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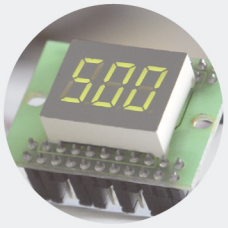


INTER-DEPARTMENTAL COMMUNICATION: APPLICATION OF LEAN MANUFACTURING AND AS IS; TO BE PROCESS ? A CASE STUDY

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INTER-DEPARTMENTAL COMMUNICATION: APPLICATION OF LEAN MANUFACTURING AND AS IS; TO BE PROCESS – A CASE STUDY

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Dissertation submitted to obtain the Master degree in Systems and Industrial Planning

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I would like to specially thank my parents, who educated me as they did and always supported and believed in me, even when they didn't have reasons to believe. This achievement is specially for them and, hopefully, for better times that are still yet to come. To my grandparents which were there for me in the most difficult times I've faced. I would also like to thank my brothers for, indirectly, influence me to strive to be better, by being there to show me what I have to do to succeed.

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A special acknowledgment to Syntegon, specially to my manager Guido Reijnders who gave me this opportunity and the tools to conclude my studies with a project inside the company.

Last but not least, I would like to finally thank my supervisor at Instituto Superior de Engenharia do Porto, Dr.ª Susana Nicola for all the tireless help and support.

Abstract

Three words characterize the current world in every organization: instability, uncertainty and survival. The competition is increasing every day, and the companies have to develop strategies that make them more attractive when a customer is making the decision about whom should he buy products from. Since sometimes the products are equivalent independently of the brand, a better customer service is usually a trigger point for the customer, and usually a good customer service is followed by good and efficient communication ways.

The specific goal of this thesis was to enhance and create a solid and trustworthy platform to communicate between colleagues and departments, improving the customer service in terms of costs and time, and make sure that quality is guaranteed independently on the technician that does the job.

This project was done at Syntegon Weert, in the Netherlands, and had as main goal the improvement of the department's organization.

Therefore, in order to achieve the goal of the thesis and optimal communication ways to improve the quality provided to the customer, this work focus on the creation of a Frequently Asked Question webpage that can support the technician every time he faces a bottleneck during a project. The creation of standard procedures that guarantee that every technician act based on the same fundamentals principles which should originate similar results, as well as provide equal instructions to the customer. Also, the creation of a platform where data can be inserted in order to make the procedures more transparent, guaranteeing inter-departmental organization, facilitating the creation of standard procedures as well.

Keywords

Packaging Industry, Jira Kanban, Lean management, Continuous improvement, As Is/To Be, Jira

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Acronyms

I&C – Installation and Commissioning

SOP – Standard Operating Procedures

MSA – Manufacturing Sector Assembly

CSJ – Cross Seal Jaws

LS – Long Seal

PANL – Packaging Netherlands

PHS – Polyethylene Heat Seal

FSE – Field Service Engineer

SAT – Site Acceptance Test

FAT – Factory Acceptance Test

VSM – Value-stream Mapping

FAQ – Frequently Asked Questions

PM – Project Manager

1. INTRODUCTION

1.1 CONTEXT

A strong organization, with a unified workforce engaged in a common vision, it can only be achieved with quality in internal communication between departments. A clear and effective communication between departments, especially inter-departmental communication, is a key asset of several organizational functions that help to keep any enterprise efficient and productive.

When technicians or workers of an enterprise don't know exactly what to do, they may waste time either trying to understand what the problem is or waiting for further instructions. "The importance of communication between different departments in an organization becomes most evident when that communication breaks down. Implementing policies to strengthen inter-departmental communication help to underscore its importance and maintain an efficient flow of information." [1]

The use of Lean manufacturing methodology and its concepts, applied to the information process between departments aims to reduce waste, which makes the flows transparent, leaner and simpler. “Lean information is a new strand of lean concepts and applications.”. [2]

The objective of this dissertation is to create standard procedures, increase the efficiency of communication between departments, build trust between teams and as a result a better customer service quality.

The student will use the lean manufacturing concepts applied to the communication and information and the As Is To Be process. In the As Is process the student will identify and evaluate a business current processes outlining the current state of the processes and any gaps or issues that need be solved. The To Be process management will map the documentation that the organization pretends the process to look like.

This study was done in an enterprise with real data.

1.2 OBJECTIVES

In order to facilitate the introduction of new employees on a department, and to guarantee the same quality and procedures in every project, whoever the engineer is, as well as avoid committing the same mistakes over and over again, this project will be based on creating standard processes and improving the communication between the machine assembly department, the machine installation and commissioning department and the project managers department. To make it possible, three main objectives were chosen to be analysed and discussed.

Below, will be specified the main objectives of this thesis, namely: development of a frequently asked question webpage (FAQ), development of standard procedures for a field service engineer (FSE) and the application of a feedback loop tool for process management.

1.2.1 DEVELOPMENT OF A FAQ

FAQ, which stands for Frequently Asked Questions, is a tool that offers an organized list of particular topics and their answers, making it possible to create a standard answer which allows the company to provide a faster solution and prevents at the same time the creation of bottlenecks.

This can also be a tool used internally. How many times does a technician have a doubt that was someone's doubt before? By having a FAQ, the goal focus on reducing the time that sometimes a technician has to wait in order to have an answer, avoiding stuck points that might delay a project, as well as reducing his dependence towards another technicians or the helpdesk.

1.2.2 DEVELOPMENT OF STANDARD PROCEDURES FOR FSE

In order to be able to provide a guaranteed quality service, the procedures should be standard, which means all the employees should provide the same kind of service instead of having completely different systems to apply. By applying standard processes, the risk of errors will naturally drop and it makes it easier to control the project status and to apply corrections in case they are needed. Not having Standard Operating Procedures (SOPs) means everyone will do what they think it's the right thing to do, which usually differs from each entity – therefore a task procedure will vary according to who is undertaking it.

In practice, try imagining the present world without SOPs. Would you fly on a plane without a standard checklist to be verified before departure? Or would you drive a car which manufacturers wouldn't have standard procedures to assure quality? Would you buy a machine without a previous checklist filled that could assure its proper functioning? The reality of several organizations is that they just lack in standard protocols, that may result on profit lost, low quality service and products, waste of time and resources, and so on. By applying step-by-step processes and standardizing all of them, a company is assuring a quality seal, as well as an efficient service provision, since the job will always be done the same way, independently of who is doing the job. Clearly documented procedures and

checklists will allow the employees to reduce the chances of mistake and will also offer a better control of the project.

By having SOPs applied on a certain company, one is able to guarantee that:

1. A company offers standardized processes which also provides consistency;
2. Everyone is able to replicate a certain process which allows a company to grow in an organized and sustainable way;
3. New employees will take less time to learn which will increase its productivity;
4. With a standard *modus operandi* and a step-by-step process it's possible to assure that a process will continue if tasks have to be delegated;
5. Is easier to evaluate the employees performance.

1.2.3 APPLICATION OF A FEEDBACK LOOP TOOL FOR PROCESS MANAGEMENT

In a world during the pandemic caused by the virus Coronavirus COVID-19, where companies are trying to understand the new picture, adapting to these new realities and focusing on being more efficient in order to avoid resources wasting, a better interdepartmental communication might reveal to be crucial. In fact, at the same time this thesis is being written, an internal project is being developed with the name "Do it right the first time", which goal is to decrease the number of trips of a technician. This supports the importance of the development of a feedback loop tool, since it will make it possible to collect data, analyse it and understand why a certain project got delayed, and wasn't possible to do it right the first time. It will also allow the company to standardize issues as well as its solutions, in order to prevent that a certain delay will happen again.

A feedback loop will make it possible to continuously absorb, learn and apply suggestions in order to achieve a constant product/service improvement based on real life obstacles and their solutions. With this tool applied to a service, the technician is able to leave a feedback which would be analysed. After that, conclusions should be implemented and the loop should be repeated in order to constantly looking for improvements. A feedback loop

might also work as a reality check. The results of what is implemented and thought might vary from the reality, which can be verified through this tool.

In order to develop this tool, it should be divided by stages:

1. Gather information

First, information has to be collected in order to decide which subjects should be focused on. Whenever an obstacle is found during a service, this should be reported by e-mail, live chat, or in a direct space for feedback, in order to be gathered, analysed, and answered;

2. Learn

After collecting the necessary data, this has to be analysed by listing this data by frequency and importance and trying to identify the causes to be able to look for the solutions. After studying the causes, one should be able to make conclusions and figure out what to be applied to eliminate those obstacles.

3. Apply

Once the solutions are drawn, these should be applied to the process. Small changes are advisable, since they are easier to be applied than big structural changes and they are also more controllable. Once they are applied, the manager should go back to step 1, and continuously focus on improving the product/service.

1.3 PROJECT PLANNING

It is possible to observe the planning referent to this project in the attachments at the end of this thesis, at Annex A.

1.4 REPORT SCHEME

This master thesis is divided in six chapters.

It starts with a small introduction of the theme, contextualizing the problem, where the objectives of the report are clarified which promotes a better comprehension of the report to the reader. In this chapter, it will also be present a project planning which gives the reader an understanding of the project schedule.

The second chapter will be about the industrial area where the company is inserted in, what kind of products does the company develop, an overall idea of its technology and the pros and cons that the company is, and will be, facing in a short-term future, and it will finish with a background description of the company on which this thesis was developed.

To contextualize the reader about the methodologies that are being studied during this thesis, the third chapter will consist in a literature review of the tools that can be used so as to achieve the desired results. Some of the described tools will not be used in the solution of the raised problem, but they give an idea to the reader that there is a wide range of management tools that can be used towards the same problem, depending on the manager choice to decide which methodology will be applied towards a certain topic.

The fourth chapter will describe traditional and agile planning methodologies, focusing on the differences and the pros and cons of each. In this chapter a project management tool, JIRA, will also be explained since there will be an attempt to implement the functionality of this tool on the company where the issue is being studied.

The case study chapter, the number five, is where the questions will be raised and analysed, in order to look for the desired solutions accordingly to the tools chosen to be applied on those different matters. Therefore, the fifth chapter will be responsible to find out the answers and at the same time start to apply them to verify the outcome of the implemented strategies.

Lastly, the sixth chapter will be about a description and an opinion based on the outcome of the applied strategies.

2. TECHNOLOGY SECTOR AND CORPORATE BACKGROUND

2.1 MECHATRONICS

Every innovative development is followed by the increasing of the complexity of the modern products. Alongside with the increase of the products complexity, it is evident that the research and development efforts for the next generation of products also become more complex. To be able to keep up with this natural evolution and give a proper solution, new technologies were developed, where conventional mechanical approaches were supplemented with new electronic and software-based approaches, creating a new multidisciplinary field that combines mechanical, electrical and computer engineering known as mechatronics [3]. This hybrid engineering demands a deep technical knowledge, as well as sharpen soft-skills to be effectively work in the diverse teams that usually surrounds it. Simply speaking, mechatronics is a multidisciplinary field that combines mechanical, electrical and computer engineering, which skills are required in advanced automated manufacturing industry. This hybrid technology is used to create simpler and smarter systems with economic advantages by unifying all of these subfields, and it is used in several industries as manufacturing, mining, aviation, robotics, and packaging industry.

Mechatronic engineering, is one of the numerous branches of engineering that is been around for some time, but it was only recognized as its own field classification recently. The term was created in 1969 by the Japanese engineer *Tetsuro Mori* [3] to relate the symbiosis that exists between the electrical control systems and the mechanical components they control and regulate.

The mentioned technology is used in systems where a mechanical movement occurs once electrical inputs/outputs are read by a PLC (Programmable Logic Controller), which are tasked to control and monitor several sensors and actuators. This system can be described in a way that a manual switch (input) is considered an electromechanical constituent

because, when pressed (mechanical movement), it will create an electrical signal (output), that will be read by the PLC and therefore a sequence of events will be triggered. However, the opposite might also happen. So, the electrical signal may behave as an input (sensor, counter occurrences, or timers) that will provoke a mechanical movement (output). Below, in Figure 1 - Mechatronics System Design, it is possible to observe how is a mechatronics system behaves.

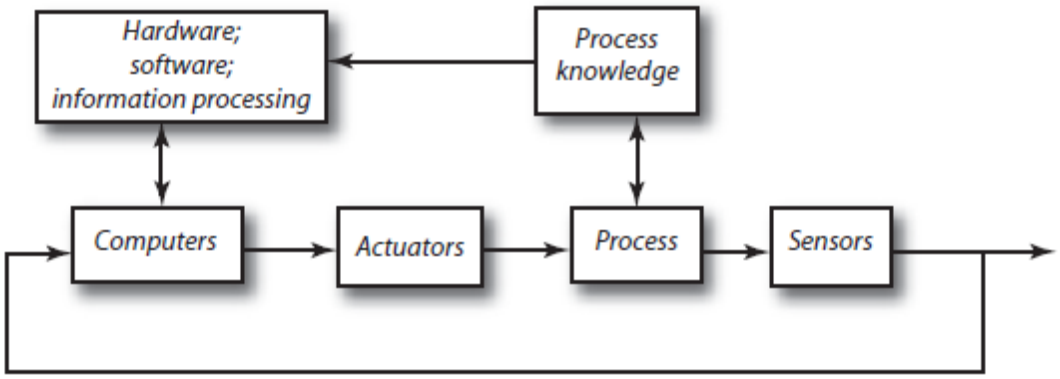


Figure 1 - Mechatronics System Design [4]

2.2 PACKAGING INDUSTRY

Packaging industry is the technology, science and art of protecting and preserving products for distribution, storage, sale and use [5]. This technology focus on designing, evaluating and producing packages. Beside the protection and preservation given by the package, which assures a good quality of the product until the end of its validation time, it has also a marketing importance, and is responsible to provide information about the packaged product.

It's an extremely important industry because, beside assuring the product quality, the package cost influences the whole production chain from the stock until the transport to the retailers, ending up influencing also the final customer, who prefers more visual attractive packages, if the price remains untouched.

Walking through a supermarket, or in normal life routine, how many packages can be seen around? While this paragraph is being written, a walnuts doy-style bag can be seen on my table, a package with a pre-made salad and a package that came with the trousers I bought online. Packages are so normal in our everyday life and that is why it is a giant industry which was driven by a century of continuous improvements and clever design solutions, since the famous Tetra Pak and bubble wrap in 1950, to the plastic bottles in 1970, which highly interfered with our lives comfort [6].

The development of this technology allowed global economy to grow up since the brands were able to safely transport their products, guaranteeing the demanding quality, all over the world. In the other hand, packaging technology also has to be able to assure the e-commerce needs, which makes this technology even more important. So, allowing companies to send their products overseas with completely different environments, the packaging materials had to develop as well, and with the enormous offer there is in the market nowadays, packaging has become essential to branding and product design, like enjoyable unpacking experiences, nice and attractive package shapes, colourful film layers, in order to stand out.

Each individual package film is cheap, but collectively thinking, all the plastic packages, bottles and cans represent a giant business that keeps on increasing, with optimistic predictions. McKinsey [6] predicts a growing rate of 3.1% annually until 2022, where 70% of this grow comes alongside the emergent markets, where a recent middle class is starting to show up and looking forward for the convenience that the packaging industry provides in our daily routine. While in North America the predicted growing rate is around 1.2% annually, two of the major emergent markets, China and India, are predicted to grow 5.2% and 5.8% annually. It's easily explained by the fact that the retail sales in China are growing quickly and are already 80% higher than in the USA. Today, it is an industry that represents $900 billion in annual revenues worldwide according to McKinsey, which is about half the size of the global footwear and apparel industry. Although consumers are starting to realize how unsustainable packaging is, this industry keeps on growing to face consumers demands.

Despite of the consumers being more aware of the environmental consequences of the packaging comfort, McKinsey also reports that majority of the final consumers are not ready to embrace environmental protection, paying more for sustainable packaging. Therefore, it will be up to the companies to research and develop more sustainable solutions without causing an undesirable price increasing. This is already happening, and nowadays the retailers and the brands are trying to use paper solutions, hybrid solutions made up of plastic and paper layers and they are trying to package with a higher percentage of recycled materials.

This is a big challenge for the brands, the packaging machines producers and all the packaging constituents' industries (i.e. film producers), since environmental consciousness is a must, but at the same time consumers are demanding more and more convenience packages. With all the daily rush we all are submitted, more comfort is required and therefore more packages that make our lives easier are consumed. Ready microwave meals, resalable food packages are just two examples that show how much the demand of this products is expected to grow worldwide, fuelling the packaging technology further.

The consulting group mentioned above also alerts that, by 2025, 250 million tons of plastic will end up on the oceans unless companies and governments develop solutions for this pollution crisis. This means that for each 3 tons of fish, there will be 1 ton of plastic. It is already known that this fishes usually mistake plastic for food, which might kill them. If it doesn't kill them, they might end up in the food chain and that is why some studies are already showing that tiny amounts of plastic are already being consumed by humans.

2.2.1 PACKAGING PURPOSES

In all industries involving packaging technology, there are several purposes for packaging. In most times, packaging has a major importance in marketing strategy since it helps glamorizing a product which will cause more attention from the customer. A bag product is literally the product identity and many customers will judge a product based on the message received from the product's package. So, even when the customer isn't aware of a determined product, the package will have a big importance on the customer's decision.

One of the most known package identity cases is the *Coca-Cola* bottle. An automatic recognizable logo with a unique shape, which drove the product to worldwide fame. Sometimes, the packaging is the main product popularity and it might mean that the package it's more expensive than the product packaged. So, packaging should be considered among the four P's of marketing mix: product, place, promotion and price [7].

So, considering that the majority of the products are selected and bought based on emotions, especially when a customer is not loyal to a certain product and must choose between two products, it doesn't surprise if some companies become experts on the art of aesthetics.

Beside the marketing aspect, there are other prominent purposes:

- **Safety**
    - **Physical Safety**
        - By holding a product, the package guarantees that the product is safe from external factors, preventing the product to be contaminated by humans' hands, mechanical shocks, vibrations, temperature.
    - **Barrier Protection**
        - Some kind of products need to be provided with barriers to oxygen, water, dust, etc. Some products should be leakless to help keeping the product quality and to extend their shelf life. With this kind of protection, there is the guarantee that the product is clean, fresh and sterile and, therefore, safe for consumption until the end of its validation time.
    - **Containment or Agglomeration**
        - Some small objects are typically grouped and packaged together, for storage and selling efficiency. 1000 cookies in one package require less space than 1000 individual cookies.
    - **Information Transmission**
        - Usually packages also inform the customer of how to use the product, how to transport, recycle. Some types of information are imposed by the governments in some industries like

pharmaceuticals, food and medical. Track and trace purposes, serial numbers, and expiry/best-before date are indicated on the packages.

- **Security**
  - Packages can be provided with solutions that help reducing counterfeit, theft and resale of the products. Sometimes packages include authentication seals and security printing. It is also not possible for the retailer to sell less quantity than it says in the package.
- **Convenience**
  - Packages might be built with some construction details that offer a better distribution, handling, display, opening, reclosing, recycling, etc.
- **Portion Control**
  - In order to control abusive consumption, a package might be a single dosage or serving. Some products, like salt and sugar, might be packaged in small single doses to be taken individually.

2.2.2 ENVIRONMENTAL CONSIDERATIONS

Environmental sustainability should always be one of the biggest concerns of every industry. We all are aware of the problems we are facing, and that we will face in the future, related to pollution, and the packaging industry is one industry that contributes a lot for plastic pollution. Therefore, there's an extreme urgency of controlling the unnecessary waste and finding solutions and alternatives for the amount of plastic used and wasted with every package.

This is a responsibility for governments, packaging machines producers, the packaging machine users, and for last, it's a big responsibility for the product consumers also. A better and more sustainable package also means a more expensive price which has to be absorbed by the final customer.

In order to reduce the footprint of this technology on the future, there are several strategies that we all should keep in our mind.

- **Prevention**
    - Waste prevention already means less pollution. It should be always the first step. By prevention, on this case, it's meant that packages should only be used if that is the only solution. A proper packaging will prevent waste, since it plays a big role on avoiding loss or damage to the product inside. So, if the package fails on preventing the protection to the product, the energy and material consumed will be only waste.
- **Minimization**
    - If and when well analysed, the mass and volume of the product to be packaged will influence the size of the package. When this measurements are correctly done, it is possible to reduce the packaging material.
- **Reuse**
    - Returnable packaging are useful and economically viable for closed loop logistics systems.
- **Recycling**
    - This is the act of reprocessing used materials into new products. Usually the recycled materials are steel, aluminium, papers and plastic.
- **Energy Recover**
    - In order to recycle some materials, they are incinerated. It is possible to use the heat created during the incineration as energy for some industries.
- **Disposal**
    - For some materials it is possible to incinerate them or place them in a sanitary landfill. However, there already some regulations that forbids this procedure because some materials might be toxic and have the potential to contaminate emissions and the ashes from the incineration.

