Digitalization of a plastic production line and proposal of methodology for the digital transition with Lean tools support

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Abstract

In the last decades, there has been tremendous technological progress in the various areas of society. One of which is the industrial sector and, like the human being, it had to adapt to the changes established. In industry, one of the most notorious productive models is the Lean Manufacturing, which has the basic principles of enhancing the productive results through waste reduction and continuous improvement of the production means. With the emergence of the 4th Industrial Revolution, the digital realm has taken a new relevance, and the transition of the production systems to it should have a growing priority.

Hence, a research was developed to substantiate that, using Lean tools and mentality, this transition from analogic to digital should be more sustainable, and enable the I4.0 full potential. This acquired knowledge was applied to a plastic components production line as an example. Then, a diagnosis of the productive system was made in order to identify and evaluate its inefficiencies. Subsequently, practical solutions were applied to the inefficiencies detected in order to eliminate them. These developments were done with the purpose of the improvement of the production line operational results through: waste reduction, process simplification, communication flow between teams, increasing of possible information extracted from the production line and, consequent usage of which, for future optimization.

Since the digitalization must be accompanied by Lean tools usage (according to the present literature), in order not to amplify precedent imperfections, this process was made so it can ease the digitalization process. After this optimization by Lean methods, it was created a system (PCIS) that has access to the information available in the manufacturing area, so it can encompass all the information, signals and results of the whole process, from raw material, to shipping for client, following the value stream of the products.

Due to the excellent results proven in the digitalization of Plastics production line, it was proposed that the same process should happen to a magnesium injection production line. With this, came the opportunity to define a method of digitalization based on these case studies.

Thus, this study is meant, to document not only a digital implementation and its issues, appealing to the available tools, but also to create a practical method for future digitalizations, regardless of the product or process. Followed by this method, is joined as supplement the limitations of digital systems faced, as well as the difficulties confronted at the time of implementation, due to the continuous inevitability of human touch dependence.

Keywords: Lean Manufacturing, Digitalization, I4.0, PCIS, Visual Management, Continuous Improvement

1. Introduction

Since the beginning of the millennium, there has been a paradigm shift in the industrial world due to the most recent technological evolution. By having the possibility to obtain more information from the productive systems – resorting to the growing digital resources available – it is now possible to study the best means of production to optimize production [1]. With this evolution, it was created a new way to interpret production and, by doing so, it became possible to: reduce waste, increasing the percentage of high quality parts, and connect the different human and material resources, from a data standpoint.

However, not all productive systems are familiarized with this technologic evolution and this study is based on that fact. Due to the market's competitiveness, it became essential for the Visteon Corporation's Plastic injection production line to develop technologically. Therefore, a digital system was conceived and implemented to improve the production line results in efficiency of processes, productivity, sustainability and ecology. This project was developed for Visteon (core idea, concept and practical architecture) in partnership with Rigorsoft (coding).

This implementation was only possible after a thorough diagnosis of the production line. The diagnosis was done with the Lean Manufacturing principles in mind. Through applying continuous improvement strategies, it is the intention to increase the final product's value, by resorting to Lean knowledge and tools [2]. The Lean approach to the case study has the purpose of defining the production line processes, so that when the digitalization is implemented, the system is robust and has its performance assured. This way, when the digital transition occurs, analogic errors detected will not be repeated, which confers a smoother automatic process.

The process of digitalization in the Plastic injection production line had positive impact, which made Visteon decide that this process should be applied to the Magnesium injection production line. With this opportunity, the possibility of developing an algorithmic method to transitioning from analogic to digital was created. This method is based on the experience verified in both case studies and sustained in the literature background presented, taking focus on Lean Manufacturing principles, I4.0 technology and taking in account the systems limitations and human factor adjacent.

2. Bibliographic Background

2.1. Lean Manufacturing

The term *Lean Manufacturing* was popularized by Womack, Joss and Ross, which is now the basis of various areas in the industry [3][4]. It was underpinned by the Toyota productive system principles but to reach this model, some technologic progresses needed to happen [5].

Industrial progress had its starting point with the invention of the steam engine. The possibility to sustain production with machinery caused an abrupt growth in production volume [6]. Then, the electrification of industry and automatic conveyors created the opportunity for mass production [7]. In addition, with the economic conjecture brought by the post – II World War, productive systems started to explore electronics' capabilities, creating automats and robots.

