to measure performance;
- Must offer the best way to preserve knowledge;
- Should be a basis for training;
- It should represent a means of preventing recurrence of errors and minimizing process variability.

3. Case study

The objective of this chapter is to present the activity of the SONAE MC group, as well as to characterize the logistic processes of the Fish Distribution Centre and identify the main challenges that currently faces.

3.1 SONAE MC

SONAE MC presents itself as the leader in the Portuguese retail market, with more than 746 stores and a turnover of approximately 3,490 billion euros (SONAE, 2015). The company owns several types of businesses and brands (82 retail brands) through which exposes its products to the consumers, the most important being Continente, Continente Bom Dia and Modelo Continente. SONAE MC has also 3 production centres: the Bread making Centre, located in Ermesinde, the Meat Processing Centre and the Fish Distribution Centre, both located in Santarém.

3.2 Fish Distribution Centre (FDC)

The focus of this thesis will be on the FDC, which is the logistic warehouse responsible for the national distribution of all fresh fish in the SONAE MC supply chain. Currently, this centre is responsible for the daily supply of fresh fish to all 226 SONAE's stores.

There are 6 entities responsible for maintaining the continuous fish flow from the sea to the Portuguese houses and these are the suppliers, the FDC, the Meat Processing Centre responsible for washing the FDC's crates, the stores, the commercial board and the outsourcing transports that connect suppliers, FDC, the Meat processing centre and the stores (Figure 2).

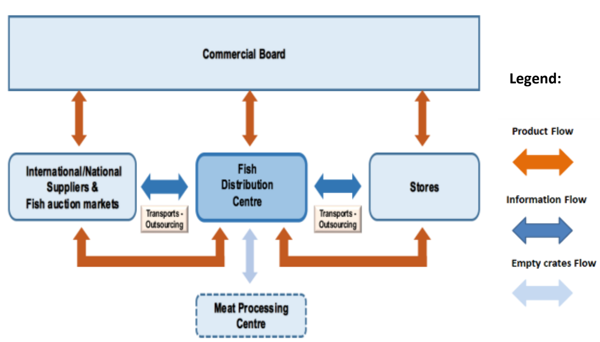

Figure 2 – Fresh fish supply chain.

The main logistic processes in the FDC are intake, production, picking, preparation area and shipping.

The Intake is the engine of the FDC, that is, it presents itself as the area that dictates the work flow of both the picking and the production, so it becomes essential to have a continuous flow with no bottlenecks. This is the first operation to begin its activity, on Mondays from 06:00a.m. to 6:00p.m. and from Tuesday to Saturday from 07:00a.m. to 6:00p.m. and it is operated by 9 workers, of which 2 are administrative personnel who perform only administrative functions.

The Preparation process is relatively recent and consists of confection and preparation of fish preparations. Currently, it is an area that operates only in a shift from 09:00 to 18:00 and to which are allocated 7 people, of which 1 coordinator is responsible for delegating and guiding the process.

The Production is characterized by three different zones: the production line which is responsible for changing storepacks and for transferring the products from the suppliers' crates to the FDC plastic crates; the "islands" which is a process where the products to be sent to the islands are prepared and to which is associated an operator per day (8h); the bivalve process, where the shellfish is separated by store according to the orders and which has allocated a variable number of operators according to the quantity of total orders. In this area, operate 19 workers divided into two shifts from 9:00a.m. to 6:00p.m. and from 11:00a.m. to 8:00p.m. The Picking zone corresponds to the part of the process where the products are allocated, according to the orders, to each of the stores. The picking team works in 3 shifts, from 8:00a.m. to 5:00p.m., from 11:00a.m. to 8:0p.m. and from 5:00p.m. to 2:00a.m., on a total of 26 operators, of which 4 are administrative personnel.