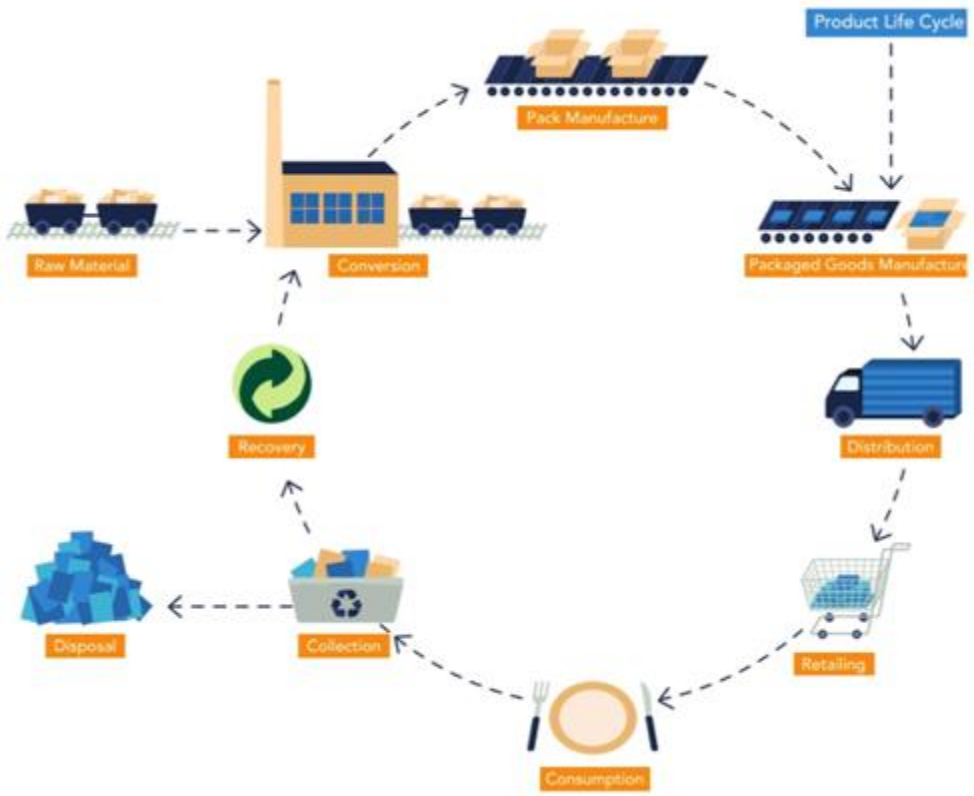


Figure 2 - The Packaged Product Life-Cycle [8]

As shown above, in Figure 2 - The Packaged Product Life-Cycle, in order to achieve sustainability in the packaging industry, packaging should:

1. Be designed based on the product, in order to optimize its performance;
2. Be made with sustainable sourced materials;
3. Be designed to be function effective, and safe during its all life cycle, in order to assure the product quality;
4. Meet the demand criteria for performance and package cost;
5. Meet the costumer expectations, choices and still attract the customer to buy the products;
6. Be able to be recycled and completely recovered after use.

2.3 SYNTEGON PACKAGING SOLUTIONS B.V. (FORMER ROBERT BOSCH PACKAGING TECHNOLOGY GMBH)

Bosch Packaging Technology, funded in the year of 1974, is based near Stuttgart, Waiblingen, in Germany [9]. In 2018, the Bosch Packaging Technology division was employing 6100 associates, and is one of the leading suppliers of process and packaging technology worldwide. It is located in about 30 locations in 15 countries all over the world. Highly-skilled engineering teams research, develop and produce complete solutions for several different industries like pharmaceuticals, food and confectionary industries. These solutions are always followed by an exemplary and comprehensive after-sales service portfolio. Given that is a worldwide based company, customers are provided with local points of contact for sales and service, which makes the customers feel they can always rely on Bosch. In the fiscal year of 2018, the results showed that sales totalled around 1.3 billion euros. In 2020 Bosch Packaging Technology was sold and changed its name to Syntegon Packaging Technology.

With the Syntegon packaging machines, pharmaceutical and food manufacturers industries produce, fill, package, and control their final products that are consumed by people all over the world.

At Syntegon Packaging, packaging solutions are invented and developed to fulfil the customers' requirements, that aim to improve the customers and patients' lives. It is the company ambition to have a strong foot print in peoples nutrition and health, having at the same time a sustainable and future-proof solutions mind-set.

Bosch Packaging, now Syntegon, was under the Bosch umbrella which always showed to be a key advantage. As a differentiation from the competition, it was possible for the packaging specialists to offer an international network like the company-mother. The BOSCH Group is represented in about 150 countries with over 410.000 employees, and about 500 subsidiary companies, which means this is a huge and one of the top technology players.

2.4 SYNTEGON PACKAGING SOLUTIONS B.V. - WEERT

In 1966, Bosch acquired two plants. One based on Viersen, Germany and the second one Weert, Netherlands [10]. The plant in Weert is one of the oldest plants from Bosch Packaging and it's still in its max functioning, being the plant with the best results on the last year and one of the top players from the Packaging division. This is the Syntegon plant which the thesis will be based on.

This plant is specialized in development and production of vertical packaging machines in the food industry, for pourable like coffee, tea, flour, sugar, pasta, rice, cereals, nuts, candies, cookies, meat, etc. Bosch vertical packaging machines are shipped worldwide, to a large number of different customers, for a various number of products, including, for example, Mars, Haribo, Mondelez, and so on.

The organigram of Syntegon Weert can be analysed below, on the Figure 3 - PANL Organigram.

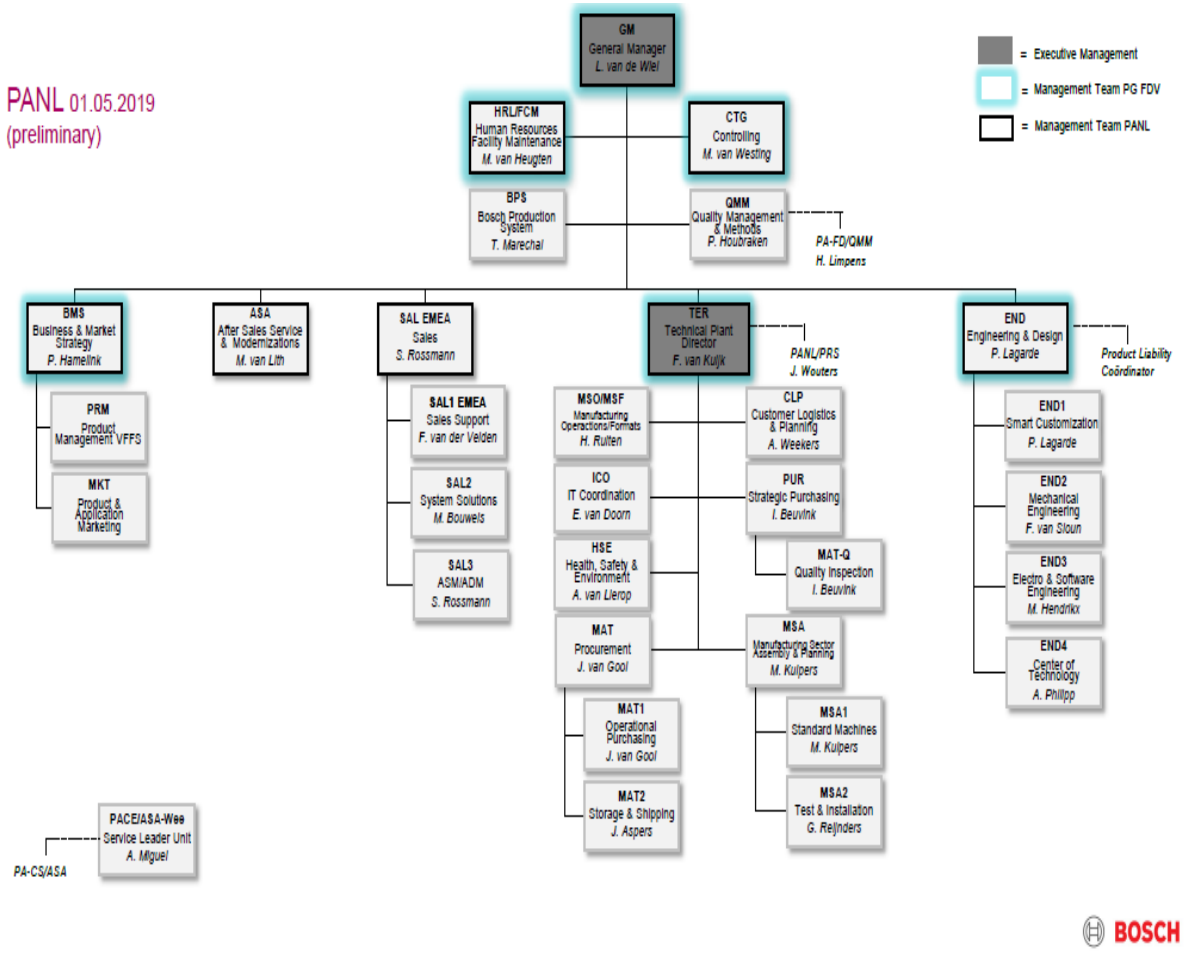


Figure 3 - PANL Organigram

During this thesis the Technical Plant department will be the one to be focused on. As it can be seen on the organigram, this department is divided in 7 sub-departments and the one where the study will be about is the Manufacturing Sector Assembly (MSA), more specifically MSA2.

2.5 MSA2

This department is the one responsible for the machine testing, and all its constituents, like printers, labellers, films, formats, etc., or the production line constituents, if the whole line solution is sold to the customer directly by Syntegon. A Packaging line might be constituted by an infeed conveyor belt, weigher, bagger, outfeed conveyor belt, check weigher, metal detector, cartoning machines, palletiser, etc. In order to guarantee the Syntegon standard

quality, this a normal procedure where usually a Field Service Engineer (FSE) check, adjusts the machine accordingly to the drawings and the customer expectations and prepares it for expedition, avoiding unexpected and undesired results that would have to be handled on a critically time, i.e., the customer site where there is a lack of necessary resources and wouldn't be easily acceptable by the customer.

After the machine is built by MSA1, electrically and mechanically checked, a Factory Acceptance Test (FAT) is done on site before the machine is shipped to the respective customer. This FAT might be done in a dry run mode, which means the machine will be making empty bags, without product, to provide the PANL (packaging NL division) with samples of the made bags, as well to demonstrate to the customer the quality of the bags made on Syntegon's site and good functioning of the bagger, as well as its constituents. In some cases, as per customer request, this FAT is done with product, which is a much more effective, efficient and reliable test to be done because the product highly-influence the quality of the made bags and the possible speed of the machine (bpm), facing all the conditions. In order to have the most possible accurate results, it is required to the customer the product which the customer will be using for this line, as well as the final and printed film, since everything will eventually influence the made bags, like the sealing temperatures, sealing pressures, sealing times, machine speed, product flow, film properties, film quality, and so on. Beside all this conditions, there's still the customer's site conditions like temperature, humidity, product infeed, etc.

The FAT process is described below, on Figure 4 - FAT Turtle Diagram.

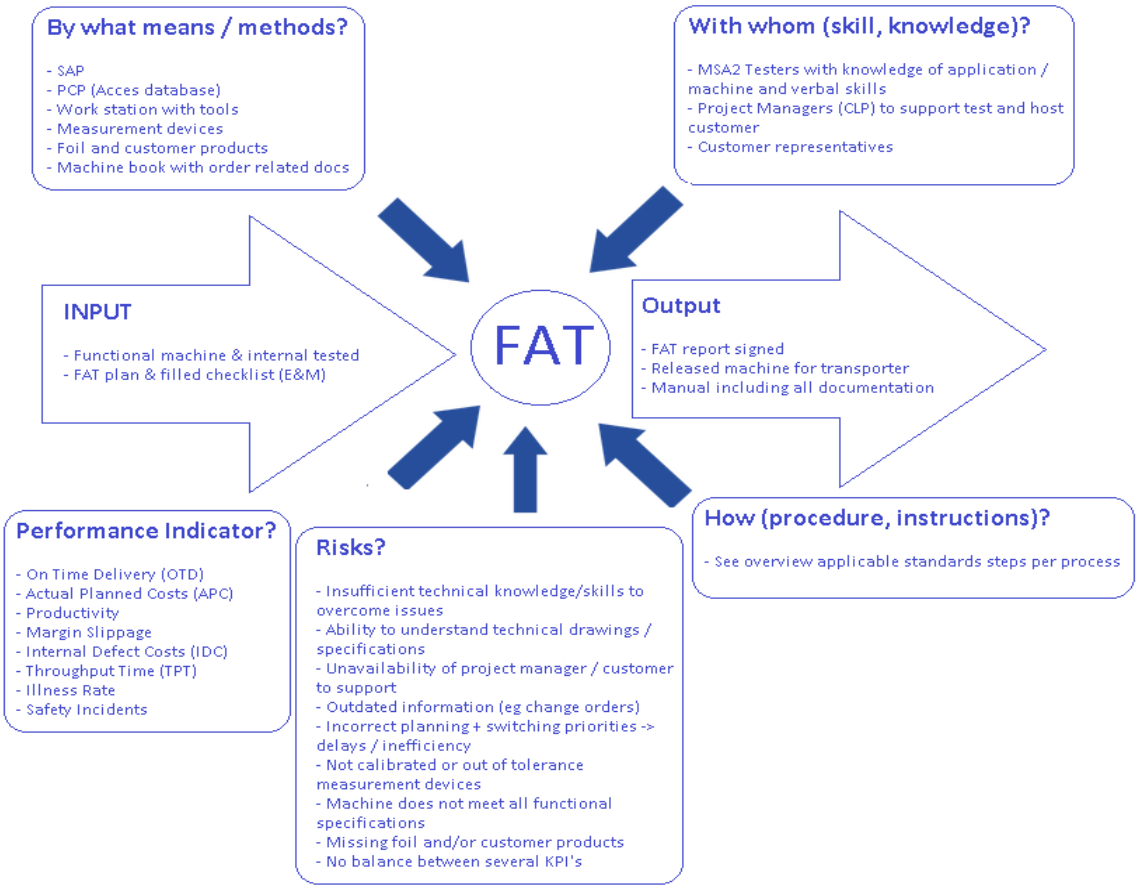


Figure 4 - FAT Turtle Diagram [11]

Once the FAT is done, and approved, by the customer, MSA 2 job is also concluded until the machine is shipped to the customer, where one of the department engineers will be meeting this machine.

The second phase of a FSE's job starts after he arrives to the customer and faces the machine on the customer's site. There, the technician will be working as a project supervisor if the solution sold is a solution constituted by several machine suppliers, that will be recognized as Syntegon's sub-contractors, as well as a Syntegon technician to install the packaging machines. Therefore, the FSE is expected to:

- Control and supervise the location of all the machines accordingly to the production line drawings;
- Electrically connect all the machines;
- Verify their correct communication via input/output tests;

- Do a dry run of the machine, with all the different formats in case there are different kinds of bags;
- Create, prepare and test all the different bags from the different formats;
- This tests depends on the product that will be packaged, since every product has its own regulations. So, the FSE must test the visual presentation of the bag, the measurement accuracy and, depending on what the product and industry demands, the FSE might also have to analyse the absence of leaks, the presence of a determined percentage of oxygen inside the bag, etc.
- Verify that all the production line constituents are operating accordingly and there are no flaws on the line;
- Save all the recipes for the different formats, kind of bags, and products;
- Give training to the customer;
- Be an efficient bridge between customer and Syntegon's project manager, with a good problem solving capacity, as well as a good ability to lead with conflict management, project and team management, in order to be able to go as much forward as possible with the project avoiding customer dissatisfaction and deadlines delays;
- Initiate, support and start of production and guarantee the customer is satisfied with the machine results, with Syntegon and with the project flow.

After all this procedures are concluded and the machine is ready to operate, a Site Acceptance Test (SAT) is usually required by the customer.

As the name indicates, a SAT is a test conducted on customer site to verify if all the requirements specified on the contract are reached. Usually it involves visual tests, leakless tests and production line performance tests. The main purpose of this test is to validate the end of the project. Visual aspects of the bag have to be accordingly customer desires, the bag has to fulfil the industry regulations, the production line speed has to be the same as optimized as possible and the percentage of success has to be superior than one previously determined by the customer and Syntegon.

The SAT process is described below, on Figure 5 - SAT Turtle Diagram.

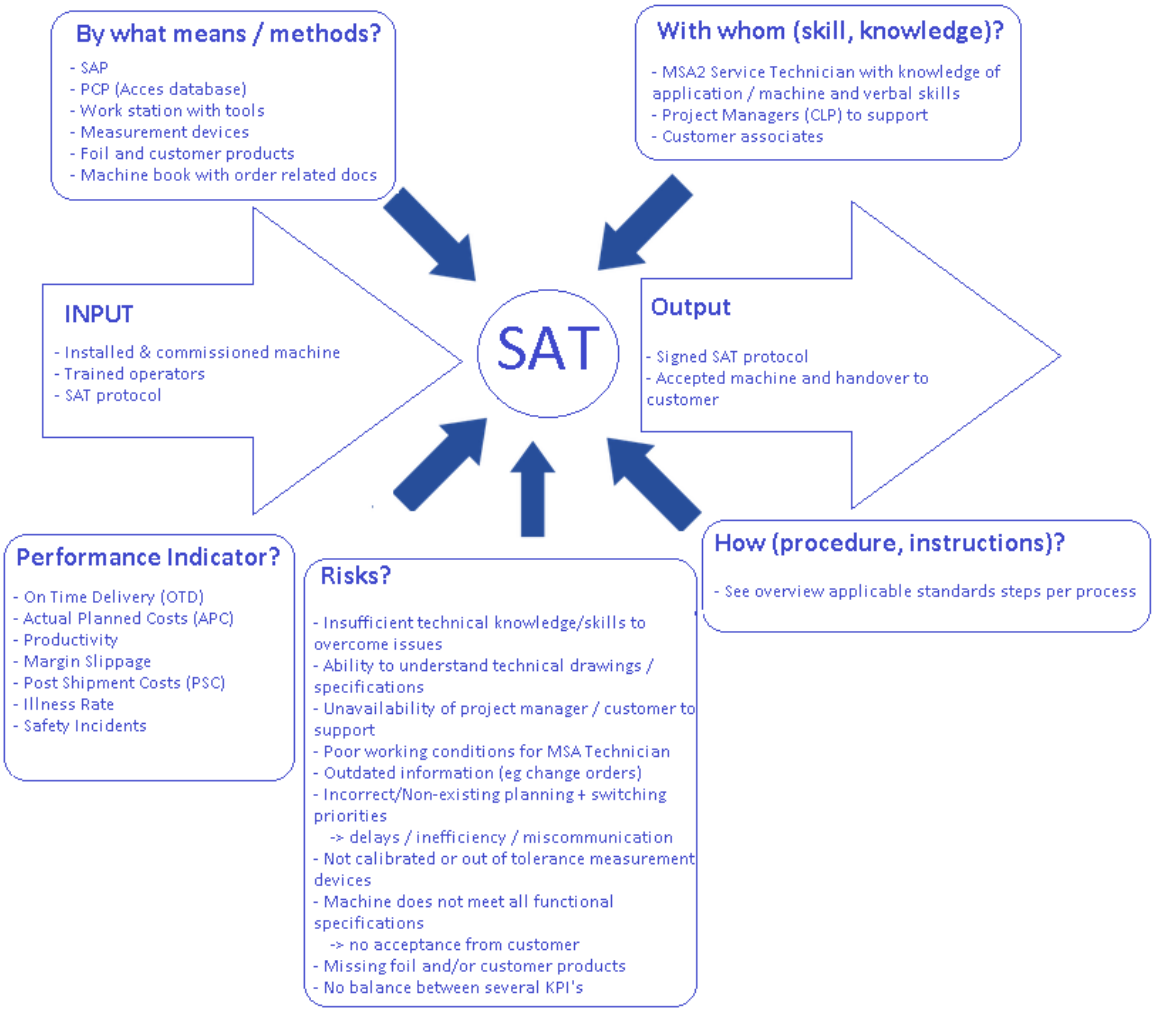


Figure 5 - SAT Turtle Diagram[12]

In order to conclude this project, after the SAT is approved by the customer and the project is finished at the customer's site, the FSE elaborates a report with all his comments about the machine, the possible delays and their reasons, the possible flaws and their reasons, as well as future solutions for recurrent or sporadic situations that are found during an installation and commissioning that might be solved before on Syntegon site while the machine is being built by MSA1, or when the machine is drawn by the Engineering & Design department (END) and ordered by the Customers Logistics & Planning department (CLP), or might be caused by the customer non-existent planning of work flow and production during the I&C. At the end, this are only obstacles that the FSE has to surpass in order to accomplish the expected results.

3. Literature Review

3.1 Lean Management

Based on the idea that avoiding needless costs could be more profitable than increasing sales, Lean methodology is a strategy management that focus on reducing waste, by making obvious what adds value, reducing and eliminating everything that doesn't, without sacrificing its productivity. "Waste is defined as any activity that does not add value from the customer's perspective. According to research conducted by the Lean Enterprise Research Centre (LERC), fully 60% of production activities in a typical manufacturing operation are waste – they add no value at all for the customer" [13].

So, while the customer defines what they are willing to pay for a certain product or service, the supplier is responsible to reduce and remove everything that doesn't add any value to the product through lean management, keeping the quality of the product by applying strategies that promote continuous improvements on the workflows and on the employee's working life quality.

Below, on Figure 6 - Two main pillars of Lean Methodology, it is described the pillars of the lean methodology, as well as the values on which those pillars rely on.

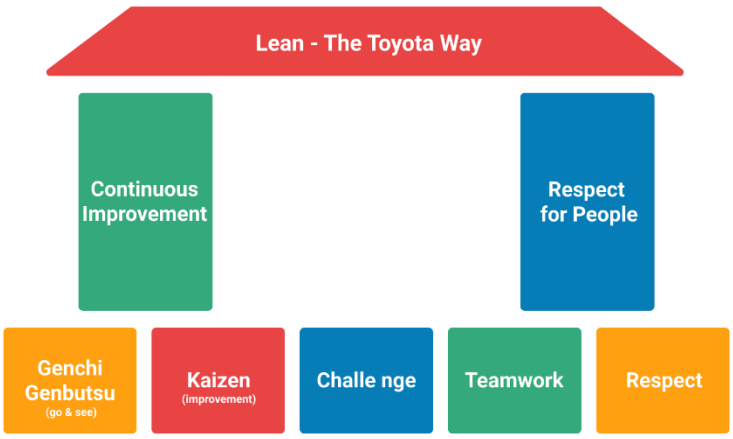


Figure 6 - Two main pillars of Lean Methodology [14]

It's a systematic method, developed in the Japanese manufacturing industry and it's also known as Toyota Production System (TPS) [15]. Although Toyota developed this methodology, whose responsibility was imputed to Taiichi Ohno [16], based on Ford's mass production line in Detroit, they didn't exactly copied the methodology but created their own "production system based on the continuous improvement of the production processes" [15]. In short, the Lean concept uses methods which goal is to ensure that the processes that are involved with a certain product remain cost attractive from the beginning to the end. So, it uses strategies that focus on reducing and eliminating time-loser details, effort or money. It is possible to do this by analysing the whole process and all its constituents, and then restructure the process or eliminate procedures that don't add any value to the customers. The Lean management basic principles includes [14]:

1. Define value
    - Customer's point of view of value lies in the solution provided to its problem, and it is the only part of the designed solution that he is willing to pay. More than that it's considered waste and noise. Therefore, after understanding what the customer's problem is, the first step consists on identifying what can be possibly done to solve it, with the less waste possible.
2. Value Stream Mapping
    - On this stage, a map must be elaborated where it is possible to represent the whole workflow. By doing this, the process can be divided in several small steps, and can also identify who's involved on it.