With technological development growing, the solution to the worldwide financial crisis adopted by companies was to reduce the number of people in production lines, in low-impact tasks [7][8]. These changes are accordant with TPS mentality, since its principles stand for error reduction and optimization of processes. Womack and Jones defined Lean as a variation of TPS that, with time, gained its own identity [4]. This methodology of business management organizes operational processes by reducing waste in every step of the organization and process, which will maximize the value flow for the client [9].

Lean Principles

The five fundamental pillars of Lean are: product classification, value flow identification, definition of the production flow, pull system and the continuous improvement mentality. With these ideologies in mind, the employees of a company can strive for better production results [2][10]. However, Lean is not only about continuous improvement, it should represent a shift in the entrepreneurial mentality, focusing on client satisfaction. One of the most used methods to represent the client needs and Lean mentality is the House of Lean. This representation (**Figure 1**) encompasses all the tools and necessities for Lean Manufacturing to obtain results, having the client satisfaction as its top priority.

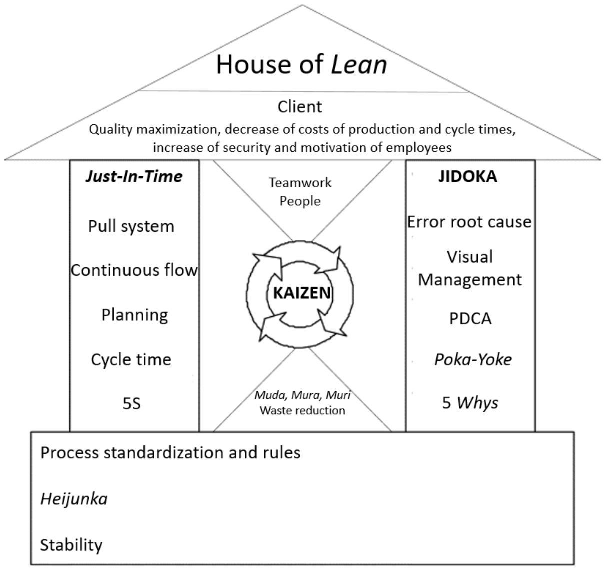

Figure 1: House of Lean adaptation [11][12][13]

Lean Tools

The organization in the workplace is essential in Lean ideology. Therefore, to improve the efficiency of employees, there are five rules to implement in every working position for it to be properly functional. The 5S stands for *Seiri*, *Seiton*, *Seiso, Seiketsu* and *Shitsuke*. With them, Lean defines the professional guidelines for the workplace. Definition of the essential equipment and its placement, clean workplace and a definition of a cleaning standard, as well as to instil this mentality of pride in the workplace's organization [14][15].

Since Lean's focus in the productive system, to extract better results is to reduce waste, it is essential to define the said waste. Therefore, there are three categories of waste: *Muda*, *Mura* and *Muri* [11][16]. They represent the waste during the manufacturing process (which can be sub-categorised [17][18]), the lack of standardization for the feeding of the production line, and overflow in the process and/or resources [2].

As for continuous improvement, Lean productive systems predispose of tools like the PDCA cycles in which the employees are imbued with the capacity of planning and improvement, execute it, check its results and act in order to standardize the positive results of that same experiment [16]. The 5 Whys method and Ishikawa diagrams are also tools that should be taken in account, for they confer the ability to evaluate the root cause of a problem [18][19]. *Kaizen* is also a valuable tool that should be put to use, for it represents the continuous improvement in all sectors of a business for company and employee benefit [20]. Finally, *Poka-Yoke* practices guarantee a defence mechanism to a process, so it can be repeated and obliterate the margin process malpractice [20][21].

Visual Management

A visual workplace should be intuitive, adjustable automatically, as well as regulated and improved, and that is possible thanks to Visual Management [22]. It has the main purpose to enhance transparency in the transmission of information and each company should develop it independently to adapt the data needed to each case [23]. Since every enterprise has its defining objectives, the information granted in the Visual Management boards or screens should only contain the required information and KPIs by team that is supposed to visualize it [24].