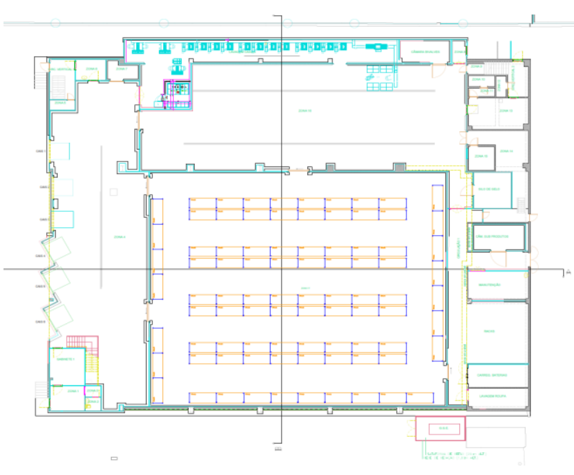

Figure 3 – FDC's layout (SONAE, 2016).

3.3 Problem Description

The main challenges facing the FDC are related to the materials flow at the intake, with the standardization of the new production system and its plastic crates system.

Before the improvements implemented, the average time that each pallet took from the moment it was unloaded to the moment it left the intake was approximately 7min/pallet (Sonae, 2016). The main objective was to reduce this flow to 3min/pallet, a goal that was mostly challenging by the labeling operation, which appeared as the bottleneck of the process that takes place at the intake. In addition to this constraint, supplier deliveries often do not respect scheduling, which originates periods of high intensity and others in which the intake is not operational, not providing a continuous flow and consequently causing intake constraints since most of the times the picking area is not able to keep up with the intensity of the flow generated in the intake during the hours of highest intensity. The challenge is to change the labeling system in order to be more efficient and cost-effective and to modify the suppliers delivery schedule in order to level the delivery of the number of pallets over the day. Still in the intake it is intended to standardize the processes and the subsequent creation of One Point Lessons (OPL) for the different unloading processes, in order to have, depending on the typology of each supplier, a predefined process of unloading.

As for the production area, the aim was to improve the fluidity and efficiency of the processes related to the production line through its standardization, and the changing of the current bivalve separation process. In the past, the bivalves were separated by each of the stores with a map indicating the stores that ordered the product and the number of units (each product in 1kg bags) that were ordered. The main problem was that operators spent a lot of time looking for the name of the stores. The challenge was to create a new identification system that allowed operators to identify stores locations more efficiently.

Another challenge was to create a tool that allowed higher control over the suppliers crates needs. That implies having a balance between the sent and received crates in order to always maintain a balance between the various entities, without there being any stock breaks in the quantity of crates. The current system was implemented in September 2016 and includes all auctions and certain national suppliers. The challenge was to analyze past data and figure out which are the causes of the constant lack of crates.

Finally, in order to control all the processes implemented, it was intended to create two checklists, one for the intake and the other for the production, so that the management team could control over time the correct execution of all activities.

4. Improvements Proposal

4.1. Intake

In the Intake there were introduced improvements such as a new labelling system, standardized tasks for the unloading operation and suppliers delivery levelling.

4.1.1. Change of the labelling system

Labelling proved to be a constraint on the intake and made processes less continuous. There are several suppliers that deliver products on pallets with more than 80 crates, which requires a high time of operation. Given the characteristics of the process, the VSM tool was not suitable, and for the understanding of the value flow a flowchart was created, along with the application of the SMED tool. All processes in the intake were done per 3 operators. On the flowchart were presented only the general activities of the 3 operators simultaneously, while in the SMED analysis were presented all the activities. Given the high volume of information it was intended not to present on the article the tables of contents nether the flowchart.

4.1.2. Single Minute Exchange OF DIE (SMED)

In order to carry out the process mapping and create the first step of the SMED analysis, several Gemba walks were made, where videos were elaborated that allowed to discriminate each one of the activities. It is important to note that all tasks are executed in parallel by three operators in a process of unloading of five pallets. Each of the five pallets consists of 88 crates. In order to have the measurements closer to reality, four simulations were elaborated. All the activities performed were measured and allocated to a table, indicating the minimum value, the maximum value and the mean value of all the observations made.

The second step was to identify the activities that add value and those that do not add value to the final product. Activities that add value were classified as AV, while activities that did not add value were classified with NAV. In this case, the only operations considered to add value were transporting the pallets from the truck to the dock, tagging the crates and transporting the pallets to the picking area. All the other activities were considered parallel activities that do not add value to the final product. In addition to this classification of activities, it was possible to conclude that the labelling activity was the bottleneck in the intake. This is due to the large number of labels required but also to the weak adhesion of the labels to the crates, caused by the high humidity in this area.