      By separating the whole process, it is possible to identify where the value is being produced and where the waste can be removed.
3. Create a continuos workflow
    - After successfully achieving the point 2, this step should focus on avoiding bottlenecks and interruptions, although they might appear from time to time when developing a new product/service. So, one must guarantee that the workflow keeps being smooth and, in case a roadblock appear, it should be easy to eliminate it by having the workflow divided in small steps.
4. Create a Pull System

- It is supposed to be guaranteed that, by having a stable and well defined workflow, teams are able to finish tasks with a higher speed and with less effort. To keep this healthy balance, a pull system has to be created. This means that, work should only be pulled if there is a demand for it. This way, it is possible to optimize raw materials and employee's effort as well as deliver product/services only when they are required.

5. Continuous improvement
    - Once the 4 previous steps are reached, the Lean management system is already built. However, the job is not finished. This is one of the most important principles in Lean Management, because this is the one that constantly solves the new problems that may occasionally occur. To encourage continuous improvement, team meetings should be done to identify problems, solutions and future obstacles.

3.2 JIDOKA & JIT

This control system was originated and implemented with many years of continuous improvements, with the goal of producing orders by the customers in a quicker way, in order to deliver faster the vehicles but at the same time keeping the expected quality. TPS was developed based on two different concepts [16]:

- *Jidoka* – which can be translated as "human influence automation", because the equipment would stop immediately if a problem occurred, avoiding the manufacture of defective products. Consequently one must eliminate the reason for the stop. As described below, on Figure 7;

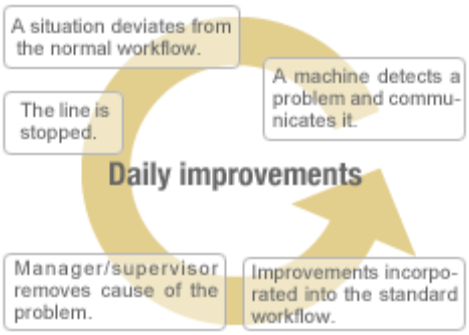


Figure 7 - Jidoka [16]

- Just-In-Time – which means that one process must only produce what is needed for the next process, when it is needed, in the right amount and in a continuous flow. To be able to fulfil a customer order in the quickest way possible, Toyota had to build the vehicle in a very efficiently way, in the shortest time possible, by following the rules below [16]:
    1. The beginning of the vehicle construction had to be addressed as soon as the order was received;
    2. In order to be possible to assemble any kind of vehicle ordered, the assembly line had to be constantly provided with the necessary stock;
    3. The assembly line must replace the used parts, reutilizing the same number of parts from the parts producing process;
    4. The previous process must be stocked with a small amount of all the necessary parts and only produce the same amount of parts that were used by the next processor's operator.

Based on this two methodologies, TPS is able to produce in an efficient and fast way, one product by one, in a continuous flow, filtering and removing waste and costs, and at the same time adding value to the production process, fulfilling the customer requirements.

3.3 3M's

For Toyota, the best way to achieve a Lean manufacturing is primarily focused on removing all the waste found on a process. For Lean, "waste" can be divided in three different kinds [17], the 3M's:

1. Mura – Japanese word for inconsistency, irregularity, no uniformity. It shows the differences seen in the peaks vs off-peaks demands. The application of just-in-time systems avoid this kind of waste;
2. Muri - Japanese word for impossible, too difficult. It shows that however difficult a process might seem, it can always be simplified through standardized work. As long as its quality is kept, every process should and must be reduced to its simplest state. This is achieved by reducing the process step by step, and combining all those small steps at the end, making it possible to be done by everyone, with higher quality and therefore reduced costs.
3. Muda - Japanese word for futility, uselessness, wastefulness. It is the most traditional description of waste, and it shows the seven main reasons of waste. Lately, talent, resources and by-products are being considered to belong to the *7 Muda* list:
    - **Transport** of the goods;
    - **Inventory** of the finished goods, work in progress goods or raw materials;
    - **Motion** of a person or a machine while operating;
    - **Waiting** time which reveals to be unproductive time;
    - **Overproduction** by producing something unnecessary for the moment;
    - **Over-Processing** by doing more than required;
    - **Defects** of all the rejected products;
    - **Talent** which means that the skills and knowledge of the employees is not being correctly used;
    - **Resources** overusing of resources;
    - **By-Products** not using leftovers that might result from some processes.

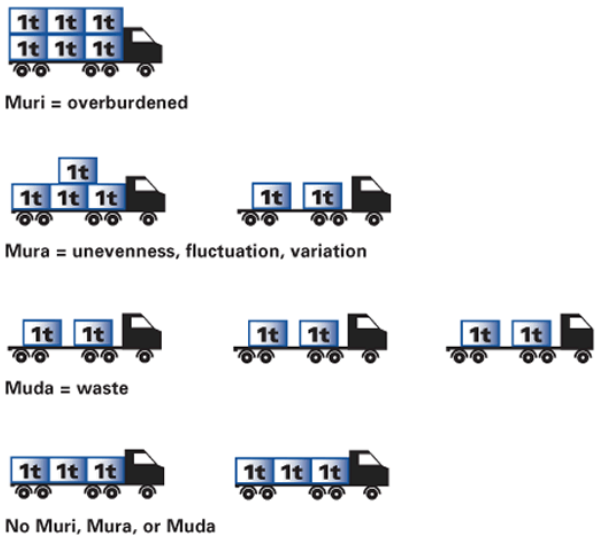


Figure 8 - 3M 94[18]

Above, on Figure 8, a representation of the three different kinds of “waste”, as well as a represention of a system with zero “waste”.

3.4 LEAN MANAGEMENT TOOLS

To be able to achieve a lean manufacturing, there are several different strategies to be applied that can lead a certain process to reduce its waste and, therefore, increase its value and consequently its profit. This waste reduction might be applied on the process itself, the surroundings of the process, the influencers of the process (human, machines or materials), etc.

There are dozens of different lean manufacturing tools that can be implemented in a business. These tools are seen the most effective when combined and applied all together as a whole, nevertheless sometimes just one tool might be able to solve the problem found by the company.

3.4.1 5S

A Japanese methodology known for its high efficiency when the goal is waste reduction while effectively increasing, at the same time, profitability, by organizing and cleaning the workplaces.

It is a Lean Management tool that, when efficiently applied, it will help to create and maintain an organized, safe, clean and efficient workplace. This methodology aims to improve a workplace organization, following the Lean principles, i.e., reducing waste and increasing efficiency. Although the 5S is a proved method, it shouldn't be the only company's improvement effort. This method should be seen as a key part of a larger continuous improvement journey.

The name is based on 5 Japanese words, and which one of them represents a step on the process [19].

Below, on Figure 9, a representation of the 5S methodology.

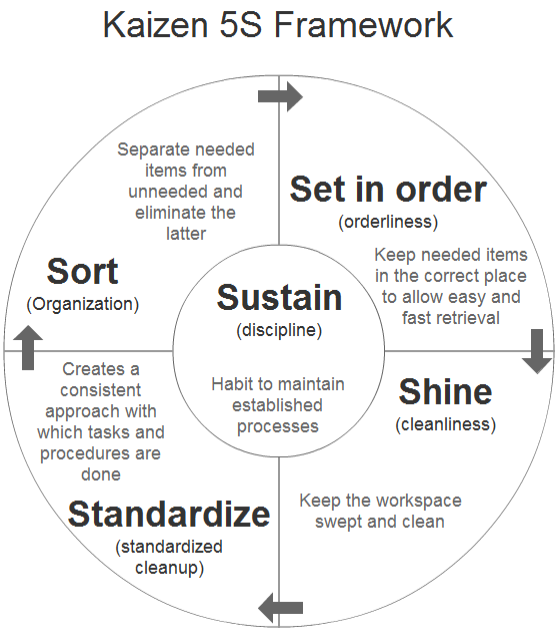


Figure 9 - 5S Framework [20]

3.4.1.1 SORT

In this step, one must define and separate what is needed and what is not needed in a certain process.

In order to correctly do this first step, the objects should be organized by their importance, from the most useful to the most useless:

1. What is always used – keep it in the working place;
2. What is frequently used – keep it nearby the working place;
3. What is occasionally used – keep it a bit away from the working place;
4. What is rarely used, but necessary – keep it in a separate place.
5. What is unnecessary – should be sold or eliminated because it's occupying space and limits the work efficiency.

This way, less time is lost while looking for an item, less distraction by having unnecessary tools around, more space available, and less obstacles.

3.4.1.2 STRAIGHTEN

On this step, it is important that it is easy to identify the different items and their locations, so that everyone can work autonomously by finding the different tools and returning them once they're not needed anymore. So, in order to make it possible, every item should be clearly identified as well as its location. Below, on Figure 10, an example of this concept at Syntegon's site.

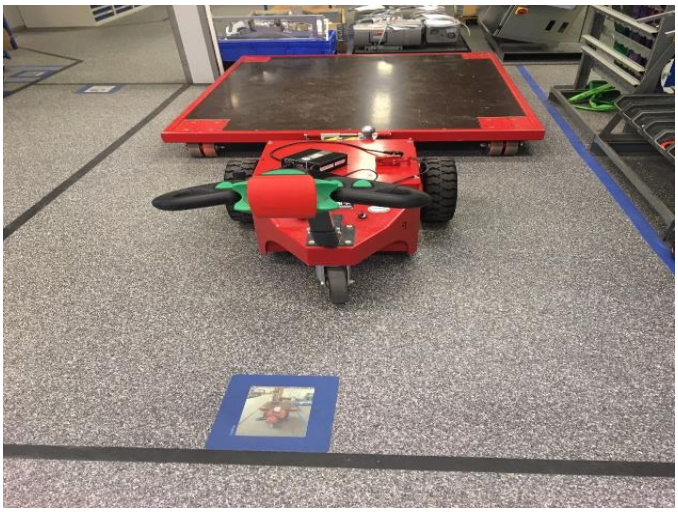


Figure 10 - Example of the Straighten concept at Syntegon Weert

3.4.1.3 SHINE

In order to keep the workplace organized and cleaned, one must clean, inspect and organize the workplace, tools and machinery on a regular basis.

- A cleaned environment provides quality and security improving, while reducing waste and preventing errors and defects.
- Keeps the workplace safe and pleasant to work in;
- Helps detecting mistakes.

3.4.1.4 STANDARDISE

In this stage, one standard rule should be created in order to guarantee that the 3 previous points are in accordance with the desired, by establishing procedures and schedules to ensure that the 3 points are being followed.

This can be done by making sure that everyone is responsible to keep their workplace organized and cleaned, and this can be guaranteed by the use of photos that help the employees to keep everything as it should be and via checklists.

3.4.1.5 SUSTAIN

Also meaning “do without being told”, guarantees that the employees are self-disciplined and are aware that this is part of their job.

This can be achieved by improving the communication between operators and supervisors, constant trainings and constant evaluation of the 5S’s progress.

3.4.2 KANBAN

Created by Toyota, by the already mentioned *Taiichi Ohno [21]*, it is a tool which goal is to create more value to the customer without generating more costs. In order to develop this tool, Toyota took a look to other stock systems, like supermarkets, where the customer buys the needed products, and doesn’t buy products to stock up. Therefore, the supermarket stocks the products they expect to sell.

It is known as a pull system, used to execute just-in-time manufacturing by limiting supplies and resources to what is needed for the immediate task, by defining upper limits to the work in progress inventory. This upper limit means that a work station will only do its activity in case the next work station gives the authorization for it, which avoids the overloading of the production lines, which also avoids over efforts of the employees and machines, as well as it prevents the company from buying unnecessary materials, making it possible to reduce its inventory, keeping it at levels that coincide with the actual consumption.

With Kanban it is possible to manage the workflow by visualizing who is working on what and where is the project at the moment. The team can focus on which task have to be done in the moment, making everyone rowing in the same direction.

So, besides being able to minimize stock levels, with Kanban is also possible to detect failures on the system, waiting and stopping times reduction and guarantees a good connection between all the work stations, making it also possible to reduce waste.

3.4.2.1 KANBAN BOARD

As represented below, on Figure 11, the Kanban board is a board that helps to visualize the workflow, by having on it what are the non-concluded tasks, maximizing efficiency. This board represents the project and it is divided in three parts: to do, in progress and done.

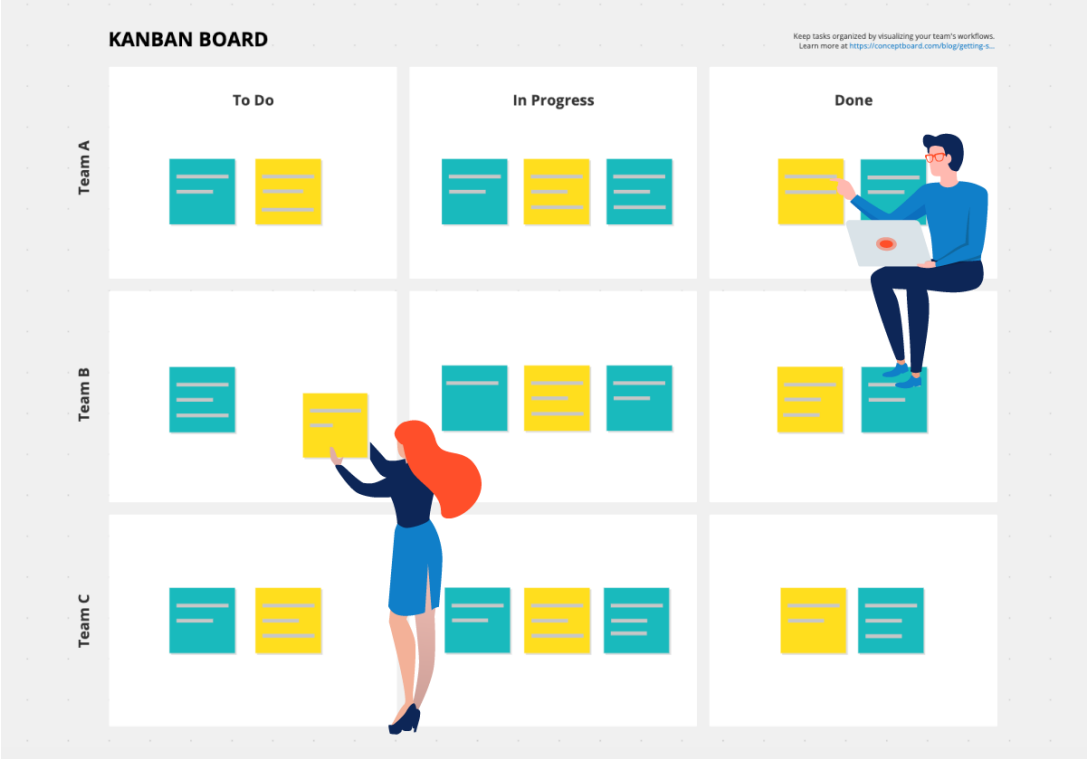


Figure 11 - Kanban Board [22]

This tool is so important because of its simplicity and ability to visualize the project status in a practical way. The three parts of the board are stages of the project that show which are the tasks of the teams, and managers are able to track the project progress, and also visualize which failures and where did they occurred.

3.4.2.2 PRINCIPLES OF KANBAN

To be able to implement this tool on a production system, there are 4 principles that everyone have to be aware of [23]:

1. Start with what you are doing now, without making any hasty changes. Changes should occur over time without being rushed;

2. Since changes shouldn't be rushed, this is an incremental process. Teams shouldn't have a lot of pressure to proceed with changes;

3. Roles and responsibilities of the different employees should be respected, and teams should identify and implement changes;

4. Acts of leadership should be encouraged, in order to keep optimizing all the processes;

3.4.2.3 CORES PRACTICES OF KANBAN

After implementing this tool, there are rules that have to be applied in order to guarantee the well-functioning of it:

1. Visualize workflow;

2. Limit work in progress, to verify that the teams finish their tasks quickly;

3. Manage and keep improving workflow, by analysing all the stages and solving bottlenecks;

4. Be explicit with process policies. Rules have to be known in order to improve a situation;

5. Implement feedbacks from employees, like review stages;

6. One has to be collaborative and experimental, in order to constantly keep pushing for improvement.

3.4.3 KAIZEN

Coming from a devastating situation due to the II World War, and without funds and resources to make large and radical changes, the Japanese companies were struggling to be able to face the demands from the market and satisfy the customers, so they needed to search, develop and promote improvements, by making small and strategic changes in every process. In order to achieve this, Masaaki Imai created the Kaizen philosophy.

Born in 1930, Masaaki is well known as a Japanese theorist and management consultant specialized in his work on quality management, specifically on Kaizen [24]. In 1985 he created the Kaizen Institute Consulting Group, in order to bring the Kaizen philosophy to the western countries. His contact with the western and eastern world, he was able to extract the best of the two worlds [24]:

- He understood that the western companies productivity was based on fast results, with the support on big technology changes, also evolving big investments. Although changes are seen in a short period of time and a fast economic growth is verified, the downside of this philosophies is that those improvements fade over time, since they require small effort to maintain;
- In the eastern companies, mainly Japanese, the goal is the application of small step changes instead of radical ones. The eastern culture is based on encouraging the employees on finding small process improvements which require small investments. This way, by focusing on a long-term change, they involve everyone in an organization. These changes may seem insignificant in a short-term but revealed to be fundamental on a long-term, with a low-cost but a high effort to maintain them. He found that this strategy promotes a slow, but sustainable, economic growth.

Kaizen, which is a junction from the word *Kai* (change) and *Zen* (good), basically means “change for the better”, i.e., “continuous improvement”, and it is a philosophy that focus on continuously improving operations involving all employees, promoting a high level of efficiency [24]. It’s a philosophy based on the rejection of the *status-quo* believing that everything can be improved focusing on small actions, by identifying issues and

opportunities and creating solutions to them, in a systematic and continuous way. For this, Kaizen is divided in 7 stages, as described below, on Figure 12.

Figure 12 - Kaizen cycle [25]

1. By gathering ideas from the employees, it is possible to identify issues and problems on a certain process;
2. With a list of problems identified, the organization can have a better structured idea of the current situation of the company;
3. By evolving everyone's solutions, it is possible to create a brainstorm of ideas with possible solutions for all the problems found;
4. After choosing a possible solution, it is possible to apply it and seek for improvements;
5. It is important to check progresses in a regular basis in order to verify if the changes are solving the previous listed problems;
6. If these changes are improving the processes, they should be standardized and adopted by the organization;

7. Since this philosophy is based on the rejection of the *status-quo*, this process should be repeated constantly in order to seek continuous improvement, since new problems might appear over time.

In order to correctly apply this philosophy in an organization, there are 10 main principles that should be adopted in order to achieve the right mind-set throughout the company [26]:

1. Every process on the company should be continuously improved;
2. Old fashioned concepts and mentalities should be forgotten by the employees;
3. Excuses aren't an option, and everything is possible to be achieved;
4. Reject the *status-quo*, implementing new methods;
5. If a defect is found, correct it;
6. Every employee of the company, from the CEO to the line operator, should be empowered and encouraged to be part of the problem solving;
7. Information and opinions should be gathered by everyone;
8. Always use the 5 Why Method, and ask 5 times to find the root cause before making decisions;
9. Economy is a keyword. By making small improvements, low investments are required;
10. There is no space for limits. Improving is a continuous process.

3.4.4 VALUE-STREAM MAPPING

Also known as a material and information flow mapping, is a flowchart method that allows an organization to structure a high complex process to illustrate and analyse it to be able to prove its steps. With a VSM, it is possible to analyse an entire process, since its creation until it reaches the customer [27].

With this analysis, it is possible to structure a process, allowing the company to identify flaws and which activities add value to the product and which ones are consider as waste, making it easier to restructure it in order to remove the undesired waste. It is important to

remember that the customer cares about the value of the product, not the effort of it. Therefore, it is crucial to constantly verify a certain process and analyse where the value is being created and where the waste is, to be able to remove it constantly. This way, it is possible for a company to guarantee that a certain company has a continuous improving mentality, minimizing lead times to the customer and reducing costs.

To create a VSM, there are four steps to be taken into account [28]:

1. Select a product family

Before starting, the organization should choose the product they want to focus on. Customers care about a specific product, not all the range of a company products. Therefore, the map shouldn't have all the products mapped.

2. Drawing the current state map

This is done by collecting all the information from the back office and the work floor that concerns the production process. By observing and collecting data, asking the involved employees about the existing process. It is possible to record the time that takes to complete the different process steps, and find the inefficient spots. This data also includes the number of workers, working hours, machinery availability and produced lots size. By recording every different step of the process, it is possible to structure the whole process, making it simpler for further analysis.

3. Create the future state map

After the data collection made on step 2, and based on the possible achieved solutions that focus on adding value to the process, and at the same time reduce the waste observed on it, it is possible to create a new state map that will promote improvements on the process.

4. From current state map to future state map

With all the previous 3 steps made, it is time to apply the new strategy in the company. In order to efficiently do it, an initial kick off is recommended among all the stakeholders. Everyone should be informed about the previous state , and what will be done in the future, as well as why in order to motivate the employees to follow the chosen strategies. Regularly

meetings between the partners should be done in order to analyse if the new strategies are being well accepted by the teams and positive results are coming from the changes made.

3.4.5 The Five Whys

As mentioned by the 1950s Toyota Production System architect, Taiichi Ohno, this technique is “the basis of Toyota’s scientific approach... By repeating why five times, the nature of the problem as well as its solution becomes clear” [29]. It is a technique based on making “why” questions in order to find the root of the problem. Usually a problem never comes alone, and with this technique it is possible to find the original cause of the problem by iterating it in several steps. Therefore, each answer to the question “why” will be the next question until the cause is found.