Industry 4.0

The contemporary industrial revolution is referred as I4.0, and with it came the concepts of CPS, IoT and Smart Manufacturing, which by cementing its position resorting to nine pillars – big data analysis, cloud computation, 3D printing, systems integration, IoT, augmented reality, autonomous robot, cyber-security and simulation – is leading the industrial realm to Smart Factories [23][25].

However, to reach this goal, the production still as to base itself in the Lean model initially, so the productive system may be granted with more versatility and maturity [23]. Both Lean and I4.0 share the purpose of adding value to the product through process simplification so it is possible to conjugate these approaches. This simplification is based in horizontal and vertical IoT tools, so that the decision-making can be decentralized, which increases its precision [26][27].

Limitations and resistance to change

With automation, it is possible to eliminate manual processes, but there are always physical procedures that require human intervention. Even though they cannot be eliminated, it is possible to implement intermediate procedures in the process of digitalisation – so these can be traced [5].

One of the biggest limitations to digitalization is the lack of availability for change. Resistance to change is a psychological phenomenon studied worldwide, and in this process there must be measures to minimize its influence [28][29][30].

In such a transversal change in the process, it is essential to engage personnel so it could happen in the less sinuous manner possible [28][31]. To assure a fast change there must be good planning. That way, in the conception phase, all possible outcomes of a path should be taken in consideration so a prediction of the influence of it can be weighted. Having feedback from all the teams involved can grant process robustness, but it can also mean a lack of direction due to conflict of interests. Therefore, it is important to have flexibility but a major guideline should be what defines the whole process [32][33].

3. Case study

3.1. Context

Visteon Corporation is a company of development and manufacturing of electronic components for the automotive industry, being the Palmela plant the biggest and highest grossing of the enterprise.

Nowadays, in 2020, Visteon is the market leader of its industry and the main goal is to keep that position. Then, to keep striving, it should be a priority to keep up with the technologic advances at its disposal. This is applied to the whole plant, but in the plastic injection production line where all processes are done analogically, the need for the digital transition is urgent. It is a production line with 30 injection machines, with the respective peripheral equipment, and around 250 moulds for injection.

The process is based on various steps. First, raw material reception and storing. Then, as production pulls raw material, it is put through heating before being sent to the injection machines. The fuse injects material in the mould and as the fluid material cools, it acquires the shape of the interior of the mould, which then proceeds to extract the parts. The parts are now put through a process of inspection, and in case of high quality part, it is stored and sent to warehouse. This whole process can only exist due to the efforts of various synchronized teams, which allow the process to flow with high standards.

3.2. Production line diagnosis

A full diagnosis of the production line must be done to detect the root cause of the line's inefficiencies. To better understand the processes, the team should go to the shop floor, and supported by Lean principals, do *Gemba* Walks [11][34]. This study follows the products value flow, from raw material to client, with focus on manufacturing and human processes.

Inefficiencies Identification and Analysis

To simplify the information acquired in the *Gemba* Walks, the process of inefficiency explanation will be done team by team, following the path of the product. It enters Visteon in raw material granules, and the RM responsible receives it. The receiving is done in person and has no quality control of the batches. Plus, when the material is stored there is no control of humidity and it is on a warehouse that is regularly exposed to open-air. Before the RM is sent to production, the employee is entrusted to dehydrate the material by heating it in silos. This way vapour droplets are eliminated from the batches, which guarantees the quality of the product, but there is no registry of the collaborator's actions. Other concern is the constant waste of time and misinformation transmitted to the worker, because the flow of information does not reach him. He has to move around long distances or wait to be informed of the production planning (and its changes), which is not a good practice and result in various types of *Muda* wastes.

Visteon productive system is pipelined in a pull system method. Client demands production, and the lines supply it, being the Plastic Department one of the various supplier of the Final Assembly Department. In constant contact with FA, there is a Production Engineer, which manages the human and equipment resources of the production line according to the clients' needs. This information is centralized, and is put in circulation by paper or by individually talking with the people involved. It is the most important job in terms of client satisfaction responsibility and with more impact on the different teams that compose the department. Even so, it relies almost exclusively in analogic and fallible processes.