In the two final stages of the SMED analysis were presented the changes that have been implemented and that have eliminated tasks that do not add value. It was also reduced the time of activities that add value. The biggest innovation implemented was the introduction of a master label for all fixed weight suppliers (this is the case for the simulation supplier and most FDC's suppliers). Each pallet was identified with only two master labels that identify all pallet crates later in the picking activity. Master labels were only implemented for suppliers who do not deliver products with repeated batches, in order to keep their traceability. With this innovation, the labelling time for each pallet was dramatically reduced, as well as the number of non-value-added activities such as constant moves to place the label roll in the trash and printing the labels. In addition, this change meant that Operators 2 and 3 were more efficient now than Operator 1, which allowed the division of tasks in order to speed up the process even more. As such, Operator 3 became responsible for shipping the pallets labelled to picking and Operator 1 is only in charge of transporting the pallets of the vehicle to the dock where they are labelled. Operator 2 is therefore in charge of labelling all the pallets. In addition to this improvement, the team was also alerted by the importance of the 5S, to ensure that they have a clean and organized workplace, so that all the necessary materials are available in advance such as garbage bags, roll of pre-printed labels, pallet trucks, among others.

4.1.3. Process Standardization

FDC is supplied by a large number of suppliers, and each supplier has characteristics that make it different from the others, either by the quantity of product delivered or by the characteristics of the products themselves. These differences require specific activities in the intake. In this way, it was possible to create four unloading models depending on the typology of each supplier and depending on if the product is to be stored or is to be transferred directly to the picking or production.

These four models created are the continuous unloading model, the total unloading model, the salmon unloading model and the 4P partial unloading model. For each one of these models was created an

OPL explaining the process. The four unloading models were developed having always 3 operators allocated to the process.

- **Continuous Flow Unloading Model**

This model has proven to be more suitable for suppliers whose pallets do not require much rework and remain less time on the dock when compared to the 4P partial unloading model pallets. In this model two of the operators are responsible only for transporting the pallets and one of them for labelling the pallets with the master label in a continuous flow of pallet handling.

- **Total Unloading Model**

The total unloading model is a process that regards all suppliers that deliver less than four pallets per truck. Since these suppliers deliver reduced quantities and their unloading is quick, it has not been necessary to develop a specific OPL explaining the process. All suppliers that are associated with this type of unloading are suppliers who supply variable weight products and are all delivered for the production area and not to picking. This way, it is not necessary to label the products and the process is even faster.

- **Salmon Unloading Model**

The salmon unloading model is a combination of the continuous flow and the 4P partial models, as it has some particularities. Salmon is a product of variable weight, that is, each crate has a different weight and in addition the crates are larger with each one usually weighting more than 20kg. Such characteristics require additional processes such as: reading each supplier label from each crate for printing and labelling, and also the removal of eight crates from each pallet with the help of two stackers in order to reduce the height.

- **4P Partial Unloading Model**

The 4P partial unloading model, as its name implies, is a discharge method in which only four pallets are unloaded at a time. This model only applies to products that are to be stored and that have to be changed from the supplier's pallet (English pallet) to a pallet of the FDC´s (EU pallet). This is justified by the fact that each pallet needs more time until it is prepared to be transported to picking, and for this reason the three operators need to be working together on the four pallets.

4.1.4. Suppliers Delivery Levelling

Another improvement proposed was the change of the delivery windows by the suppliers in order to reduce the delivery peaks and to have a more constant and continuous flow. In order to change the scheduling, in addition to analysing the delays of each one of them, certain aspects were also taken into account:

1- Schedule the delivery of each supplier as soon as possible;

2- The quantity of product delivered by each supplier;

3- When two suppliers are unloaded at the same time, one of them must have goods of fixed weight and another of variable weight, in order to supply both production and picking, not just one of these;

4- Dimensions of the truck in which the products are delivered;

5- Pallet typology (EU pallet / English pallet).