It is a simple, yet powerful tool, because it cuts directly through the symptoms of a determined issue until the causes. Its simplicity is based on how this technique is applied, since the only thing one must do when a problem occurs is to ask “why?” five times. By each step, a new cause will appear until the final cause is reached.

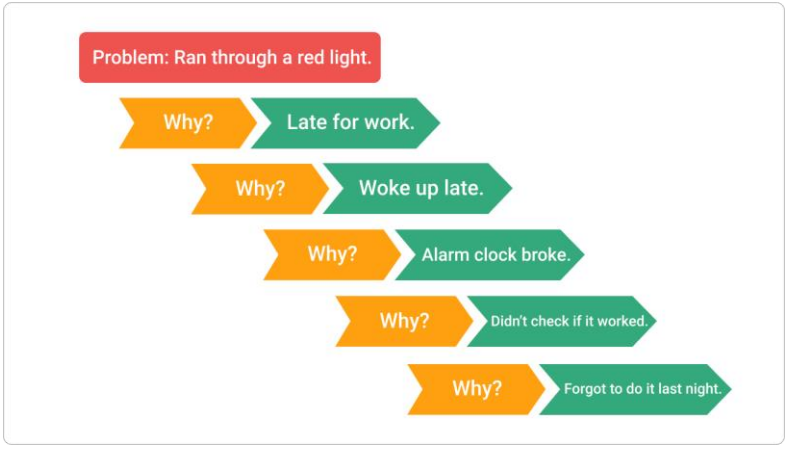


Figure 13 - 5 Whys [30]

In the example shown above, on Figure 13, it is possible to find the root of the original problem by iterating every step of it. After these five iterations, the cause and the solution

for the problem can be determined. The 5 Whys tool goal is to motivate the trouble-shooter to find the actual reasons of the problem, by going further on the chain of causality in direct increments throughout the layers that are related and involve the found issue, instead of making assumptions or logical tracks

This model follows a structured and simple step process [31]:

1. **Gather a team** that are familiarized with the problem and the process;
2. **Define the problem** so everyone involved knows exactly what the issue is, which gives to the team a more clear idea on where to focus;
3. **Ask the first "why"** after having the team and the problem cleared. Why is a certain problem occurring? Although it's a simple question, its answer shouldn't be a simple one, since it requires a serious and reliable thought on the issue. The answer ought to come from things that actually happened, not simple guesses. The answer to the first why shall be direct and based on actual facts, in order to avoid this process of becoming a deductive one. The purpose is to keep the answers short, direct and conclusive for the purpose of avoiding producing several possible answers and causes, which will lead the trouble-shooter to nowhere conclusive;
4. **Ask "Why" 4 more times** until you find the root of the problem.
5. **Know when to stop** if asking "why" doesn't produce more useful answers;
6. **Address the root cause** after identifying the cause of the events chain, the corrections will be applied on this cause, in order to avoid all the other events to occur;
7. **Keep a track on your measures** to control if them are doing their job by eliminating the initial problem found. This is a fundamental step, because it allows you to understand if the applied counter-measures are being effective or if they need adaptions, which can be done by going back to point 2.

3.5 AS-IS/TO-BE METHODOLOGY

If an organization is seeking to apply continual improvements strategies, this methodology might be crucial. To improve a certain process, the manager should be provided with its

current state, its flaws, and also the project directions. With a process current state well elaborated, it is possible to focus on the necessary corrections in order to eliminate the flaws found and be able to driven the process towards the desired direction.

In this methology, there are two phases completely distincted. The first one would be the "As-Is" phase, which identifies and analyses what is the process actual stage before any changes are applied. It allows the project manager to obtain an overall idea about the process and makes it possible and easier to apply the necessary strategies to look for continuous improvement. This analyse can be done on a specific process in a small department or team, or even in a whole organization for restructuring or introducing new business products.

Based on history events, Business Process Trends, a market analyst, says on his report "The State of Business Process Management 2018" that the reasons that motivates the managers to implement business process changes are usually concerned in the following topics [32]:

1. Saving money;
2. Improve an existing process or create a new business process;
3. Improve customer satisfaction;
4. Improve organizational responsiveness;
5. Improve business coordination and supervision;
6. Introduce a new product;
7. IT upgrades;
8. Respond to unique events like merging companies or acquisition of new companies;

Below, on Figure 14, the weight of the reasons that motivated the managers to implement changes, in percentage, since 2006 until 2017. The history shows that the biggest reasons to change procedures usually rely on the necessity to save money, the necessity of improving customer's satisfaction and the necessity to improve management coordination, all those subjects mentioned previously as the points to improve during this thesis.

	2005	2007	2009	2011	2013	2015	2017	
Need to save money by reducing costs and/or improving productivity	33%	56%	56%	57%	54%	53%	53%	98
Need to improve existing products, create new products or enter new lines of business to remain competitive	19%	36%	36%	28%	34%	33%	28%	51
One time event (merger or acquisition)	2%	4%	4%	4%	3%	5%	7%	12
Government or business risk management (Sarbanes-Oxley, ISO 9000)	11%	17%	17%	13%	13%	17%	21%	39
Need to improve customer satisfaction to remain competitive	19%	37%	37%	31%	37%	46%	42%	77
Need to improve management coordination or organizational responsiveness	23%	51%	51%	38%	35%	30%	36%	66
Need to improve management of IT resources (ERP applications)						15%	26%	47
Need to reduce cultural resistance to process change						17%	15%	27
Other, Please Specify						12%	8%	14

Figure 14 - Reasons to focus on business process change [32]

Once the project manager obtains the overall idea about the process, and how it works, it is important to divide it in tasks as well as the different teams involved. By having the whole process divided in tasks and sub tasks, it's possible for the manager to analyse and find the tasks where improvements can be applied. In order to be able to do this, all the employees that interfere on those tasks should be heard and should be questioned about flaws on the process and what do they think the solutions could be. This will provide a macro idea based on how the process is build and also a micro idea based on the actions made by the employees that interfere in all the tasks of the process.

In order to achieve an overall idea of the process, the manager has to follow the following steps [33]:

1. Describe the process, as well as all the entities involved (employees, suppliers, customers) and all their interactions;
2. Detail the description of the process, task by task, as well as business alternatives;
3. Define task description, its times as well as its intervenients;
4. Do interviews and questionnaires to the involved employees;
5. Define the process inputs and outputs;
6. Look for systems that allows the manager to automate tasks.

Based on the picture collected previously, with the support of tools like personal interviews, questionnaires and by observing the process, it is possible now for the manager, to analyse all the tasks and start looking for possible improvements to be applied. However, before the manager goes further in the process of applying the supposedly necessary changes, a To-Be map should be elaborated. It is advantageous and fundamental to have it in order to have a concrete finish line, to be able to see where the manager wants the project to go, and this way it will be also possible to evaluate its progression. With all the information detailed and organized on a map, it is possible to have a reference point to locate where the improvements should be applied on the different process steps, and also possible to analyse and make conclusions about the results of the application of the chosen strategies. Beside this, it is also possible to standard a process, which will work as a guarantee that the employees will follow the new process, instead of going back to their comfort zone by regressing to the previous one.

A To-Be map will document the future status of the process, in other words, how the manager wants the process to be. Based on the As-Is diagrams, this is a team work with all the stakeholders of the process and its main focus is to develop improvements on the current process and eliminate the waste found on the previous process. Usually, the entities participating in this stage are experienced people on the matter and are also able to contribute to the optimization of the process which can also make it doable on the organization they are inserted. This is the stage where the solutions brainstorm happens, and where the solutions are defined.

Below, on Figure 15 - As-Is/To-Be Diagram a diagram describing a certain process before (As Is, in pink), and after the changes (To Be, in green).

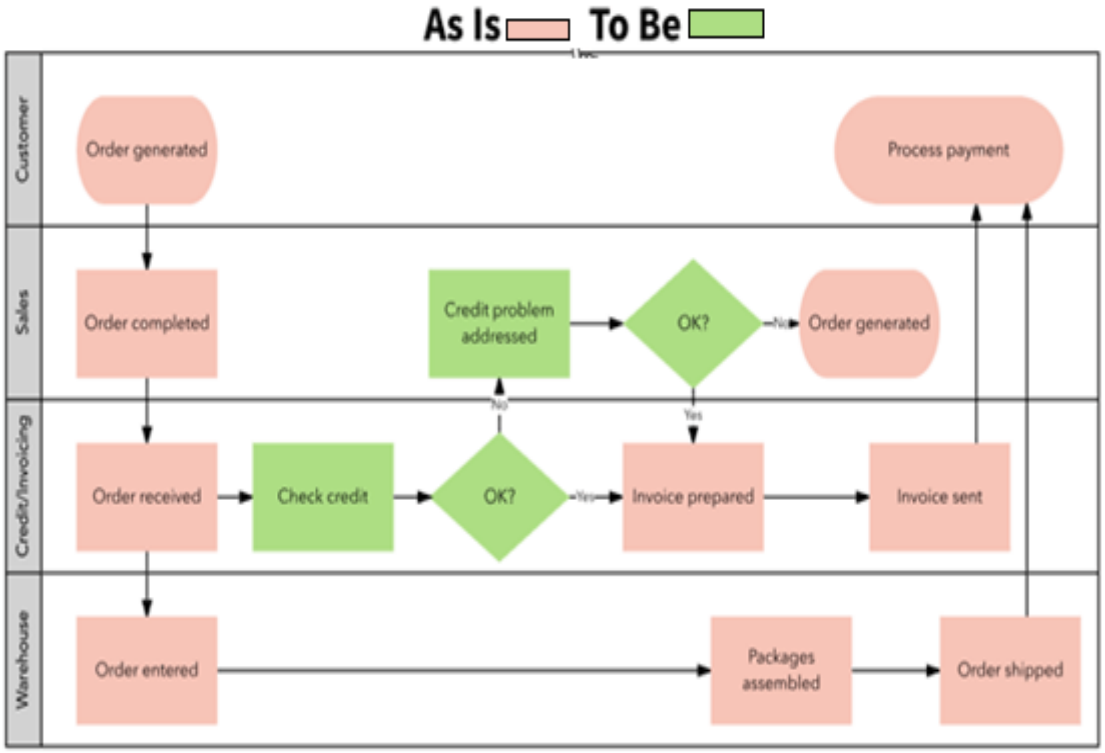


Figure 15 - As-Is/To-Be Diagram [34]

4. PLANNING AND METHODOLOGY

In this demanding and fast-paced world we live in, the project managers role's importance is significantly increasing with time and it is becoming one of the most important pillars to avoid a business to fail and to guarantee that a certain project meets the deadline without unnecessary waste, focusing on delivery quality and satisfying the customer's requirements. In fact, either it is a software development project or a physical product project (like machine building, or construction industry), both small and large organizations are depending more and more on an effective project management to assure that the customer is satisfied with the product delivered, both in quality, time and cost.

So, in order to develop a certain project, first one should decide which kind of methodology (traditional, or agile) is more suitable for the kind of project that it will be used on. Since both of these methodologies have advantages and disadvantages, they should be chosen accordingly to their specific characteristics vs the project required characteristics.

Therefore, before choosing which methodology will be used, the PM must be aware of the project characteristics, such as [35]:

- Approach;
- Success measurement;
- Project size;
- Management style;
- Perspective to change;
- Culture;
- Documentation;
- Emphasis;
- Cycles;
- Domain;
- Upfront planning;
- Investment return;

- Team size.

4.1 TRADITIONAL METHODOLOGIES

Considered the heavyweight of the methodologies [36], it is known as a plan based methodology that requires a heavy and extensively detail on what is required, in order to be sure that the customer knows exactly what it is pretended by the end of the project, since this kind of methodology doesn't allow big changes throughout the project development. This approach takes time and costs as fixed variables, which expresses that these traditional methodologies often faces budget and timeline issues.

Since every detail should be specified, traditional methodologies demand specialized and diverse skills, which means increased difficulty on managing the people who deal with the project complexity on a daily basis.

It takes a linear approach, implying that all the phases of the project have a sequential order, to initiate a new phase, the previous one must be concluded. It is also known as a methodology that doesn't require a high-level of security and it consists in 5 specific phases [37], as shown on Figure 16:

1. Requirements analysis/Initiation;
2. Planning;
3. Implementation;
4. Monitoring;
5. Maintenance/Closure.

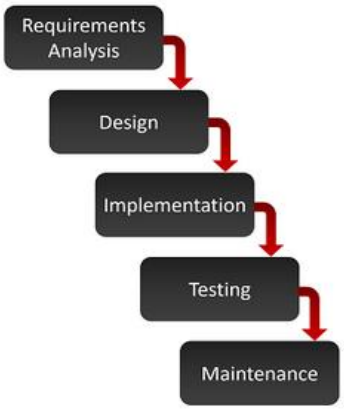


Figure 16 - Traditional Methodologies – Waterfall [38]

The Waterfall methodology is used when the PM totally understands the requirements of the project – for example in machinery building industries where all the stakeholders clearly know the final product, since the product is completely defined in advance, and all the requirements have to be supplied in the initial phase of the project without any chance of being changed once the project development starts. So this methodology have evident cons like [38]:

- It is not possible to conduct intermediate evaluations, which means testing can only be done once the development process is concluded;
- Due to the impact on delivery dates and project budget, once the developed process is on its testing stage, it is not possible to go back and change anything;
- Due to the presence of several specializations, high formalization and standardization, a big amount of documentation is required by the end of the project, which is expensive and time consuming;
- The project might not fulfil all the customer requirements since the developed process is based on the developer's interpretation and once delivered, it's too late to be modified.

4.2 AGILE METHODOLOGIES

In an attempt of making the traditional methodologies more flexible by, for example, being able to apply changes during the process, these methodologies were developed in order to address those issues raised by the traditional systems. The name was chosen due to the lightness and simplicity of these methodologies and are used to elaborate complicated and sensitive processes, that might change throughout the project, and when security is much important. It behaves as a non-linear process and it uses an iterative and teamwork, collaboration and flexibility approaches [35].

Agile project management methodologies are precise and user friendly. They don't focus so much on fixing time and costs, since it is an iterative approach which focus more on incorporating customer feedback and continuous releases. They allow customers to make

modifications in case they need, and customers are also highly involved in every stage of the process, which means they can review every stage and make the necessary suggestions to improve. As a result, the customer receives a product that was continuously verified and it should be accordingly to the customer's requirements, protecting both the developer and the customer, by guaranteeing that the product supplied is what the customer actually pretends it to be.

Besides being a flexible management methodology which focus more on the customer's solution design, it is also considered an advantageous methodology due to [38]:

- The possibility of changing the designed solution at any time, although it is defined in advance;
- In order to facilitate the communication between user and developer, user requirements are provided periodically;
- The solution is usually determined by dividing the project in stages that will be delivered separately. This way the customer can evaluate the solution created and make the necessary changes, if needed;
- Re-usable components can be created;
- Documentation is not a priority.

Since it is a methodology that works with iterations, a project is time managed into sprints, that usually lasts for around 4 weeks [37]. At the end of each sprint, a product is released, tested, verified, and commented by the customer. This way, the supplier is certain that the customer agrees with the product developed, avoiding future corrections, and at the same time it won't provoke undesired delays and quality issues from the customer's point of view. Therefore, there's no need to make a detailed and long term planning, but there's an extreme importance on receiving and incorporating the customer feedback, to be able to continuously improve the product while new sprints are concluded. In conclusion, each iteration, that lasts a sprint of approximately 4 weeks, is released and sent to the customer, to be reviewed and analysed. Corrections are done in case the customer thinks they are necessary, otherwise, the next iteration is started. This is a continuous method that will happen as many times as required, until the project is concluded. Below, on Figure 17 - Agile Methodology, a representation of the agile methodology iteration process.

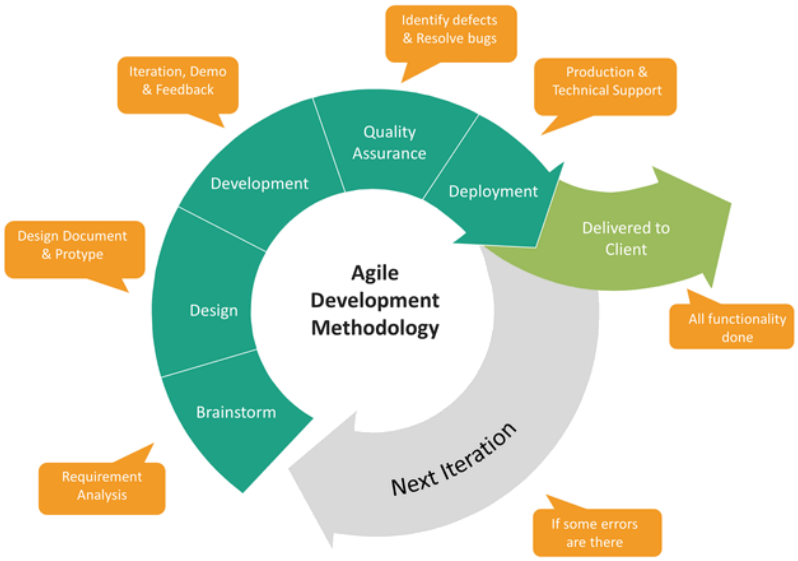


Figure 17 - Agile Methodology [39]

The Agile methology was popularized by the Manifesto for Agile Software Development, created by several software developers, which is based on the following 12 principles [40]:

1. The highest priority is to satisfy the customer through early and continuous delivery of valuable software;
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage;
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale;
4. Business people and developers must work together daily throughout the project;
5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done;
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation;
7. Working software is the primary measure of progress;
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely;
9. Continuous attention to technical excellence and good design enhances agility;
10. Simplicity - the art of maximizing the amount of work not done - is essential;
11. The best architectures, requirements, and designs emerge from self-organizing teams;

12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behaviour accordingly.

The main goal of the Manifesto is to discover better ways of developing software by doing it and helping others do it. In this Manifesto, the priorities aren't divided as usual:

- Individuals and interactions, over processes and tools;
- Working software, over comprehensive documentation;
- Customer collaboration, over contract negotiation;
- Responding to change, over following a plan.

Scrum and Kanban are the most used Agile frameworks, but they differ a lot in their rules. Scrum, for example, doesn't allow interruptions during sprints, work is always time boxed, it demands daily meetings, among others [41] . This means every feature is previously decided and it has to be completed until the next sprint. After its conclusion, the sprint is locked and considered finished. By locking the sprint, it gives the team the opportunity to make necessary last minute changes. After this, there's a feedback stage in order to evaluate if the delivered amount of work is approved by the stakeholders.

Below, on Figure 18, an example of a scrum process.

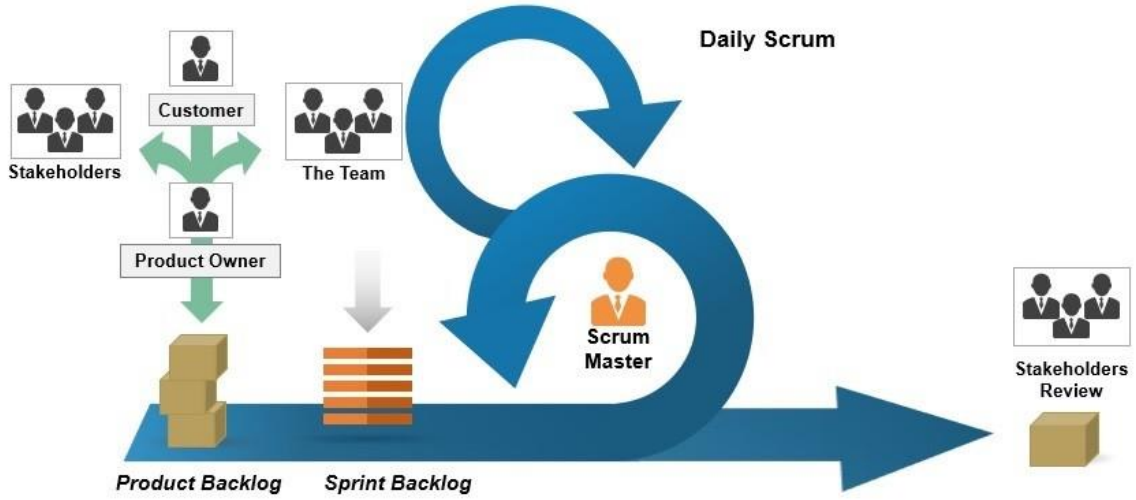


Figure 18 - Scrum Method [42]

On the other hand, in Kanban's case, there are two main rules [41]. The work in progress needs to be limited, and it is mandatory to visualize the workflow, since the main focus

isn't the time, but the workflow itself. Nevertheless, there should be a big limitation on the size of the queues, since Kanban's main goal focus on productivity and efficiency of the product. It assures the developer that the product supplied is quality superior, and by concentrating on the workflow will keep things moving, decreasing at the same time the size of queues, as shown below on Figure 19.

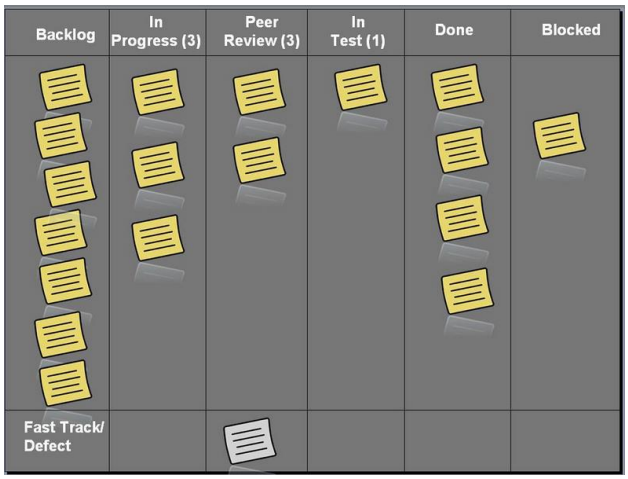


Figure 19 - Kanban Method [43]

So, in conclusion, if the goal is to provide a feedback for the stakeholder, scrum is the advisable framework to be used. However, Kanban would be the preferable tool if a team is responsible for maintenance and fast reactions.