The inspection specialists are responsible for the evaluation of the quality of production. In case there is any doubt or anomaly, they must contact their supervisor or Process Engineer, which will clarify and finds the means to correct the issue. It is also their function to remove minor contaminations, possible sprues, and to store the parts in their container. To help them establish a criteria there are QPS in the workplace that are meant to give guidelines to the employee, but most of them are not updated, and none of it follows a design standard with method of inspection. This is a great issue, because with incorrect quality standards, the production might be compromised.

Adding to the inspection and logistics of each part, the operator needs to keep track of the production and account it, as well as the defective parts. Their task is to take notes in the production sheet, in which they write down information like the hour of beginning and end of production, quantity of produced parts, as well as defects by type, or information like the amount of stoppage time of the machine. At the end of each shift, the supervisor collects every production sheet and delivers it to the Process Engineer. One of the Process's Engineer task is to interpret the information received and try to correct possible future mistakes. But this process is so extenuating, time absorbing and associated with such high level of filling errors that there is no pay-off by doing it. Even so, it is a mandatory process, which reveals a massive waste of resources and spawn attention of each team involved in the process.

A team of technicians also supports the production, and they are sub-divided as: Injection, Tooling and Maintenance. Each with its specific task, form a highly functional team, with clear practical appetences, but lacks of bureaucratic discipline. Since they are used to always deal with practical issues, they rely on operators and supervisors to complete their registries, whom comply. These malpractices have toxic impact on the relationship between all teams of the production line, since the message that it transmits is that there are people above their mandatory tasks. This creates tension between the Engineering team and all the others, and it erodes their image, which needs to be promptly corrected.

To complement the quality evaluation, the Quality team of the line is responsible of checking each part and check their procedures of quality assurance. This includes visual inspection, dimensional check and in some parts even physical testing. The dimensional measurements are done with callipers analogically, which doesn't guarantee high repeatability and precision results, when compared to other equipment in the market. The results are registered manually, and only after a variable period of time, transferred to a digital database. In case of negative results, the Quality collaborators should notice the Process Engineer and the production line, so that the issue can be solved. Even so, the observable result is that the message can be lost. This may happen to forgetfulness in both sides, or simply for lack or faulty of information, which needs to be solved in order to protect the production.

Inefficiencies Resolution resorting to Lean

Before the digital transition, it is required for the identified inefficiencies to be corrected accordingly. With this, there is a clear goal of correcting an issue in its source, instead of propagating it in an automatic process ahead.

By determining that the origin – with the 5 Whys logic – of one the most critical inefficiencies of the production line was the lack of quality control of incoming raw material, it became possible to investigate a solution. After some ponderation, it was implemented a MFI testing process, in which the RM responsible uses a machine to test samples of each batch received, for their MFR and compare it with quality tolerances. This quick try, implies an automatic registry that can be integrated in the future.

In order to optimize the layout of the operators' workplace, it was created a structure in which they position auxiliary parts for their work, **Figure 2**.

Figure 2: Structure for comparative parts

This change was followed by a full update of every QPS while implementing a standard procedure of individualized part inspection. With this, it is possible to guarantee that a percentage of defective part detected increases.

Parallel to this change, the procedure of the Quality Department's underwent an updated, being implemented a CMM that confers measurement reliability. The programming was done individually for each part, and its results are transferred automatically to a database. This way, it they become reachable for future analysis.

3.3. Digital system proposal

To have a full perspective of the current and past production it is imperious to create a system that can comprehend the essential features of the productive system. By using the equipment's electric potential, human input and computational power, those ideas become possible. Then, a digital system – PCIS – was developed so that all the production's requirements and tools are encompassed and accessible, **Figure 3**.

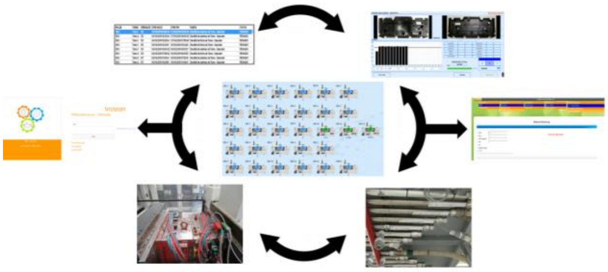

Figure 3: PCIS coverage of the productive system's tools

The system's database has the capability of aggregating information from the various steps of the process. It stores datasheet information from each mould, raw material and equipment available, so that, when a mould is in production, every data is crosschecked for production validation.