The size of the reception team was translated into capacity and for each 30 minute interval a certain capacity was established according to the number of employees present on the intake. For example, Monday from 06:00a.m. to 06:30p.m. there are in the intake room four employees (with a capacity of 15 pallets), but 41 pallets were received, resulting in a excess of 26 pallets. The employee schedule was also changed according to the new supplier schedule.

4.2. Production

4.2.1. Production Lines

For the new productions lines it were defined four types of work functions were defined: 1) line supplier that is responsible for placing the supplier crates next to the weighing machine; 2) the weighting operator who is in charge of transferring the product from suppliers crates to the FDC’s crates; 3) the end-of-line operator that places ice in the FDC’s crates on the product and places the final crate on the pallet to be taken to the picking room; 4) the MISU that is the operator responsible for all the parallel activities. For each type of worker it was made an OPL explaining the process. After the standardization of all processes, training was given to the entire production team and together with the 5S concepts, not only to guarantee a correct hygiene and maintenance of the line, but also so that each member of the team has full knowledge of what her/his function is at each and every moment in which it is acting in the production line.

4.2.2. Bivalve Process

In the bivalve process, the main improvement was the change of the identification system. Previously it was operating in PBS, where the operators processed each order of each of the stores independently, passing later to PBL, where each employee distributed only a single product through the various stores, and now was implemented a system operating in PBL but with identification. The difference to the previous system is that all 165 crates positions in the trolleys have an associated number. This identification means that it is no longer necessary for the employees to search the store through the crates labels, but simply identify the store by the respective number that appears on the map. The allocation of bivalves to their stores has become a much more direct, effective and efficient process.

4.3 The FDC's Crates System

As mentioned, FDC's crates system, due to the lack of control over the crates, often leads to shortage problems, both at the FDC level and at the supplier level. In order to provide the FDC with higher control over the crates flow, two analyses were developed: 1) analysis of the years 2014, 2015 and 2016 of the products quantities delivered by the suppliers; 2) evaluation of the cycle time of the crates sent to each of the 226 Sonae stores and also sent to the suppliers. After having the weekly quantities of products delivered by all suppliers, those values were divided by the average weight per crate. Finally, we added all the crates necessary for the different products per week, to finally obtain the number of FDC's crates required per week and per supplier (Figure 4).

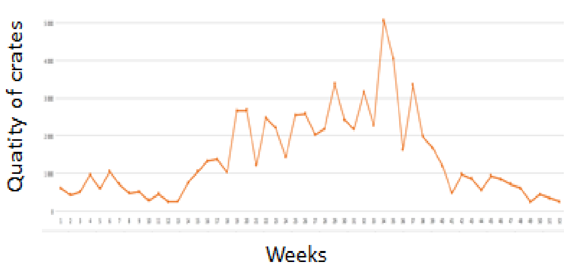

Figure 4 – FDC's layout (SONAE, 2016).

As it is possible to visualize in the graphic for one supplier, this tool enabled the Fish Distribution Centre to have a much more accurate view on the supply of boxes for each of its suppliers during the year, allowing to identify seasonality and to have a more efficient distribution of its crates by the different suppliers.

Another component that was studied was the cycle time of the crates. To elaborate this study, several crates sent from the FDC were identified. For each store and for each supplier, three shipments were made and their respective return time was counted. The crates for the suppliers were identified with labels of different colors to represent the day of shipping and the crates for the stores were identified with clamps with a unique code, since they still are submitted to a sanitization process before reaching the FDC, which would have made the labels not viable.

4.4 Process Confirmation

In order to ensure the correct execution of the processes implemented over time and to introduce the Process Confirmation, two checklists were made, one for the production and one for the intake so that the heads of each area could guarantee the correct execution of the various procedures implemented during the year. Audits should be done weekly and in both shifts. The purpose of the audit is 100%. Whenever the result is not 100%, actions should be taken to improve these problems and ensure that they do not happen again in the future.

4. Results

4.1 Intake

4.1.1 Suppliers Delivery Levelling

After changing the suppliers and employees schedules a more continuous and standardized flow of materials was verified in the intake. There were simulated three situations: the current situation, the situation with the changing of the intake team schedule and another one with both the intake team and suppliers schedule. This last one is the optimal situation but until the end of the internship only a few suppliers schedule were changed.