4.3 TRADITIONAL METHODOLOGIES VS AGILE METHODOLOGIES

As seen above, it is possible to conclude that the biggest difference between these two methodologies is the adaptability factor. In the agile methodologies, if a change is required, this won't stop the team's work process, but will, instead, determinate how to handle those changes in the best way, improving the product's efficiency and quality on the customer's point of view. Also, the verification process occurs in every sprint, which is way earlier than in the traditional methodologies, where it is only possible to test their functionalities once the process is completely concluded. This happens due to the fact that these traditional methodologies don't allow changes, and they demand a predictive process, relying on defining and documenting a stable set of requirements before the project starts [36].

Below, on Figure 20, it is possible to analyse the differences between the mentioned methodologies.

	Agile Methods	Heavy Methods
Approach	Adaptive	Predictive
Success Measurement	Business Value	Conformation to plan
Project size	Small	Large
Management Style	Decentralized	Autocratic
Perspective to Change	Change Adaptability	Change Sustainability
Culture	Leadership-Collaboration	Command-Control
Documentation	Low	Heavy
Emphasis	People-Oriented	Process-Oriented
Cycles	Numerous	Limited
Domain	Unpredictable/Exploratory	Predictable
Upfront Planning	Minimal	Comprehensive
Return on Investment	Early in Project	End of Project
Team Size	Small/Creative	Large

Figure 20 - Agile Methods vs Heavy Methods [36]

4.4 JIRA

From the japanese word *Gojira*, which means Godzilla, the JIRA software testing tool was created by an Australian company, whose function is to track software bugs, issue tracking and project management [44]. Software process management like this allows the developers to work better as a team and in an agile way, because it is possible to observe the pendent issues, organize tasks and workflows.

JIRA is a versatile software that can be useful on the following aspects [45]:

1. Projects – JIRA allows the project manager to control the project and detect the defects very effectively;
2. Issue – Efficient on issue tracking and manage the defects;

3. Workflow – It is possible to design the workflow with this software. For example, a company has a business requirement. After creating the technical design, test cases have to be created, to guarantee that it is possible to test the developed product;
4. Search – It is easy to find the previous versions of a certain project. By adding new versions to the old versions, it is possible to analyse what happened previously, how many defects occurred and what the team learned from those previous stages;
5. Dashboards – It's a board that is available after logging into the software. With this dashboard it is possible to keep track of assignments, which are the issues that team is battling with and which issues were tested and concluded already.

The possibility of including, on the platform, the whole team involved in the project allows a more efficient communication, lowering unnecessary noise during the project and highly increasing the team's productivity [46]. Another pro is the software's ability of providing information updates for all of the team at the same time, because once something is updated and saved, the whole team has access to it. With this platform, where it is possible to plan, discuss and organize tasks, the company also observes a cost reduction, production time optimization and it's easier to give a prediction of the sprints duration to the customer. Beside all of this features, the JIRA software also allows the stakeholders to easily access the project reports, providing them real time insights and showing how the process is developing during a certain sprint. All these functionalities allow the team to make any necessary small adjustments.

4.4.1 JIRA KANBAN BOARD

Kanban Board and Scrum might be the most popular agile frameworks used in JIRA. With Kanban Board it is possible to observe, in real time, the project status, due to the fact that all the tasks are visible, allowing the team members to see their state at any time [47].

Simply speaking, with Kanban Board, it is possible to observe the whole workflow status and which tasks are first in the product backlog (To do), which teams are working on the unfinished tasks (Doing), and the concluded and blocked tasks (Done). Historically speaking, this was done on a physical board with post-it notes. This board would indicate

the teams how they should proceed after the conclusion of a task by being aware of what work was still undone. With JIRA, it is possible to do it in a virtual way, with virtual boards.

The Kanban methodology is characterized by [47]:

- Flexibility

In this methodology, one team focus on the workflow that is “in progress”. After this stage is concluded, this team is responsible to start the first task present in the product backlog (pull). The product owner may change the priority of a certain task during the project and he should keep the most important task on the top of the product backlog, in order to assure that the most valuable output will consistently be developed.

- Minimize time cycles

Cycle times represent the time from the moment a process is started, until it gets shipped to the customer. This time can be reduced by using an overlapping skill, which means that a certain product (or software) can be tested whenever they need, which means it can also be tested while being developed, optimizing the cycle time.

- Visual Metrics

With Kanban, it is possible for the different teams to analyse the project status, with the help of charts, allowing the stakeholders to control the cycle time taken by each issue, and be aware of the number of issues existing in each stage. With the control of this data, teams can aim for an improvement of team efficiency and effectiveness, since they can change aspects in case it is necessary.

- Continuous delivery

The main goal of continuous delivery is to quickly deliver a product with low defect risk. While some agile methods require sprints with 2-4 weeks of duration, Kanban methodology and continuous delivery complement each other by aiming to a faster product delivery. Kanban might be considered as a continuous flow methodology since one single team (development team, for example) is used to develop, test and review the new features continuously.

5. CASE STUDY AND PROCESS IMPROVEMENT PROPOSALS

As mentioned previously on this thesis, there are some issues in the company that needed to be reviewed and, if possible, improved. The inefficient communication between departments, the lack of standard protocols, which makes it difficult to guarantee a constant quality on the service, and the time wasted when a technician don't have an answer on time, due to different timezones or simply impossibility of obtaining an answer when needed.

5.1 FAQ

This Frequently Asked Questions webpage, as the name indicates, is a tool that will offer the technicians an independence level that they aren't able to experience at this moment, by providing answers for questions that are usually made by a technician during an I&C, or for new required answers that might had been questioned already in another project. As sometimes the technician's working hours differ from the back-office working hours, due to time zones, the necessity of working extra hours, or the impossibility of having someone constantly ready to provide answers to the technician, the creation of a FAQ simply allows the technician to obtain faster answers and therefore, the technician doesn't face bottleneck points which can provoke a project delay and, consequently, an unsatisfied customer as well as an increment in the project costs which were previously predicted.

As there is no data available about previous projects and its efficiency, or the issues found during an I&C due to stuck points where the technician couldn't obtain a quick answer, the study will be done in a theoretical way.

In order to develop the application of this tool, it will be applied the As Is/To Be tool, where it will describe the method being used right now, as the moment this thesis is being written, and the future method to be used at the end of this project.

5.1.1. As Is

The biggest advantage of this kind of analysis is the possibility of creating a base on an organization process, as the As-Is analysis will show the current method of the process and will allow the manager to identify possible improvements. Without having a solid foundation of how a certain process is operated, it is difficult to improve the method. It is simply not possible to try to reach a destination without being aware of what the starting point is.

The “As Is” situation is the existence of a disorganized big amount of folders, by machine type, which number have been accumulating along the years. These folders are manipulated by one person, with no supervision at all. Besides that, there is no official communication between the MSA2 department and that person, which makes it impossible for a new technician to be aware of the existence of those folders, and, therefore, how to use them and be properly supported by them.

Those folders are only constituted by datasheets (pdf and word files), updated and outdated, of all kind of equipment that can be installed in a machine. So, whenever a technician is dealing with a problem, he must do a research on the company server folders, therefore he needs to have wi-fi access at the customer site and time to find the necessary information. Other way of finding information is by contacting the Helpdesk and technician colleagues. None of this is optimal because the Helpdesk isn’t completely focused on supporting the field service engineers - since they are responsible to support the customers instead, and also due to the fact that the technician is dependent on the colleagues or helpdesk availability, which might differ with time zones, working days, etc. Beside this, if the technician wants to obtain fast and correct answers, he has to be aware of who’s responsible for those topics – which is tremendously hard for a new technician in a company with the dimensions of Syntegon.

Majority of the times, the MSA2 technicians rely on self-knowledge or on colleagues support, which although it works, it is not optimal nor efficient. Besides taking time and possibly creating bottlenecks in the I&C project, this also might lead the technician in a an undesired and non-standard way which might result in a harder and faulty method for the technician and for the future technicians that might have to do the follow-up of the same project.

Below, in Figure 21, it is possible to visualize how this folder is organized. The reader is able to observe that, in the “overige” folder, which means “others”, there are 4.18GB of pdf and word files. It is not sustainable for a technician to look all over this folder for one single file, and once he finds it, this file might be outdated, in a language that the technician doesn’t dominate, or it might not help at all since usually they are only datasheets.

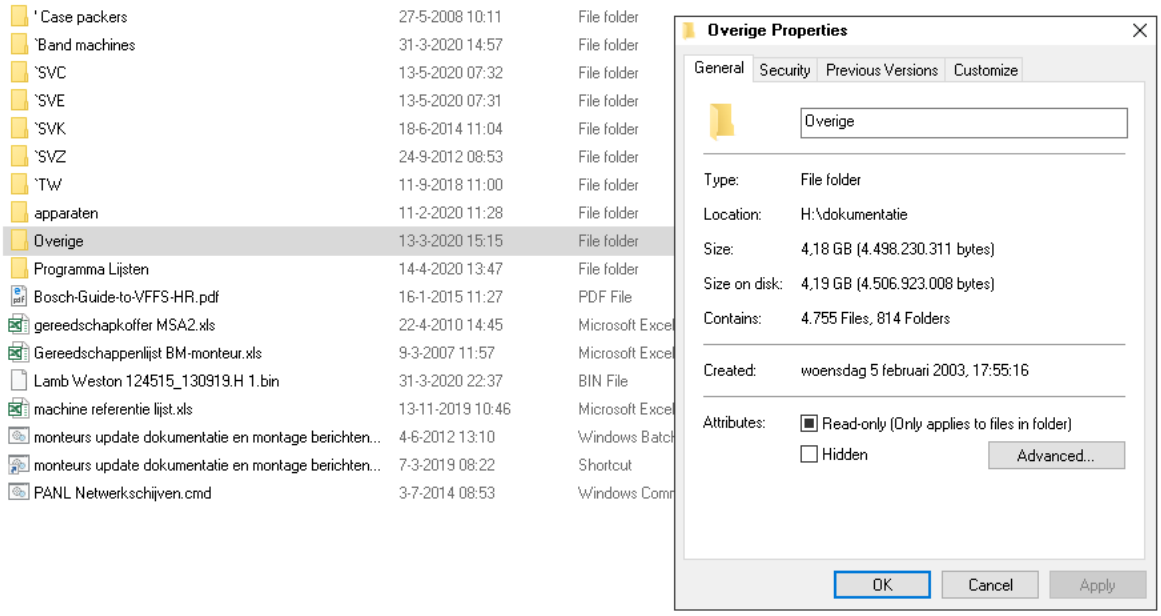


Figure 21 - As Is

5.1.2. To Be

The solution found to solve the issues previously mentioned is the creation of a FAQ webpage, which main focus is to provide updated and organized information to the technician, on time, without the usual dependency on the helpdesk, or other colleagues. With this webpage, once a technician has a doubt of how to install a certain part of the

machine, or how to teach a certain sensor or initialize a calibration, he doesn't have to wait for the availability of others. Instead, the technician only has to search for the machine type that he's working in the project, and inside the machine's folder he will be provided with the necessary explanation of the part or equipment of the machine. With this "live" and standard information/procedure, the company is able to guarantee a quality and efficiency level that can only fail if the technician has a faulty method or if the technician is facing obstacles provoked by the customer, like delays or lack of resources.

This FAQ will be divided by machine types, as well as by its components, in a friendly user environment that focus on allowing the FSE to fastly access to the necessary information in order to continue the project without undesired stuck points. For this, the manager of the MSA2 department has to confirm the information updated to the webpage, and the webpage has to be continuously improved and corrected, if necessary, by its technicians. It is a department page, only accessible to the technicians of Syntegon Weert, so it is possible to control the information as well to verify its correctness.

In order to locate the reader and give him a practical idea of how the To Be method will look like, there are 3 figures below. Figure 22, shows the Index of the FAQ. On the left side of the webpage it is possible to see a "Page Tree" where the user can find all the different topics separated and organized per machine and per equipment. In Figure 23, and Figure 24, the reader is able to observe how will the FAQ look like at the end of this project. While the first figure shows the setting instructions of a certain sensor existing on the machine, the second figure shows how the technician will be provided with operator manuals for the different HMI's and a training file.

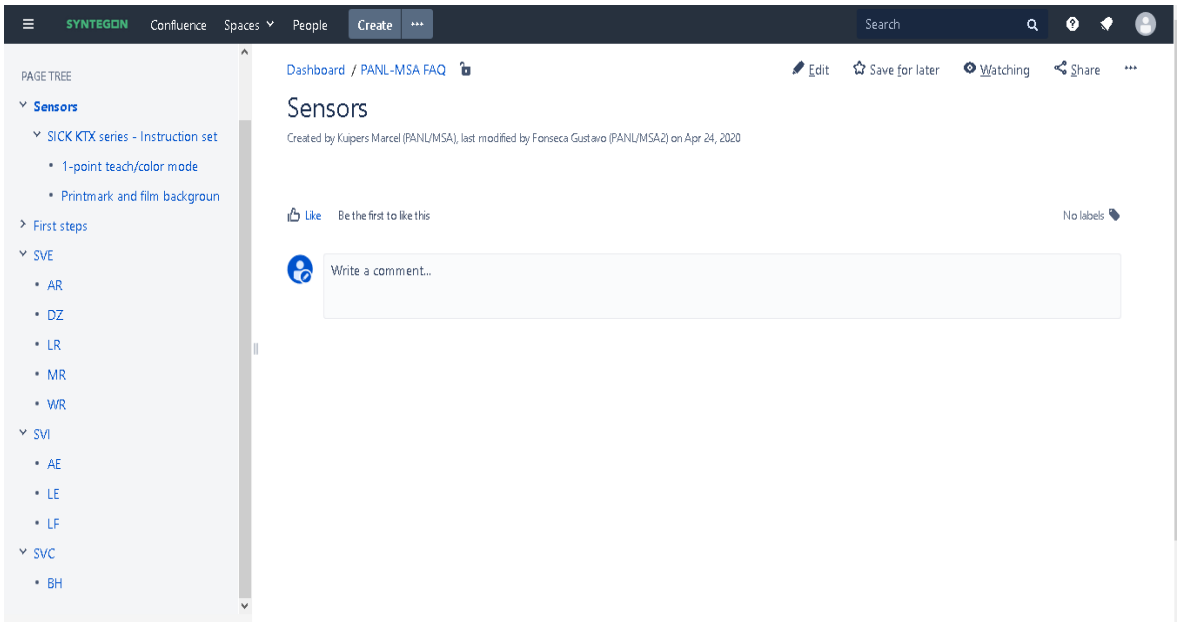


Figure 22 - To Be - Index

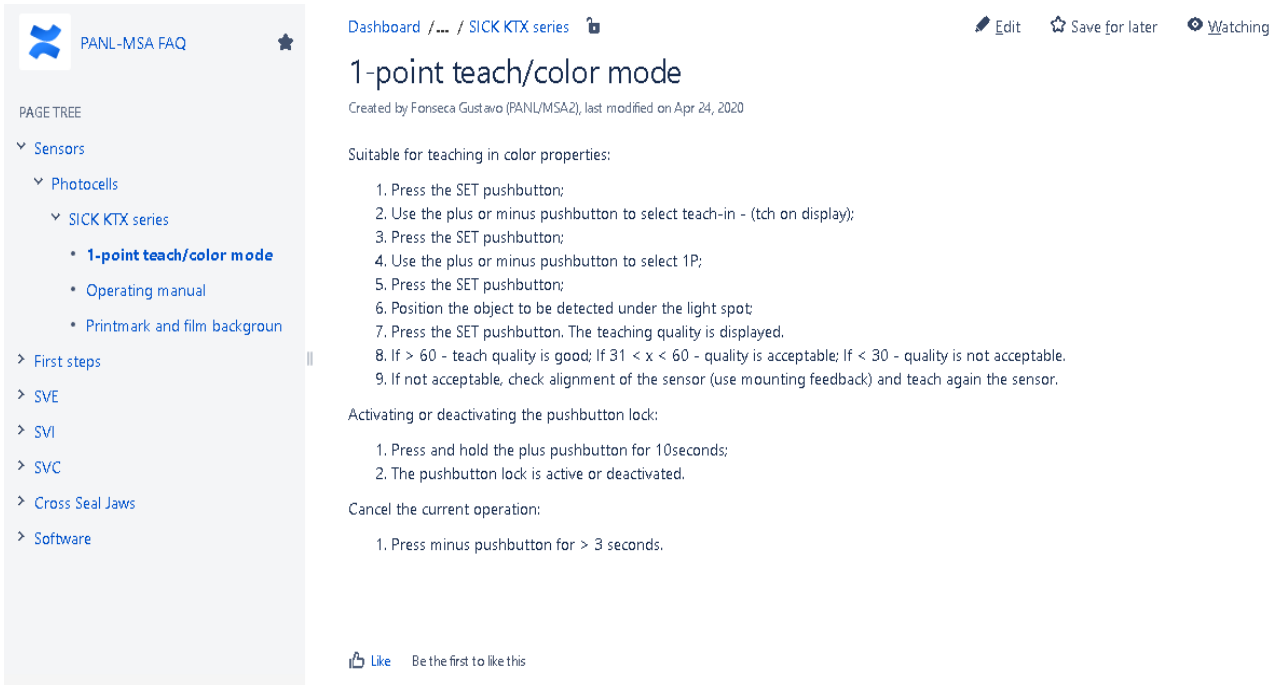


Figure 23 - How to teach a sensor – To Be

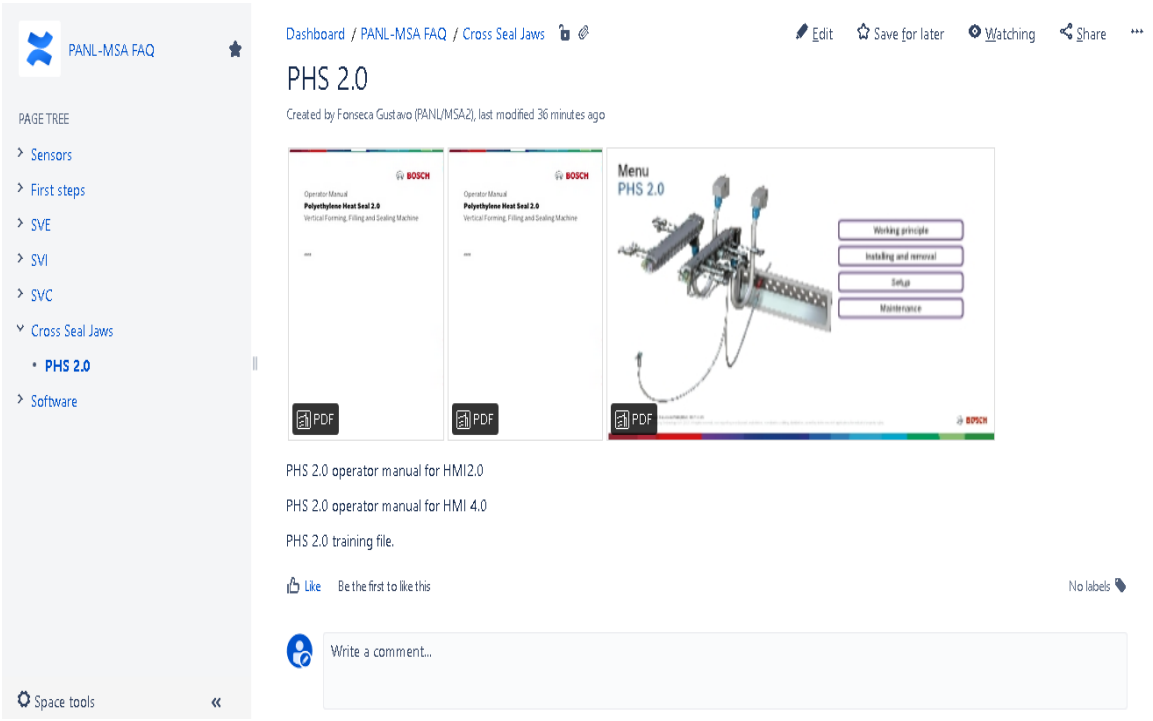


Figure 24 - CSJ PHS 2.0 – To Be

Below, in the Figure 25, it is described the As Is method, via the 3 first topics. This method, simply for not being a method, is already a correction that has to be made. One of the big foundations of Lean Management is the goal of eliminating waste. In fact, as said before in this thesis, “Lean methodology is a strategy management that focus on reducing waste, by making obvious what adds value, reducing and eliminating everything that doesn’t, without sacrificing its productivity.” Therefore, it is necessary to reduce all the disorganization and dependency that the technician might face, by providing him tools to help him do his job strongly supported by concrete, updated and easy-access information, as shown in the 4th topic, which symbolizes the To Be method. Besides being able to eliminate waste, it is possible to guarantee a continuous improvement since this FAQ will be continuously updated.