There were structural flaws in the process that could compromise the production. Hence, to eliminate those inefficiencies, defence mechanisms were created. By adding *Poka-Yoke* in physical and digital processes, the system requires human intervention and guarantees process quality. This way it becomes impossible to neglect every step of the required tasks, and fulfil the production necessities inputted by the Production Engineer. Raw material assurance, mould validation, machine and peripheral equipment status check are some of the areas that are impacted positively by these changes.

Previously, when the shift's plan was transmitted to the line it was frequent to have imprecisions of the time, in which the moulds were to be started up or moved from a machine. Sometimes, the wrong mould would even be placed in the wrong machine. This represented high delays in production and even low quality parts.

With the plan's transmission in real time, and immediate response to corrections, these errors are decreased. But to really eliminate this waste of resources, the system uses the information of the datasheet of the moulds, RM and injection machine to create a validation loop. This *Poka-Yoke* system (**Figure 4**) combines the acquisition of signals attributed to each of these process characteristics. In each mould, RM piping and machine were placed physical sockets which emit a signal to the system's database. Only when this circuit is closed, the production is set to flow. This is just one example of the types of mechanisms implemented with 100% verified results.

The identified issues with more impact on the knowledge acquired from the production line were on the involved analogical bureaucracy, information transmission between teams and lack of Visual Management. As mentioned previously, the flow of information became easier with PCIS. The system transmits two different Visual Management boards to TVs strategically put in the production line, and to every computer on the inspection workplaces. There, everyone on the line can consult the plan and possible changes, in real time. Instead of the previous condition where only very few people would know the information directly, which caused daily entropy in the production. It is also possible to acquire the real-time status of each machine, which has tremendous impact on the team of technicians. This way, they can interpret their operations priority, and correct it more efficiently and quicker.

As for the bureaucratic procedures, it is now possible to declare every essential task in the system in a clear and intuitive way. This method is more practical and allows a better usage of resources for subsequently study of the line, since it aggregates and filters the information needed. It also solved a long recurrent issue. Now, every person is responsible for its tasks and it is possible to evaluate with facts who complies with them, recurring to the task fingerprint in the database.

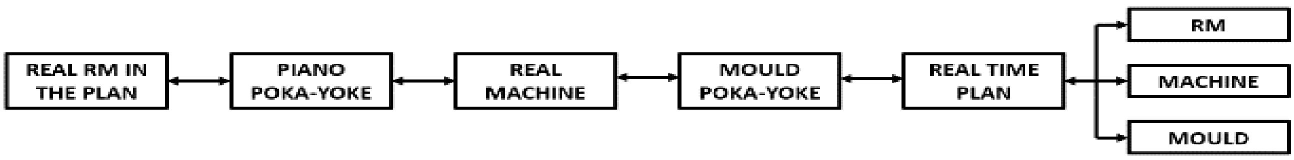

Figure 4: *Poka-Yoke* mechanism explained

To reach the goal of liberating the operator to focus exclusively on the inspection and storing of the parts, a Quality menu was created, Figure 5. In this, it is possible to get the full information of current production data, operational KPIs, and hyperlinks to other Visteon tools for QPS, Logistic and Maintenance.

Figure 5: Quality Menu

The user spends most of the time in this interface, in which he only has the responsibility of annotate the number, type and local (in the picture) of defects found during production. The accounting of production is done by machine impulses, alleviating their tasks, which increases their inspection time for each part.

None of these functions would have any purpose if there would not exist production traceability. That is why a reports generation menu was included in this implementation. There, the Engineering team has the capacity of manage the production, and create detailed analysis based on reliable facts extracted from the production line results. All of this in a timesaving manner, instead of the analogic analysis done previously. PCIS generates and saves the reports in friendly-user files. With this, it is possible to simplify the information for everyone, and develop a closer relationship between departments of the company.

However, the greatest outcome of this procedure is the ability of correcting inadequate processes. By having data supported facts, making a decision is easier, and the solutions for waste reduction appear more naturally. Finally, it is a useful tool for internal and external audits. All the procedures required by the OEMs are present in the system, and with the reports function, all data is reachable. The stored information includes user and production data, time and duration of mandatory tasks, amongst others.