4.1.2 Labelling system

Changing the labelling system was one of the most valuable improvements in this section. After the introduction of the master label, 30 counts of the new time of the labelling task were performed. The results were surprising, the approximately 2min/pallet required to label a pallet with 88 boxes was reduced to 15 seconds per pallet (two master labels), which represents a 700% productivity increase in that process.

4.1.3 Process standardization

With the standardization of the unloading models, the team became more aware of the procedures to be adopted according to the supplier's typology. This allowed for higher fluidity in the process and increased organization of the team itself.

With the process standardized and always having three operators allocated to the process, times were measured for each type of unloading model and it resulted that for all of these, except for two suppliers that use the model of 4P partial unloading model, demonstrated, on average, a time equal to or less to 3min/pallet (Table 1). Two suppliers were considered per unloading model and for each of them were taken into account 20 pallets.

Table 1 – Average time per unloading model.

Model	Minimum value	Maximum value	Average value
Continuous flow unloading	00:01:49	00:02:52	00:02:43
4P partial unloading	00:02:50	00:05:45	00:04:58
Salmon unloading	00:02:30	00:03:10	00:03:00
Total unloading	00:01:35	00:02:07	00:01:50

The average value of all the observations made was approximately 2 minutes and 50 seconds per pallet. In compliance with the norms and procedures implemented, this average value should be maintained throughout the year.

4.2 Production

4.2.1 Production Lines

With the new layout of the production lines and the standardization of the tasks, there was an increase in line productivity of approximately 54%, in relation to the old production model. Line productivity was provided by the number of labels printed on the production line per hour of production. Each printed label represents one crate. Productivity was calculated over two weeks and the mean of these observations was then compared with the average productivity of the old system. For reasons of confidentiality, it was decided to present only the productivity increase in percentage, not the absolute values.

4.2.2 Bivalve Process

In the bivalve process, the main change was the identification method. In the past it was operating in a PBS system with a productivity of 21sec/kg (Source: CDP, 2016), later it changed to PBL with an increase of productivity of the approximately 16sec/kg, and currently with the introduction of the new system, productivity is, on average, 12 sec/kg. These values were extracted based on the measurement of times over eleven weeks.

The productivity increase with the new identification system is significant, being approximately 75% when compared to the old procedure in PBS and approximately 33% in relation to the identification in PBL.

4.3 FDC Crates System

With the elaboration of the new analysis for the crates system, it became possible for the FDC to have a higher control over the crates flow. This study allowed to identify several seasonalities in the delivery of the suppliers and in this way to better control the allocation of crates to each of them according to the time of the year. Currently, FDC does not only know the quantity and range of boxes it needs to send to each of its suppliers, but also the average time each of these crates take to return to the FDC. In this way this process has become more efficient and cost-effective, minimizing the risk of FDC holding more crates than what it actually needs.

5. Conclusions

The present case study of the Master Dissertation was carried out at the Fish Distribution Center of Sonae MC, and its main objective was to increase its productivity through the application of Lean methodologies and tools.

In order to apply the Lean Philosophy, first several Gembas walks were carried out in the field in order to collect the necessary data through meetings with the responsible personnel, videos of processes, meetings, among others. The analysis of these data together with the mapping of it allowed to have a better view of the material flow in the FDC and, in this way, to identify the waste and the opportunities for improvement that it presents.

After identifying the opportunities for improvement, in production and in intake, as well as the Lean strategies and tools to implement, suggestions were made for improvements in each one of the sections. In the intake, the SMED tool was applied, which allowed change the current labelling system, the levelling of the suppliers delivery was carried out and the models of product unloading were also standardized according to the type of the suppliers. Consequently, the time per pallet in that area was reduced, allowing an average time of 2 minutes and 50 seconds per pallet. In Production, the change in the layout system coupled with the elaboration of

OPL's, allowed a productivity increase of approximately 54%. Still in production, the bivalve process identification system was changed, from a simple PBL process to a new PBL process with identification, and which, in turn, allowed to increase productivity by 33%. It is important to note that all standardizations were made taking into account the 5S principles, always ensuring a clean and organized working place.