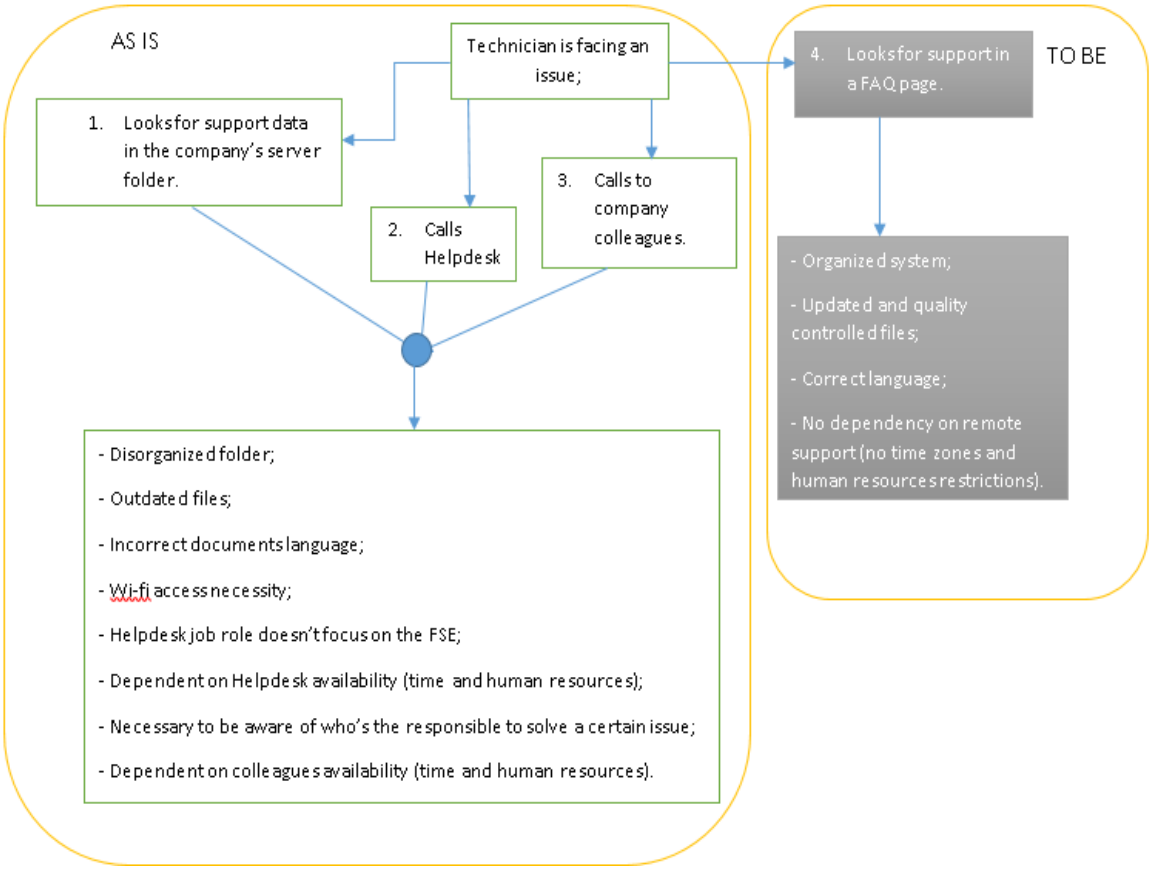


Figure 25 – As Is/To Be

5.1.3. RESULTS DISCUSSION

As explained previously, there is no collected data during the previous years that would allow the comparison between the As Is method and the To Be method. Therefore, in order to exemplify the creation and appliance of the FAQ, the 5 whys tool will be used, and a theoretical conclusion based on a SWOT analysis, present on Table 1, will be developed.

Let's think on a practical and simple example. The technician is responsible for an I&C on Peru, with a time difference of 7 hours (to Amsterdam), and is about to teach a sensor that never worked with. He's an unexperienced technician and, although he tried to contact the back-office or his colleagues already, none of them are available because they are off work. Therefore, the problem in this situation is the incapacity of the technician to proceed with the I&C, provoking an undesired time waste.

1. Why? -> Technician didn’t teach the sensor;
2. Why? -> Technician didn’t know how to teach the sensor;
3. Why? -> There is no step-by-step procedure available for the technician to follow;
4. Why? -> There’s no platform to include those procedures;
5. Why? -> No one ever created that platform.

It is possible to conclude, after the appliance of the 5 why’s tool, which was the reason that incapacitated the technician to proceed with the I&C. Obviously, the reason is that the technician wasn’t aware of how he could teach the sensor, but the main problem is how alone a technician can be in a project in the other part of the world with completely different time zones and an enormous lack of resources to surpass the obstacles he finds at the site’s customer, due to the non-existent platform with the usual and standard procedures, as well as information about the machine itself, its parts, its components, its functions, its properties, etc.

Below, in Table 1, a SWOT analysis comparing the weaknesses and threats of the As Is method with the strengths and opportunities of the To Be method.

STRENGHTS (To Be)	WEAKNESSES (As Is)
- Greater independence of the technician; - Better quality of processes and procedures; - Fast, updated and unequivocal information; - Provides the technician with a better and bigger responsiveness; - Greater Efficiency;	- Technician is too dependent on the back-office; - Online technician support is lacking; - Back-office not able to provide answers on time due to different time zones or human resources unavailability; - Technicians provided with different methods; - Hard to measure technician performance;
OPPORTUNITIES (To Be)	**THREATS (As Is)**
- Reduction of technician stopping times during an I&C; - All the technicians are provided with the same information; - Possibility of reduction I&C times; - Possibility of reduction I&C costs; - Bigger customer satisfaction; - Development of standard procedures based on equal information; - Possibility of measuring technician performance; - Possibility of reducing waste and keep a constant continuous improvement;	- Bigger I&C times leads to bigger costs; - Different methods might lead to different and undesired results; - Project delays and machine malfunctions; - New technician needs more time to adapt and be integrated; - Customer insatisfaction might lead to future business revocation;

Table 1 - As Is/To Be SWOT analysis

5.2 STANDARD PROCESSES FOR FSE

The creation of standard procedures in lean manufacturing is a way of establishing precise step by step methods in order to develop products and services in the safest, easiest and most effective way according to the available technology [48]. Therefore, by applying standard methods, a company is able to guarantee that all its employees will provide the same kind of service (technically speaking), based on the exactly same methods, independently on who the technician is, minimizing mistakes and variabilities while increasing the possibility of controlling the projects. Standardized procedures help the technician structure their work, removing pressure on the technician and reducing the stress of performing the I&C properly, since there is a guideline on which the technician can and should be based on. Lastly, it guarantees to the department a continuous improvement mentality due to the fact that it is only possible to evaluate improvements when there are standardized and documented procedures. As standard improves, the former standard becomes the basis where the future standard relies on [48]. Without any

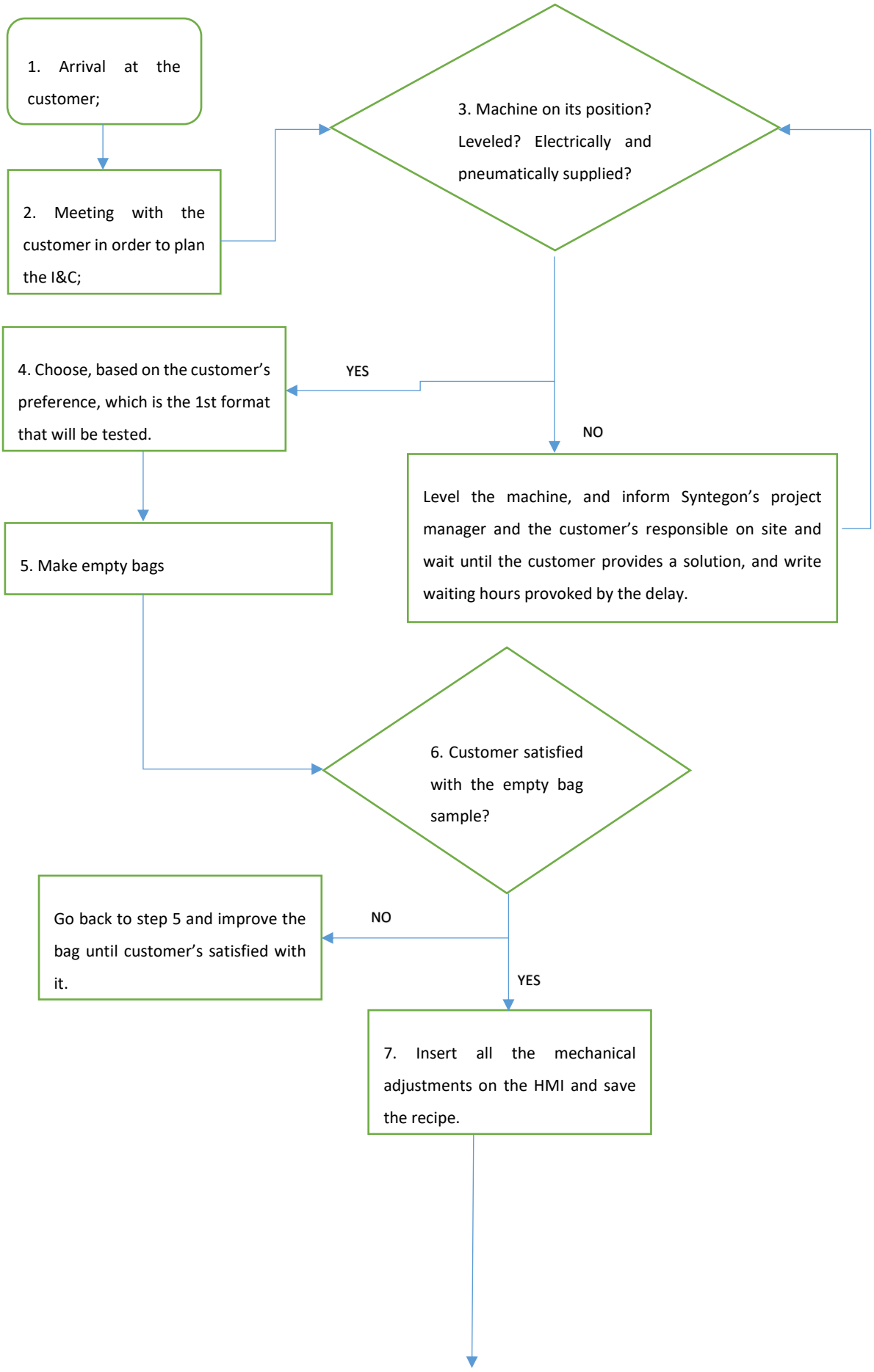
SOPs, there is no way of granting the quality of the service since the technician's methods differs with the technician, and it is difficult to improve the quality of a service if there is no basis to be relied on.

What happens in this moment at Syntegon Packaging (former Bosch Packaging), is that there is no standard procedure for an I&C which makes it impossible to guarantee that the job will be done the same way, no matter who the technician is. It makes it also difficult to evaluate the technician performance, because every project is different as well as every customer, but without standard procedures, there isn't a screenplay that the technician can follow, which also requires more adaptation time in case it is a new technician.

Therefore, it is part of this thesis to create and try to implement an I&C SOP, where the technician will have a step by step procedure to follow during an I&C, and how to work properly with the machines achieving the desired results in the desired times, with no delays which results in a bigger customer satisfaction as well as less costs involved.

5.2.1 I&C SOP

In this sub-chapter, represented in Figure 26, the goal is to create and demonstrate how would an I&C SOP procedure look like. This SOP gives to the FSE a step-by-step screenplay of how to proceed during an I&C, guaranteeing that every technician will proceed based on the same instructions, which will assure that the service procedure will be the same no matter who the technician is. This will allow the company to understand what failed during the I&C, why did it fail and in which phase of the I&C did it fail. With this detailed and organized information, the company is able to conclude if this was the company's fault, or if the customer didn't allow the FSE to proceed with his work as planned. Therefore, it allows Syntegon to correct the procedure, or to instruct better the technician in case it's the company fault. It will, at the same time, allow Syntegon to allocate the possible project extra costs onto the customer in case the project deadline is deviated due to customer's inefficiency.


1. Arrival at the customer;
2. Meeting with the customer in order to plan the I&C;
3. Machine on its position? Leveled? Electrically and pneumatically supplied?
YES
NO
4. Choose, based on the customer's preference, which is the 1st format that will be tested.
Level the machine, and inform Syntegon's project manager and the customer's responsible on site and wait until the customer provides a solution, and write waiting hours provoked by the delay.
5. Make empty bags
6. Customer satisfied with the empty bag sample?
NO
YES
Go back to step 5 and improve the bag until customer's satisfied with it.
7. Insert all the mechanical adjustments on the HMI and save the recipe.

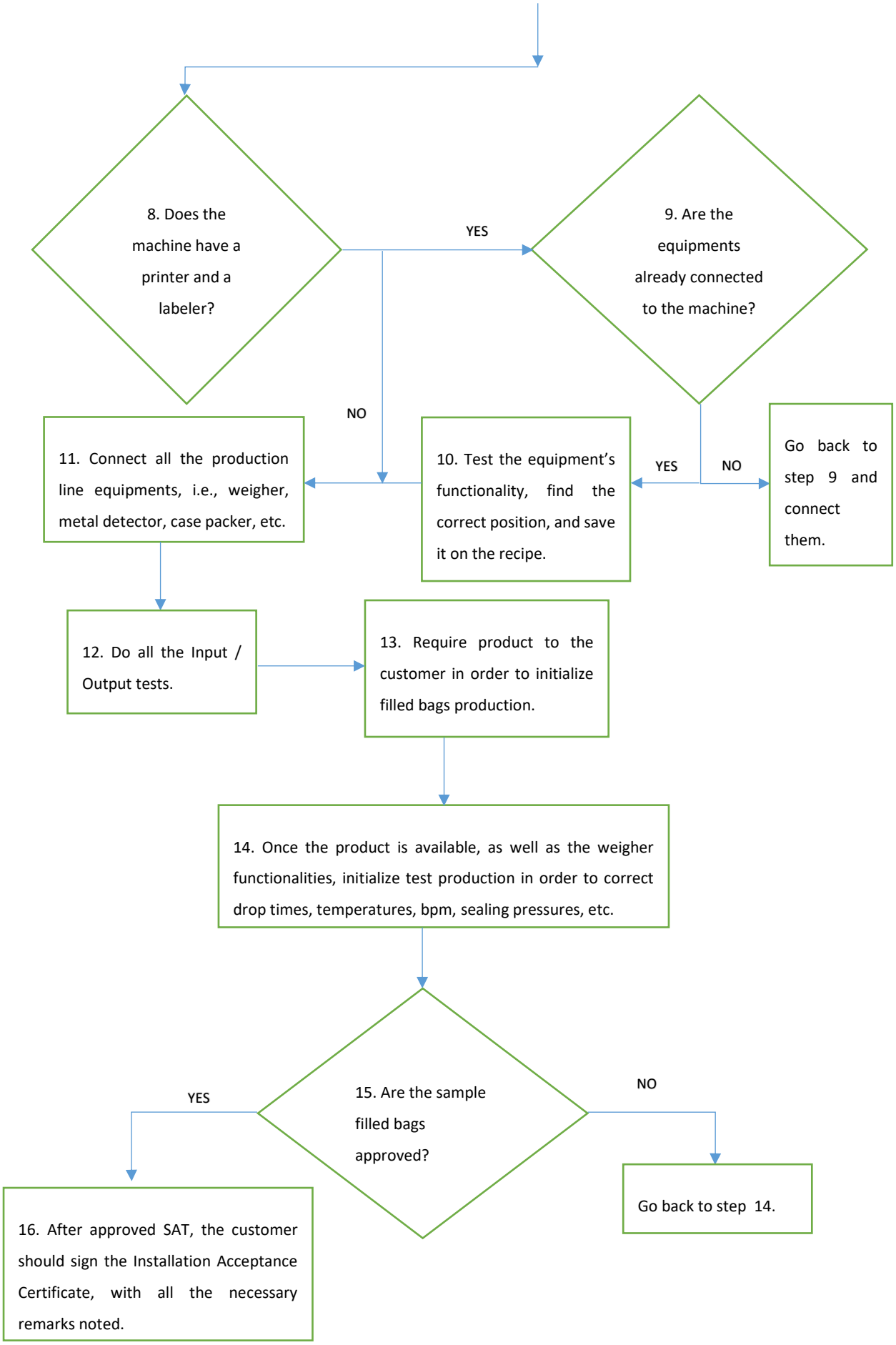
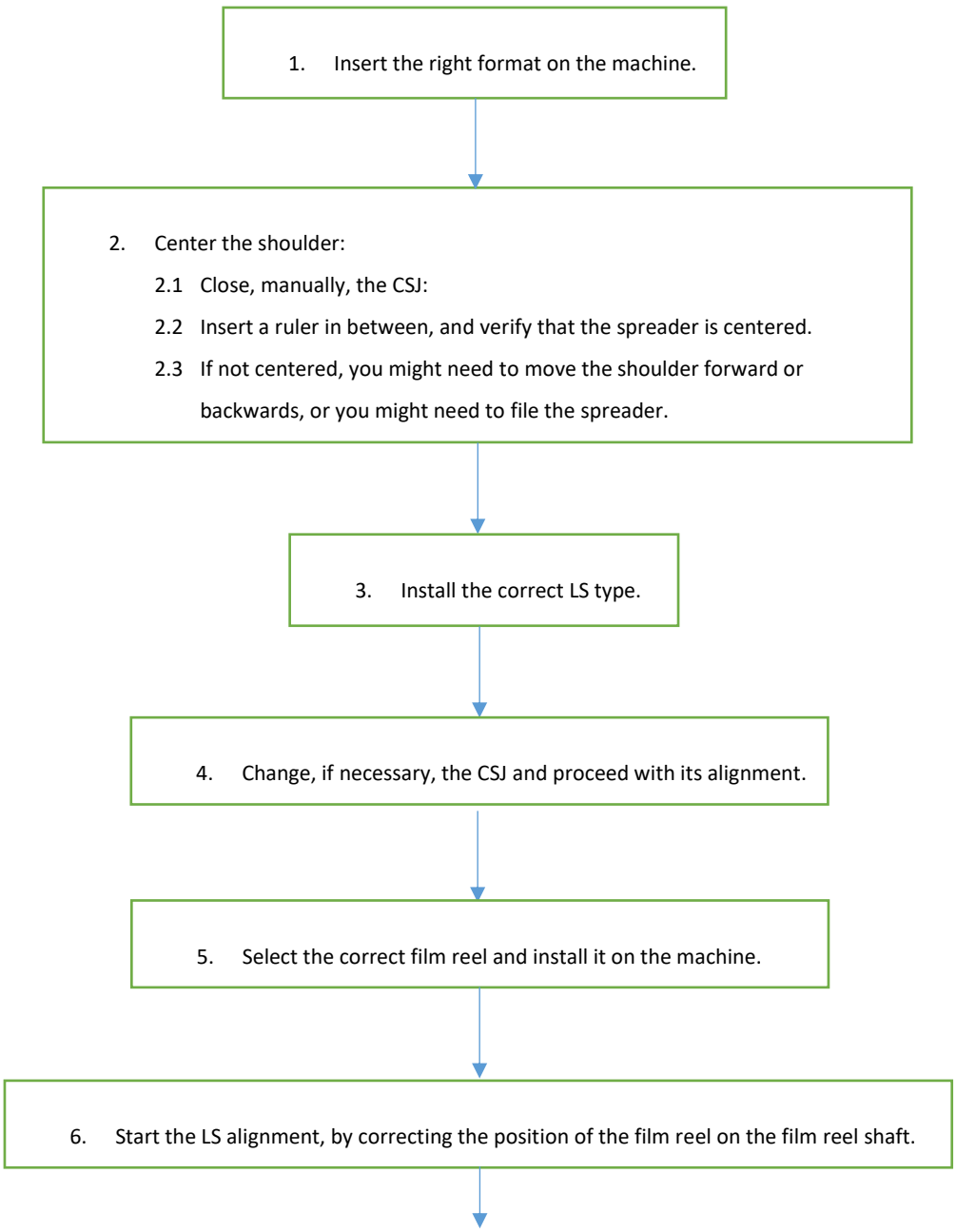


Figure 26 – I&C SOP

5.2.2 PILLOW BAG SOP

In this sub-chapter, represented in Figure 27, the goal is to create an SOP that will guide the FSE with a step-by-step screenplay in order to achieve an optimal pillow bag, guaranteeing that every technician will proceed based on the same instructions, which will assure that the bag creation procedure will be the same no matter who the technician is. This will allow the company to guarantee a level of quality, understand what failed during the I&C, why did it fail and in which phase of the I&C did it fail. It will also allow Syntegon to be assured that customers will receive the same instructions and same training independently on the technician sent.