4. Digital Implementation Methodology

The necessity for the creation of a digital implementation methodology comes from the lack of information available in practical cases. This happens due to confidentiality clauses demanded by the companies during the digital transition or, because these processes are recent, so there is not a lot of published information about it.

4.1. Thixo Molding case study

The results shown by the PCIS implementation in the Plastics Department led Visteon Corporation to take action, and expand this project to other production lines. Therefore, it started the expansion to the other injection productive system in the plant. The magnesium injection production line – Thixo Molding – is recent (was created in 2016), which in terms of data collecting processes results in lack of maturity. This, combined with a bigger electronic potential, increases the possibilities of flexibility and sturdiness of processes after the digital implementation, having PCIS as its foundation.

Thixo's productive system is the correct next step for this transition because it has the same management – which results in same team structure – and similarity in implemented processes.

Process characteristics and Inefficiencies

Even though it is a similar process, it has some divergences when compared to the Plastics. Hence, it is crucial to define the process, analyse its existing inefficiencies by doing *Gemba* Walks and adapt the existing system PCIS to the needs of Thixo's productive system.

The first specific characteristic found, was that this process only requires one raw material, and the suppliers batches are done frequently. Therefore, there is very little necessity of raw material control, in contrast with the Plastics.

The assigned area to the injection machine is called "cell", which is enclosed during the process for protection. The productive system is composed by seven cells, each one has trimming, and/or drilling machines as well as automated robots that guarantee parts moving. After all machining processes on the cell, the part is put on a conveyor that guides it to a common conveyor for all parts.

This will move the parts from every cell to one of two Vibra Finishing machines – responsible for the cooling and surface quality improvement of the parts through vibration. The inspection workplaces are located after this process, where the operator evaluates the quality of the parts and does the logistic procedure to warehouse. This means that the process works as parallel injection machines, producing parts to be inspected in series, which differs from the Plastics.

The other main characteristic found, was that this productive system is more susceptible to process stoppage. However, it has a bigger electronic potential because of the centralized PLC that acquires signals from all existing equipment in the process. Hence, it is possible to study the line's root cause of stoppage if the signals read by the system are correctly chosen.

System's adjustment to Thixo

Through the lessons learned in the digital implementation at Plastics, it was possible to avoid previous errors. In terms of bureaucratic processes implemented, the transition was smoother, and the team's coordinators and technicians understood quicker the increase of responsibility established.

As for the adaptation of the parallel-to-series production, it was possible to centralize all parts being produced in each computer of the inspection workplace. Then, the coordinator attributes which operators inspect which parts, and they are in charge of selecting the default parts that the system presents. Only after doing the PN choice in this intermediate menu (**Figure 6**), will the operator be able to correctly input the defective parts.

Figure 6: PN choosing interface

There were implemented other new navigability features to simplify the users interactions with the system, due to this particularity in production. One of which was a type of defect database, that allows the system administrator to associate different types of defects to each PN, instead of a fixed list for every PN.

As mentioned, at Thixo there are a substantial number of stops in production, but before digital implementation there was no tracing method for its analysis. This resulted in an identified critic step of the implementation. To solve this issue, the system had to acquire all the signals from the PLC and associate each of them to a type of stoppage. Then, the system acquires the amount of time for the response to the problem and its resolution. After those factors are measured, the system attributes automatically a root cause for the issue and (depending on the total time of stoppage) generates a report of stoppage automatically, or with the technician intervention.

4.2. Proposal of methodology for digital implementation

When beginning the digital transition, it is essential to define clearly the type of industrial process to convert, and its needs, (**Figure 7**). Most of the data can be converted to digital but there might be some that cannot, and those should be identified. Then, the digital system in which is included the information to extract, KPIs, team coverage, visual management, these are some of the aspects to set. It is also at this point that the digital infrastructure is stipulated so that no future issues of digital component are raised. The production sets the pace, not the digital realm.