Regarding the FDC´s crates system, two analysis were made, being investigated the crates quantities delivered per each supplier and also the cycle time of each crate that leaves the FDC to the stores or suppliers. In this way, it was possible to have a better view on suppliers needs, identifying seasonalities and allocating FDC's crates more efficiently.

It was also implemented a Process Confirmation, where two checklists were created, one for the production and the other for the intake in order to allow the supervisors to have a higher control over the correct execution of the procedures implemented in all the processes.

The accomplishment of the initial objectives stipulated for this Master's Dissertation, allowed to implement improvements to the FDC that not only increased its productivity, but also enabled entire team to work together for a single purpose, inducing a climate of proactivity.

6. References

Abreu, M. F., Alves, A. C., & Moreira, F. (2017). Lean-Green models for eco-efficient and sustainable production *Energy* 1,1-8. https://doi.org/10.1016/j.energy.2017.04.016.

Alcaraz, J.L.G, Maldonado, A.A., Iniesta, A.A., Robles, G.C., Hernández, G.A. (2014). A systematic review/survey for JIT implementation: Mexican maquiladoras as case study. Computers in Industry 65, 2014, 761–773.

Almomani, M. A., Aladeemy, M., Abdelhadi, A., & Mumani, A. (2013). A proposed approach for setup time reduction through integrating conventional SMED method with multiple criteria decision-making techniques. *Computers and Industrial Engineering*, *66*(2), 461–469.

Baykoç, Ö. F., e Erol, S. (1998). Simulation modelling and analysis of a JIT production system. *International Journal of Production Economics*, 55(2), 203–212.

Dombrowski, U., Ebentreich, D., & Krenkel, P. (2016). Impact analyses of lean production systems. *Procedia CIRP*, *0*, 607–612.

Fullerton, R. R., McWatters, C. S., e Fawson, C. (2003). An examination of the relationships between JIT and financial performance. *Journal of Operations Management*, 21(4), 383–404.

Lystad Erik, Ferguson Mark, Alexopoulos Christos, (2006). Single stage heuristics for perishable inventory control in two-echelon supply chains. Gorgia
College Management.

Knechtges, P., & Decker, M. C. (2014). Application of kaizen methodology to foster departmental engagement in quality improvement. *Journal of the American College of Radiology*, *11*(12), 1126–1130.

Maarof, M. G., & Mahmud, F. (2016). A Review of Contributing Factors and Challenges in Implementing Kaizen in Small and Medium Enterprises. *Procedia Economics and Finance*, *35*(35), 522–531.

Melton, T. (2005). The Benefits of Lean Manufacturing: What Lean Thinking has to Offer the Process Industries. *Chemical Engineering Research and Design*, 83(A6), 662–673.

MĺÍkva, M., Prajová, V., Yakimovich, B., Korshunov, A., & Tyurin, I. (2016). Standardization one of the tools of continuous improvement. *Procedia Engineering*, *149*(June), 329–332. https://doi.org/10.1016/j.proeng.2016.06.674

Mourtzis, D., Papathanasiou, P., & Fotia, S. (2016). Lean Rules Identification and Classification for Manufacturing Industry. *Procedia CIRP*, *50*, 198–203.

Nunes, L., (2015). Integration of Ergonomics and Lean Six Sigma. A Model Proposal.

Sazvar, Z., Mirzapour Al-e-hashem, S. M. J.,
Govindan, K., & Bahli, B. (2016). A novel mathematical model for a multi-period, multi-product optimal ordering problem considering expiry dates in a FEFO system. *Transportation Research Part E: Logistics and Transportation Review*, *93*, 232–261.

Shingo, S. (1985). A revolution in manufacturing: The SMED system. Cambridge, MA: Productivity Press.

Womack, J. P., Jones, D. T., e Roos, D. (1990). The Machine that Changed the World: The Story of Lean Production. New York: HarperCollins Publishers.

SONAE (2015). Consultado em 30 de Março de 2017: https://www.sonae.pt/fotos/publicacoes/20160412_sonae_ppt_institucional_fy15_pt_454889461572d2cbff02cd.pdf.