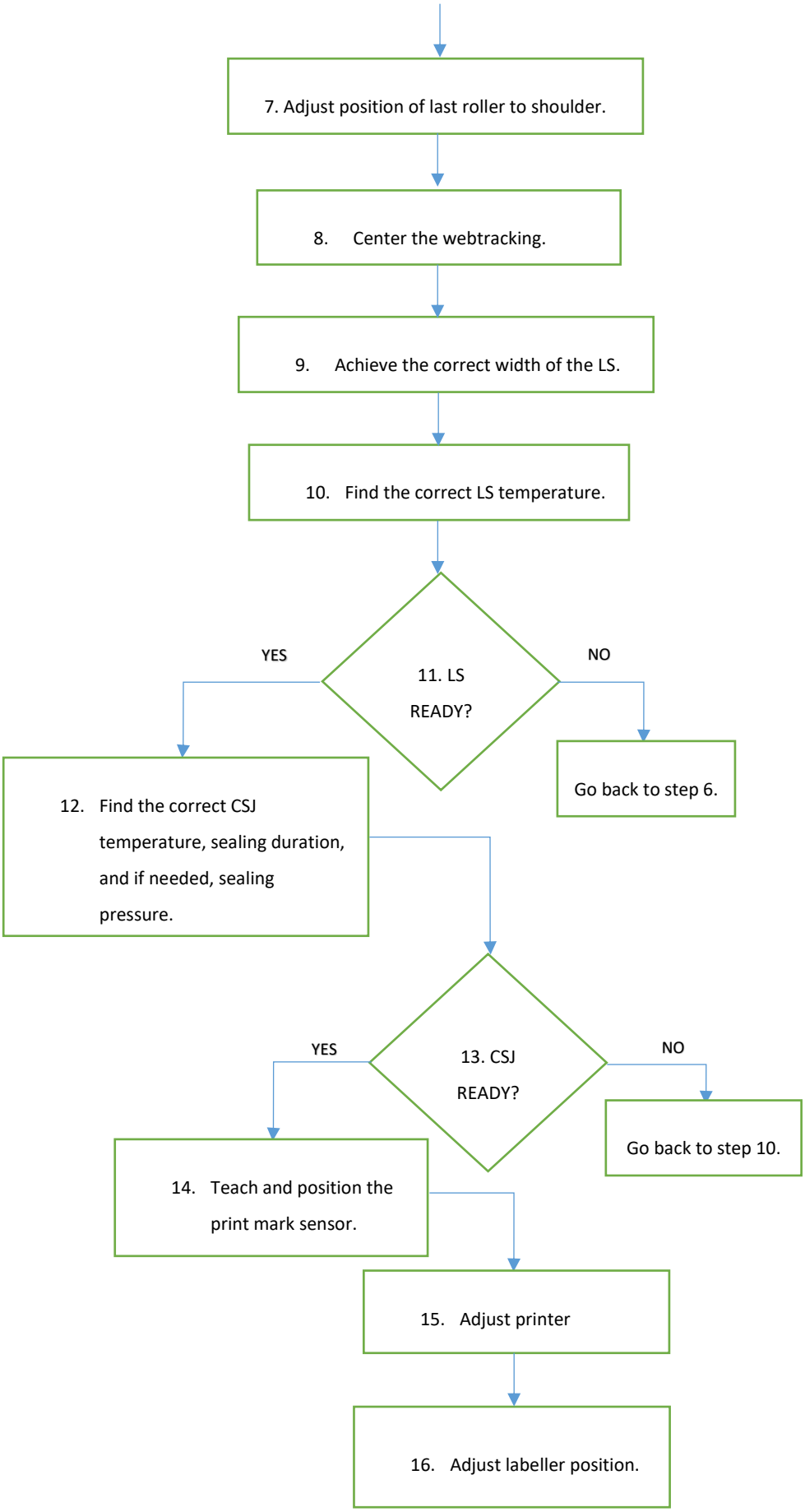
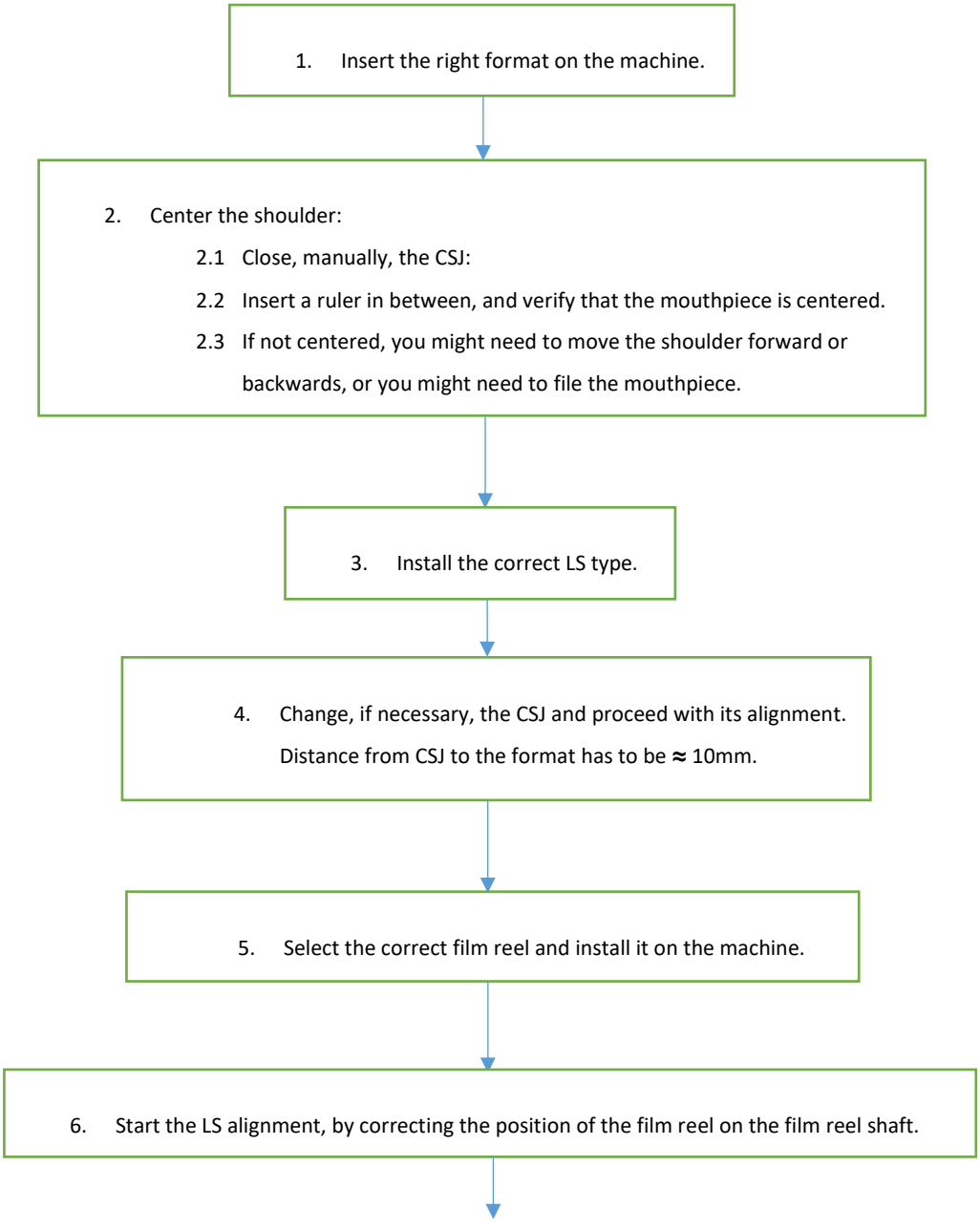
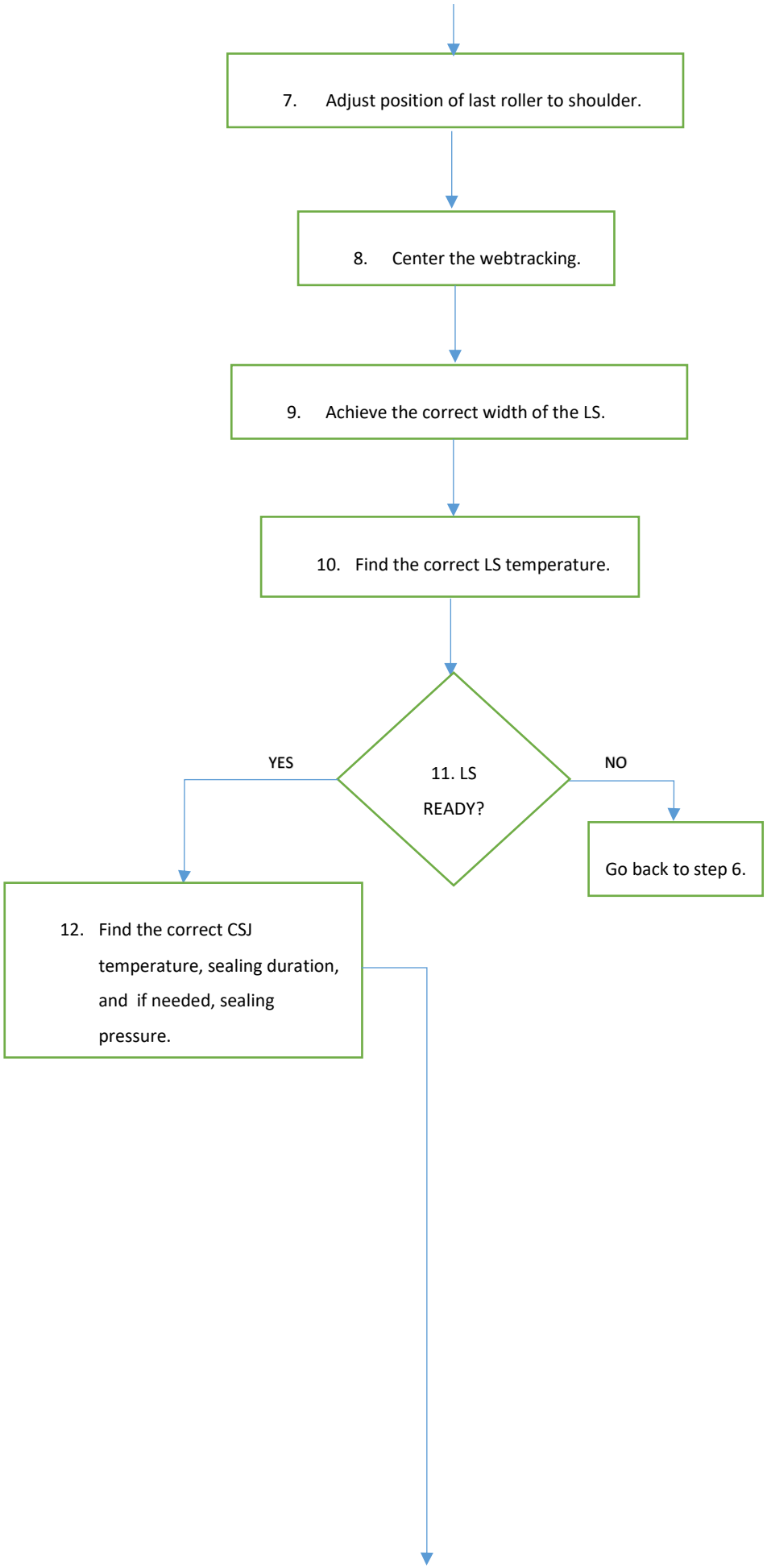


Figure 27 – Pillow SOP

5.2.3 BLOCK BOTTOM BAG SOP

In this sub-chapter, represented in Figure 28, the goal is to create an SOP that will guide the FSE with a step-by-step screenplay in order to achieve an optimal block bottom bag, guaranteeing that every technician will proceed based on the same instructions, which will assure that the bag creation procedure will be the same no matter who the technician is. This will allow the company to guarantee a level of quality, understand what failed during the I&C, why did it fail and in which phase of the I&C did it fail. It will also allow Syntegon to be assured that customers will receive the same instructions and same training independently on the technician sent.




7. Adjust position of last roller to shoulder.
8. Center the webtracking.
9. Achieve the correct width of the LS.
10. Find the correct LS temperature.
11. LS READY?
YES
NO
Go back to step 6.
12. Find the correct CSJ temperature, sealing duration, and if needed, sealing pressure.

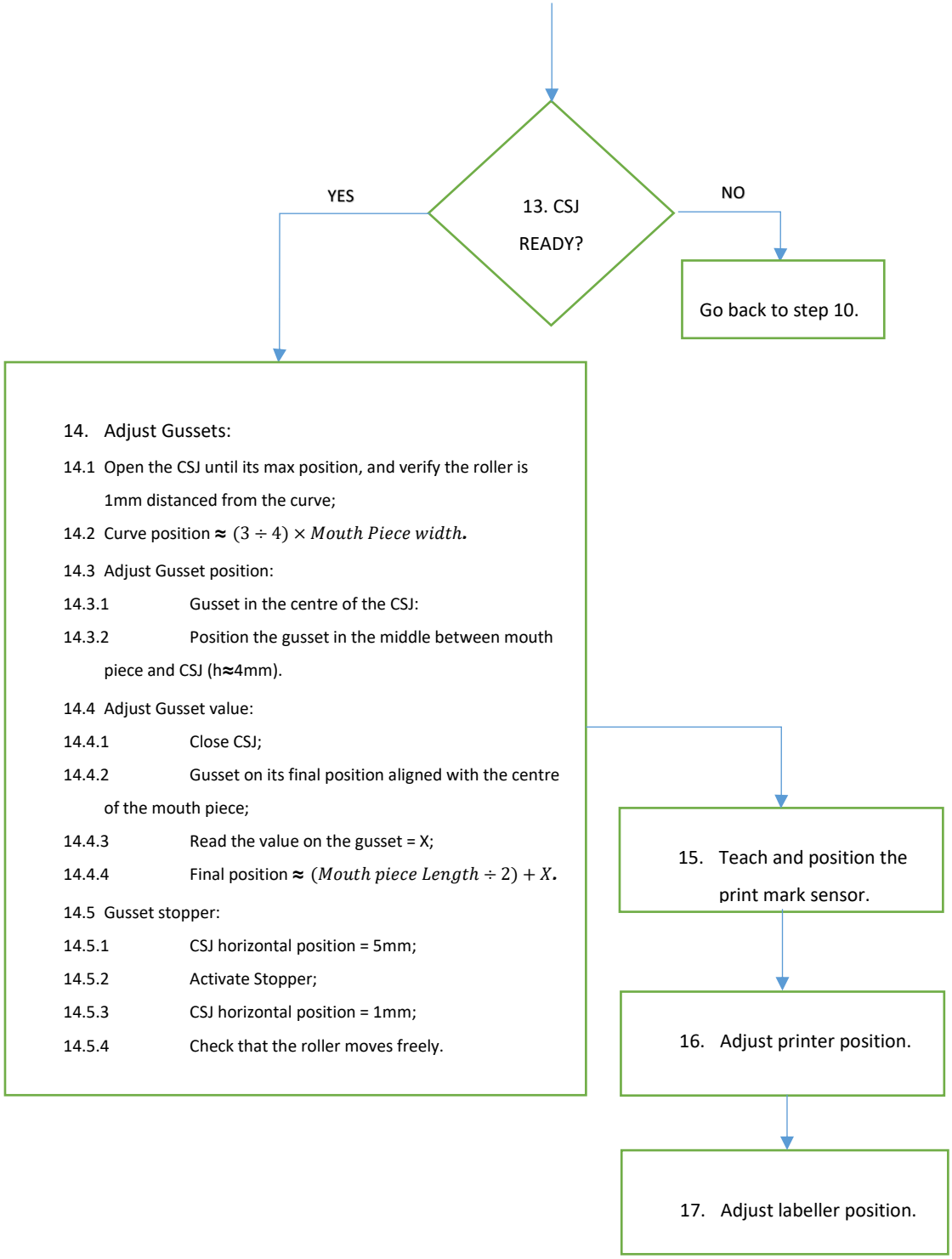


Figure 28 – Block Bottom SOP

5.3 APPLICATION OF A FEEDBACK LOOP TOOL FOR PROCESS MANAGEMENT

As mentioned in the beginning of this thesis, the world changed after the Coronavirus COVID-19 crisis. The world, the vision about the world and the strategies that the companies are using. During this crisis, the I&C projects suffered a lot of restrictions. In fact, during the lockdown, where the majority of the countries closed their borders, the MSA2 technicians weren't allowed to travel anywhere. Since this is also time for contemplation, Syntegon started a project named "Do it right the first time" which consists on decreasing the number of trips needed when an I&C project is occurring.

In order to achieve the goal of doing it right the first time, this project will be based on data analysis, since it will focus on decreasing recurrent mistakes, finding solutions for usual problems, and make the technicians more efficient and independent. This project will certainly pay in favor of the development of this feedback loop tool. The "Do it right the first time", will require data extraction and, therefore, data analyse in order to understand why sometimes it is necessary for a technician to go back to the customer. Is it a Syntegon planning fault? A customer's fault? A technician's fault? At this moment, although these reasons are usually known, they aren't organized, nor collected to further review. Consequently speaking, this means that this information will eventually get lost or it won't reach the right hands to be dealt with. Therefore, with this tool, it will be possible to clearly understand why did a project got delayed, and by understanding the causes of the issue, it is indeed possible to attack those causes and prevent it to happen again, increasing significantly the customer service quality as well as decreasing the project costs. Beside this, once a problem occurs during an I&C, this tool will also facilitate the creation of standard issues, as well as its standard solutions, which will be inserted on the FAQ webpage, guaranteeing that a certain kind of issue will not provoke undesired delays on the future projects, and without those delays, Syntegon will be able to achieve the previously mentioned goal of "Do it right the first time".

Initially on this thesis there's a chapter with a context to situate the reader about the meaning and goal of this thesis. In that chapter, it is mentioned that "A strong organization, with an unified workforce engaged in a common vision, it can only be achieved with quality

in internal communication between departments. A clear and effective communication between departments, especially inter-departmental communication, is a key asset of several organizational functions that help to keep any enterprise efficient and productive.". It is a fact that sometimes the technicians aren't aware of the project's goal, or are stuck at some point during a project, and without an efficient and effective communication between them and the responsible for the project it is not possible to get a proper answer. Without an efficient and effective communication platform, information might get lost, the solutions given to the technician might not be correct nor standard, it is difficult to build trust within the organization, it is hard to track the issues and the solutions, which might cause also a big waste of time and, consequently, resources, and, at the same time, it is practically impossible to evaluate both the solution provided for a certain issue as well as the applicability of it.

While this thesis is being written, the procedure applied in the company is the following:

Every time a technician faces an issue during an I&C that he's not able to surpass, he has to inform the PM or go directly to the specific engineer responsible for that issue (software, mechanical, electrical, etc.), via e-mail or phone call.

- If a technician reports an issue via phone call:
    - Written data will not be available;
    - Saved and organized data will not exist;
    - It will not be possible to track the issue;
    - It is possible that no standard procedure will be provided;
    - It will not be possible to track the solution and its efficiency;
    - The FAQ might not be updated accordingly;
    - Procedure isn't 100% transparent.
- If a technician reports an issue via E-mail:
    - Written data will be available;
    - Not possible to guarantee that the data will be saved and organized;
    - It is only possible to track the issue by its direct intervenients;
    - It is possible that no standard procedure will be provided;

- It is only possible to track the solution and its efficiency by its direct intervenients;
- The FAQ might not be updated accordingly;
- Procedure isn't 100% transparent.

"To retain clients and insure the flow of repeat business, you need to maintain a high level of customer service. When the departments in your company are efficiently sharing information, then clients can be properly attended to, and customer service improves." [1]

In order to attempt to get an optimal data collection, its retainment and its analysis, it is necessary to build a platform where this data can be inserted and accessible by everyone of the company, which will promote an efficient information sharing. With the right method adopted, the company is able to guarantee that:

- All the data is written, saved and organized;
- Everyone, direct intervenient or not, can track a certain issue;
- Standard procedures are provided to the technicians every time;
- Everyone, direct intervenient or not, can track the solution given and its results;
- FAQ is updated accordingly;
- Procedure is completely transparent, since everyone has access to it.

This platform will be nothing more than a feedback loop platform, where all the data is inserted in order to be continuously absorbed, analysed and to develop solutions for the reported issues. This platform will allow the technician to report an issue, or leave a feedback about an occurrence during a project that needs to be analysed (To Do). The PM, after receiving this "ticket", is responsible to allocate the issue on the responsible to analyse it (electrical, software, mechanical engineer, etc.), and come up with a solution (In Progress). Once the engineer comes up with a solution, the procedure is sent to the FSE, which will apply and verify the results of the solution. If the proposed solution solves the reported issue this "ticket" should be considered finished (Done), and the FSE may proceed with the I&C. After this, in order to guarantee a continuous improvement, and in order to guarantee that, in case this situation happens again, the FSE will be strongly supported by a trustworthy platform, both the issue and the solution should be verified and correctly

inserted in the FAQ in order to support the FSE in case the same issue occurs in another project. Although this is a more bureaucratic system, it ensures that if it happens the next time, the FSE doesn't have to repeat the procedure. Instead, he will have the tools to solve the issue without being dependent on anyone.

5.3.1 JIRA KANBAN

JIRA software is nothing more than a tool that is responsible for tracking bugs, issues and solutions tracking, and it is an important tool for project management. This is an interesting software to be applied in order to develop a feedback loop tool, because it allows the technicians and the PM to work better as a team, in an agile way. This way, it is possible to observe the pendent issues, organize tasks and workflows. It also makes it possible to understand why a project got delayed, in which step, which was the cause of it, etc. JIRA tool reveals itself as a highly interesting tool to be applied on project management because it allows all the direct, or non-direct, intervenients to be part of the process and to analyse and make conclusions about it. Beside all the organizational benefits that this tools brings, it also allows the technician to have a stronger back-office support, and allows the back-office to analyse the technician necessities during his project or even his professional necessities (individual evaluation).

As said previously on 4.4.1, "the possibility of including, on the platform, the whole team involved in the project allows a more efficient communication, lowering unnecessary noise during the project and highly increasing the team's productivity", as well as it will also inform the whole team which tasks have been uploaded and are on hold (To do); it is possible to know once the tasks are allocated to someone and who is that someone (Doing), and which tasks have been solved and concluded (Done). Beside all this, this tool allows to understand how much time was lost with every process and, eventually, what were the reasons for that time.

5.3.1.1 Project Creation

Below, in Figure 29 - JIRA Kanban Board, the JIRA Kanban project created for the MSA2 is represented and named as “PANL I&C Support”. The first step of this project is naming it in order to create it. The goal with this Kanban board is to have the simplest possible way of exchanging information, so the workflow will be divided in 3 columns (To do, In Progress, Done).

Figure 29 represents the main page of the tool, where everyone with access to it is able to check which issues are open. This also reveals to be interesting because, since everyone is able to make comments, this means that it is possible that some technician, or some PM, already faced a certain issue and therefore they can provide an answer faster than the normal *modus operandi*.

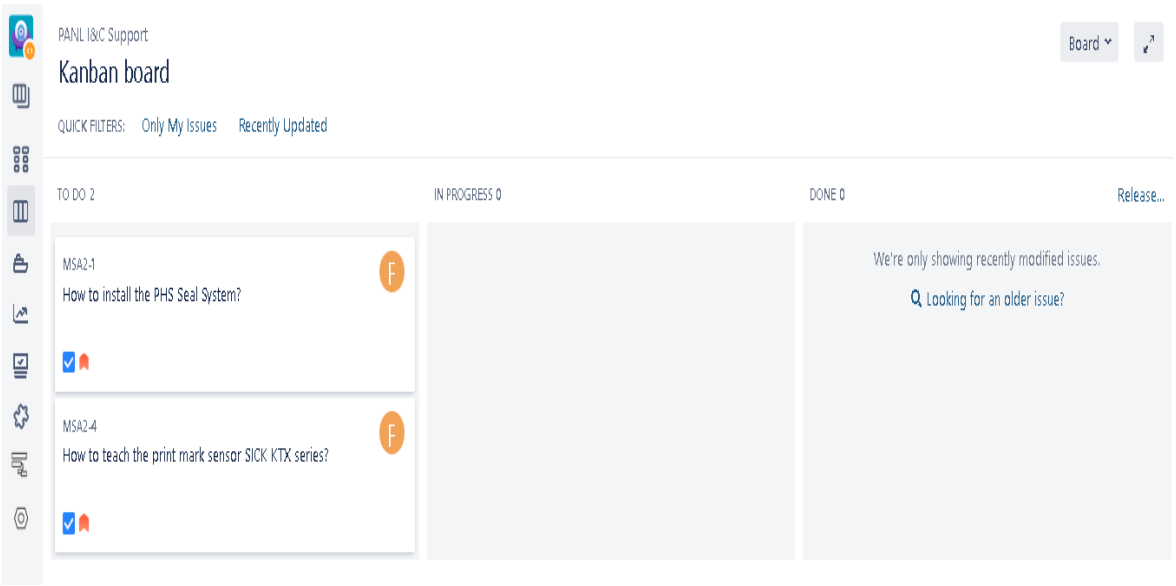


Figure 29 - JIRA Kanban Board

5.3.1.2 Issue Creation

Once the project is created, and the intervenient have been given access, it is now possible for them to create issues in case they face obstacles during an I&C that aren’t able to surpass without being supported by the back-office.