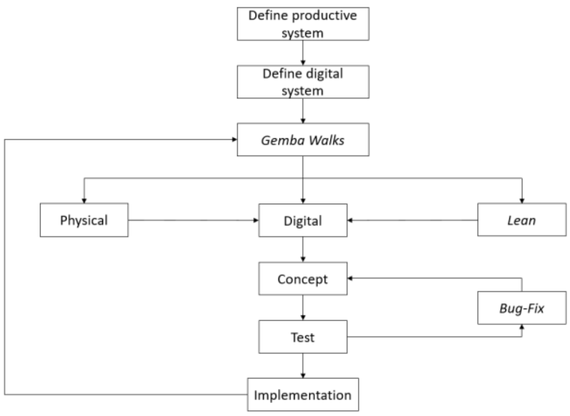

Figure 7: Digital transition methodology

After this, it is time to observe the productive system's characteristics and the digital system requirements. This process is done at the *Gemba* Walks, and the process analysis should be divided in three categories: physical, digital and Lean. The physical represents the limitations to the digital realm, the digital represent the existing virtual processes and those who can be converted into which. As for the Lean, represent the verified issues that must be corrected previously to the digital conversion.

For this observation to be successful, the Engineering must initially guide the *Gemba* Walks and it should follow the value stream logic. This way, the team's priorities are prioritized along the observation of possible inaccuracies. After that, the Development team should conduct its own observations, so it can have impartial analysis and conclusions. In this phase, the direct intervenient of a specific process should be approached to further clarification, to foment workplace environment improvement.

With these processes executed, it is now possible to correct the inefficiencies making the production line prepared to digital transition. Now, the development of the system must be done, preparing a user friendly application for every team. Having the code and structural/digital infrastructures ready, the go-live is the next step. In this, the sturdiness of the system is tested. This is the critical phase of the digital transition and every bug detected should be fixed quickly to preserve system credibility, only after that should new features be introduced. To ease the transition, an implementation by modules should be applied, to reduce the impact of the new processes thought. During this process, the contact with the different teams should be kept close, so that new ideas can be implemented and, with that, increasing the confidence of the teams in the system and levels of engagement of the employees in the new processes.

4.3. Limitations and resistance to change

Regardless of the implemented system, this type of transition will always entail limitations. However, the bigger the electronic potential, the bigger the possibilities of a smooth transition, and as the Thixo example shown, a centralized equipment for all signals helps to establish a foundation for a digital system. However, there are limitations, like the available inspection time, which will limit the time for defect registration. Hence, the system should maximize the time for process operations and be simple, to avoid becoming obsolete.

The on-going implementation of the digital transition increased the levels of engagement of all collaborators of the productive systems. This method enabled that their input could contribute for improving the navigability – which is one of the main issues of a system – and even sturdiness processes. The fomented sense of collaboration allowed a healthy implementation environment and, with that, the resistance to change was less felted.

Even so, there were extraordinary cases in which simple training was not enough. Particularly in the technician's teams, there were though cases of conflict. Although those were already being foreseeable, due to the insubordination on the bureaucratic processes verified previously to the digital system, only with psychological strategies was it possible to revert those collaborators' attitude towards the system.

5. Conclusion

In the present work, two digital transitions in industrial productive systems were registered, and with that, a methodology was developed for future similar processes. This implementation was done resourcing to Lean Manufacturing tools and principles, to improve the lines' inefficiencies.

After identifying the lines' inefficiencies, it becomes possible to create solutions to improve the lines. Examples like the raw material testing, dimensional control improvement, or *Poka-Yoke* mechanisms applied to the productive systems had great impact in waste reduction and process sturdiness.

To encompass all data and signals from the productive systems, a digital application was created. PCIS has the purpose of centralizing information in order to distribute it to all employees in an intuitive manner. This way, the tasks definition per team are more established and clearer.

Learning this new system was easier due to the modules go-live strategy of implementation, in which each menu was introduced progressively, smoothing the transition to the users and showing very positive results in the teams' morale.

This system shown great results in terms of communicational quality between teams, which was one of the main wastes observed. With that in mind, the tasks in each workplace were defined in a clearer way, and with proper scheduling by person, everyone's performance was improved.

In terms of production accounting and tracing, by automatizing the process, it became possible to ease the operators' task, and directly improve the quality of the data extracted from the production line.

Due to the improvement of the operational results observed, PCIS expanded to the Thixo Molding process, which granted notoriety to the system. In this second process of digital transition, the results observed were even better, especially in terms of process fluidity and lack of resistance to change. Therefore, the possibility of expansion granted this document the value of creating a methodology of digital implementation independent of the process.

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