First, the technician should look for the issue that he's facing on the FAQ webpage. This page might have the information that the technician needs in the moment, although in an initial stage this will hardly happen, due to a no updated FAQ. As the goal is to uncomplicate, organize, reduce waste and make this tool as friendly-user as it can be, too much information is not welcome nor cases repetition. That's why it is so important to keep the FAQ webpage organized as well as updated.

In case the issue isn't present on the FAQ webpage then it is time to create the issue. During the creation of this issue, the reporter is able to define several differentiating characteristics, as shown below:

1. Name of the issue;
2. Type of the issue, which can be considered as a Task, Bug, Improvement, etc.;
3. Priority, which can be Top, Medium or Low;
4. Label, which should differentiate immediately about which part of the machine is the reporter referring to;
5. It is possible to assign this issue to whoever the reporter finds adequate – usually it should be assigned to a Project Manager as shown below;
6. Add a text description in case it is necessary;
7. Attach photos or videos in case it is necessary;

Figure 30 - JIRA Kanban Issue "To Do" shows the created issue on the Kanban board, status "To Do", which name is "How to install the PHS Seal System?". In this example, the technician isn't aware of how to install the PHS seal system, and since it is a bottleneck because he is not able to proceed with the project in case he can't install the PHS seal system, he considered it a High priority Task. PHS seal system is related to the CSJ, therefore this issue should be labelled as CSJ. The technician assigned this issue to his PM (Project Manager X). In this page of the platform it is also possible to see when the issue was created (23/6/2020, at 12:30pm).

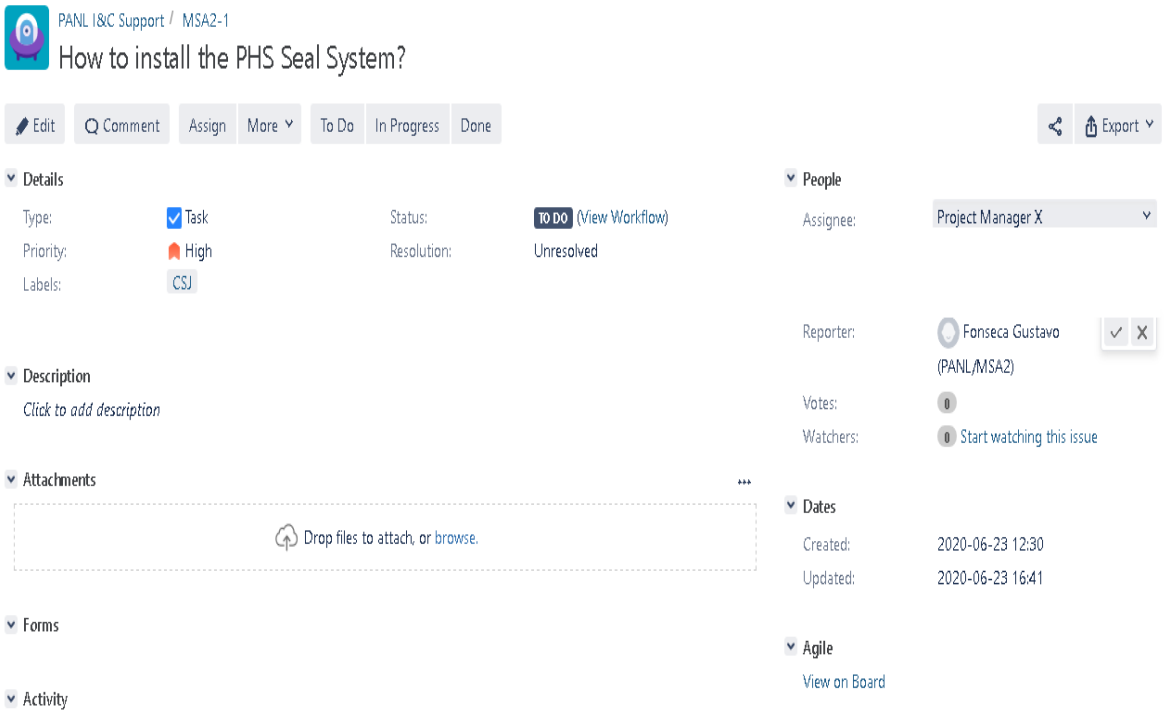


Figure 30 - JIRA Kanban Issue “To Do”

Once the assigned PM gets the notification of the open issue, he’s responsible to find the right person to allocate this issue. Changing, manually, the issue status to “In Progress”, in order to inform all the intervenient that this issue is being given the proper attention.

Below, in Figure 31 - JIRA Kanban Issue “In Progress”, it is possible to conclude that the issue is already “In Progress”, which means that the issue was allocated to the right entity already. In this example, the responsible for the solution uploaded a pdf file where the technician can find the standard solution for his issue. Once the technician proceeds with the project and tries the solution provided, he’ll be able to give a feedback on the JIRA Kanban.

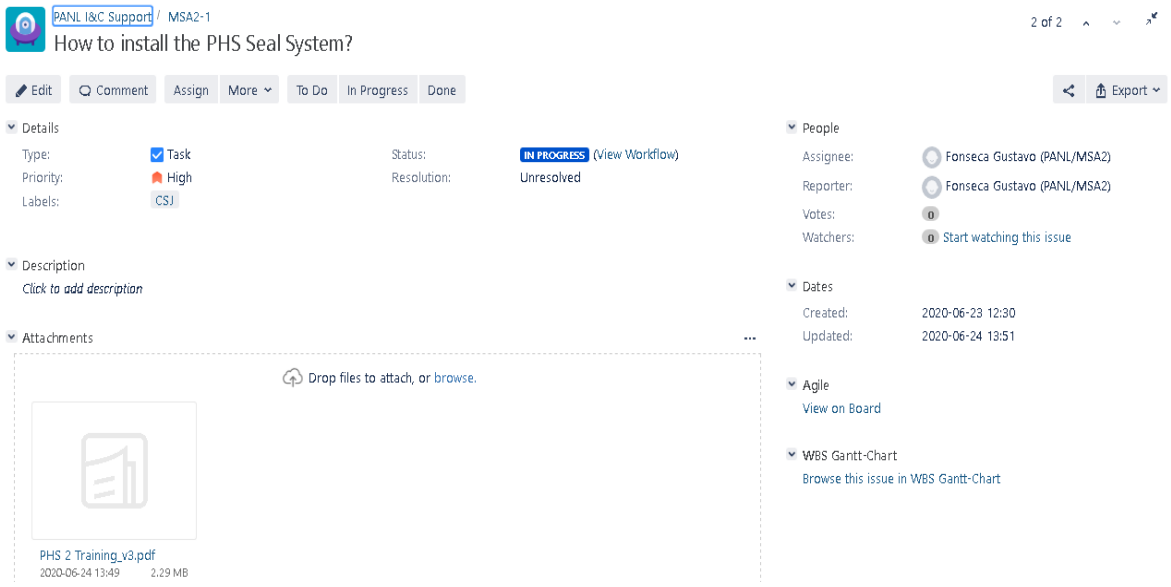


Figure 31 - JIRA Kanban Issue “In Progress”

On Figure 32, it’s possible to watch in the comments, who did the PM allocated the issue to, as well as the comments from the solution provider, where he informs the technician that there’s a topic on the FAQ webpage that will help him solving this issue.

Figure 32 - JIRA Kanban Issue “In Progress”

Once the issue is allocated to the right person, and changed its status to “In Progress”, the Figure 33 shows how will be the JIRA Kanban board look like after this project update.

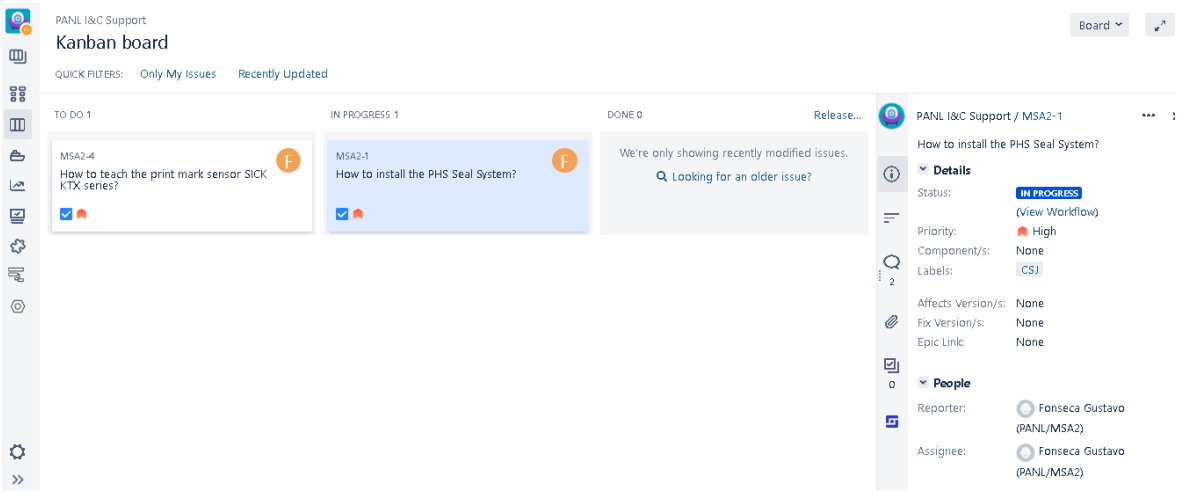


Figure 33 - JIRA Kanban Board Issue “In Progress”

After the technician is provided with a standard method to solve the created issue and proceed with the I&C, he is able to evaluate and verify if the solution given is adequate to his problem. If the solution provided is adequate, he should manually change the issue status to “Done”, as shown on Figure 34 and Figure 35, as well as inform the intervenient in the process about the output from the solution given. In this case, as the technician informs the intervenient, since there is already available a standard method in the FAQ, there is no need to upload a new one to the FAQ webpage.

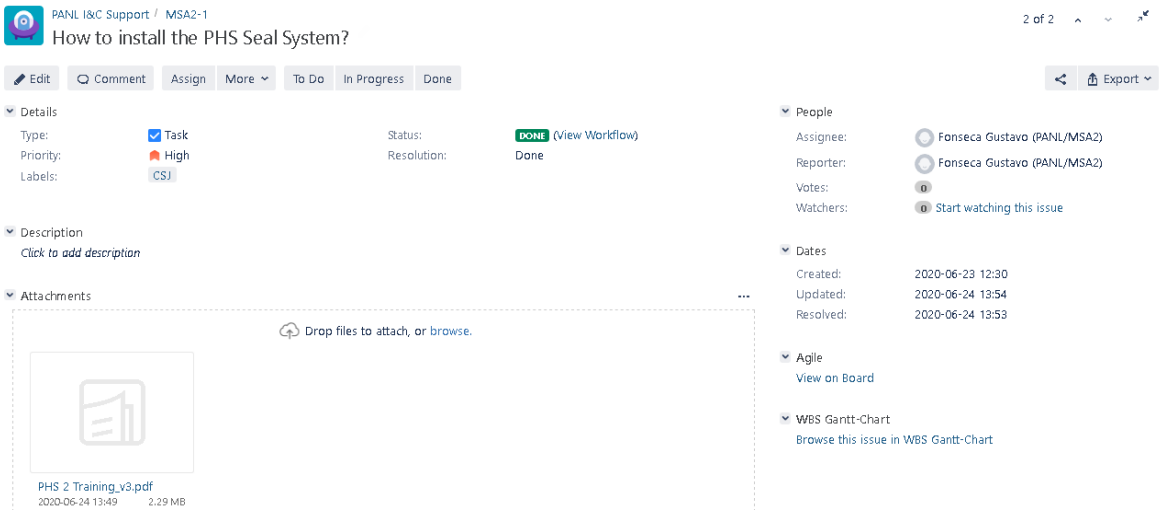


Figure 34 - JIRA Kanban Issue “Done”

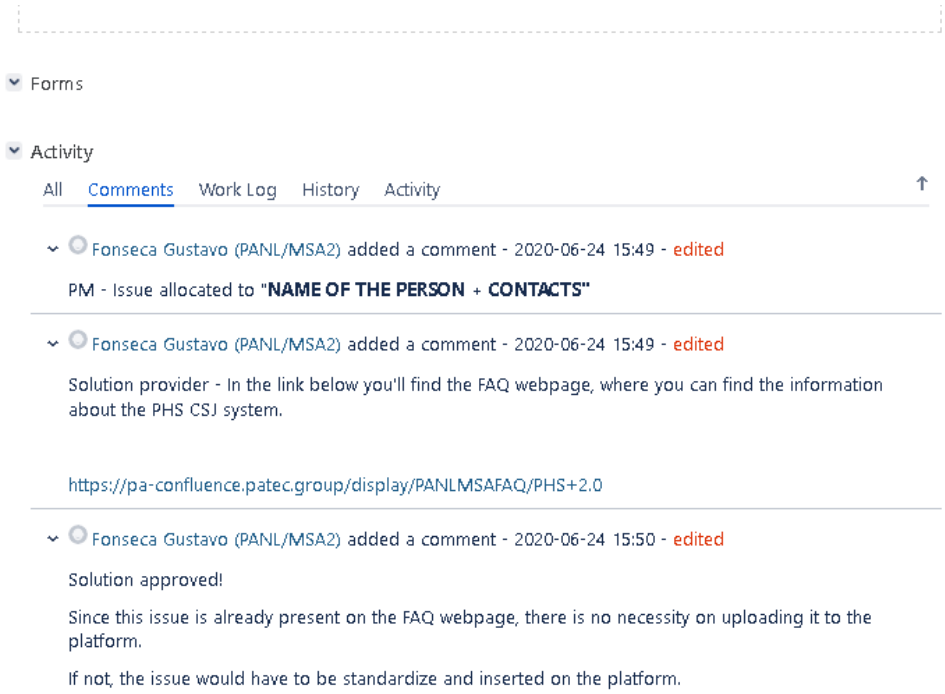


Figure 35 - JIRA Kanban Issue “Done” - commentaries

After the previous update given by the technician where he informs that the issue is solved, the JIRA Kanban Board will look like it’s shown below in Figure 36.

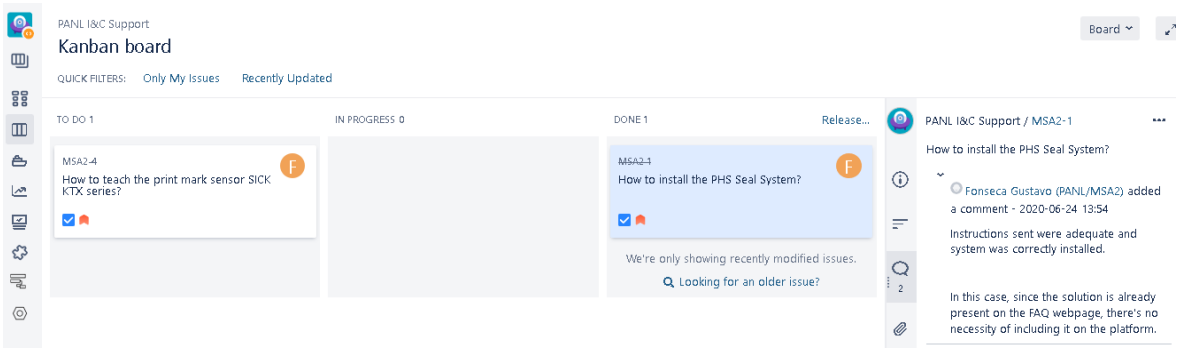


Figure 36 - JIRA Kanban Board Issue “Done”

6. CONCLUSIONS

The year 2020 was an atypical and game changer year. Suddenly, a lot of companies suffered big restrictions in their business model and major workflow reductions due to the lockdown which made factories slow down the production, resulting in less profit since the structural costs practically remained the same. At Syntegon, for example, a new project started with the name “Do right the first time”, which goal is to reduce the number of trips that usually a FSE has to take in order to start and finish an I&C project. Since it was a year when, during some months, the workflow was significantly lower comparing to as it would be in a normal situation, it was a time for companies to reflect also.

The opportunity to do this project comes in a perfect timing to fight the process inefficiency that Syntegon was experiencing in the communication processes between the MSA2 and other departments, as well as the absence of standard procedures that guarantee consistency and processes uniformity. Therefore, this was developed with the purpose of aiming towards a better, more efficient and transparent communication between departments in order to give to the field service engineers a stronger and organized platform that will allow them to achieve bigger independency as well as better results, while at the same time focusing on standardize the technicians *modus operandi* to be able to guarantee a certain quality independently on who the technician is.

The first goal of this work was to create an online support platform for the FSE when they are in an external project (at a customer’s site). Although there are standard processes to operate with the machines, and to install machine equipment, those standard procedures usually never reach the FSE. With this tool, Syntegon will be able to guarantee that there will be a platform with trustworthy and organized documentation and useful updated information to support the FSE, and will assure that once a standard procedure is developed, they will be incorporated on a webpage and all the FSE will have the opportunity to do their job while supported by tested and validated standard procedures. Beside this, in case a technician is facing an issue that he can’t surpass, he might be able to

find the same issue on the FAQ webpage, with a standard procedure which will guarantee a certain standard quality, more independent FSEs, less project bottlenecks and therefore less costs, bigger I&C efficiency, which also promotes a higher customer's satisfaction.

The second issue that this work is solving, is the lack of standard procedures in the MSA2 department. As a result, once a technician goes to an I&C project, every one of the technicians have their own methods, which means that it's impossible to guarantee a certain quality, independently on who the technician is. Without standard procedures, the company can't guarantee that every technician will work the same way, which means that the results will be different. This might reveal low quality procedures for some technicians, which means customers are not satisfied, and high dependency of the FSE, who needs even more time than the usual to adapt since he's not supported by SOP. With a SOP, Syntegon is able to guarantee that every technician will be based on the same guideline, explained step by step, which will mean similar machine outputs, the training given to the customer will be the same independently on the technician, and it will be easier to evaluate a technician, due to the similarity of procedures and, therefore, the expected outputs.

Last but not least, in order to fight the communication inefficiency between departments, this work focused on creating a platform for all the I&C project intervenients. This platform (JIRA Kanban) was the solution provided on this thesis, for a communication process that isn't as transparent as the company wishes. Since sometimes the technicians struggle with working on different time zones, extra hours, or simply because they aren't supported as they should be, or with the desirable pace, this platform will allow the technician to expose his issues, and all the project intervenients will be notified about it, making it possible to analyse and conclude what the faulty processes were. Once this platform is applied, the technician will be able to ask for indications with detailed information such as text, attached files, etc.. Therefore, with this platform, where everyone have access to see its status, it is easy to identify who provided the solution, when was it provided, if the given solution solved the issue, etc.. With this information, it is possible to understand where and why did the project got postponed, which allows the company to correct the procedures in case it is necessary. Beside this pros, it will also simplify the creation and inclusion of SOP on the FAQ webpage, due to the fact that the FSE should be provided with standard

procedures, which can be added to the FAQ platform afterwards, once the solution is considered accurate.

This work solves some loose points that the company is facing for a long time already and never had the will to solve them. The solutions present in this work will guarantee that there is an increase of the quality of the exchanged information, faster, more organized and better decision making, more efficient procedures and therefore the possibility of I&C costs reduced, bigger customer's satisfaction, improved teamwork and improved internal communication and alignment.

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Annex A

Stage Nr	Stage Name	Beginning	End	November		December		January			February	March		April			May	June	July	August
				18 - 24	25 - 1	2 - 8	9 - 15	6 - 12	13 - 19	20 - 26	8 - 29	1 - 22	23 - 29	3 - 12	13 - 19	20 - 30	1 - 31	1 - 30	1 - 31	1 - 31
1	**Introduction**	23-3-2020	12-4-2020																	
1.1	Context	3-4-2020	12-4-2020																	
1.2	Objectives	23-3-2020	29-3-2020																	
1.3	Project Planning	3-4-2020	4-4-2020																	
1.4	Report Scheme	3-4-2020	12-4-2020																	
2	Technology Sector and Corporate Background	18-11-2019	15-12-2019																	
2.2	Mechatronics	18-11-2019	1-12-2019																	
2.2	Packaging Industry	18-11-2019	1-12-2019																	
2.3	Syntegon Packaging Solutions B.V. (Former Robert Bosch Packaging Technology GMBH)	2-12-2019	8-12-2019																	
2.4	Syntegon Packaging Solutions B.V. - Weert	2-12-2019	10-12-2019																	
2.5	MSA2	9-12-2019	15-12-2019																	
3	**Literature Review**	11-12-2019	29-3-2020																	
3.1	Lean Management	11-12-2019	8-1-2020																	
3.2	Jidoka & JIT	13-1-2020	19-1-2020																	
3.3	3M's	20-1-2020	26-1-2020																	
3.4	Lean Management Tools	8-2-2020	22-3-2020																	
3.5	As-Is / To-Be Methodology	23-3-2020	29-3-2020																	
4	**Planning and Methodology**	3-4-2020	30-4-2020																	
4.1	Traditional Methodologies	3-4-2020	12-4-2020																	
4.2	Agile Methodologies	13-4-2020	19-4-2020																	
4.3	Traditional Methodologies VS Agile Methodologies	3-4-2020	19-4-2020																	
4.4	Jira Tool	20-4-2020	30-4-2020																	
5.	Case Study	1-5-2020	31-8-2020																	
6.	Conclusions	24-8-2020	31-8-2020																	