

# Applying the Lean Concept through the VSM Tool in Maintenance Processes in a PIM Manufacture

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**Abstract**— Lean concepts were usually focused exclusively on the manufacturing areas, leaving aside administrative areas. However intense competition has led many organizations to begin to realize that these concepts would also be beneficial to competition with the implementation of lean thinking in their offices. This study addresses the Lean Office theme, a derivation of Lean Manufacturing. The vision of the Lean concept of identifying and eliminating wastes enables improvements in the flow of service call handling at a manufacturing plant in the Manaus Industrial Pole - PIM, using the concepts that were initially developed for manufacturing, making adaptations to the administrative areas, preserving the essence of the concept and applying lean thinking to improve the flow of care. For analysis of the current state through Value Stream Mapping -VSM, timing and 5S Concept.

**Keywords**— Value Stream, Lean Thinking, Lean Office.

## I. INTRODUCTION

After the Second World War, the Japanese of the renowned Toyota saw that it was necessary to create an orderly process of finding and eliminating waste in a decisive way, aiming at productivity and becoming more competitive, adopt Lean Manufacturing, a methodology for production improvements and efficiency in companies, inspired by the Toyota Production System. According to the history, the bibliography presents the lean concepts directed only in the manufacturing areas, leaving aside the administrative areas.

However, the constant dispute in the market led them to begin a perception that Lean concepts would also be useful in the competition with the implementation of lean thought and its application in the administrative areas, being called Lean Office.

The company in the segment of white lines with its sector and maintenance that acts in the service of technical services in the conservation of equipment and machines have been presenting a great waste of time and information. With this scenario, the environment is favorable for Lean Office deployment, using the holistic vision of the Lean Office to identify the waste and possibilities of improvements in the flow of maintenance calls at a Manauara factory in the white line industry.

## II. THEORETICAL FOUNDATION

A survey of theses, case studies, and books with themes related to the present work were constructed. We conducted research and reading with textual considerations with the purpose of absolving the work context, favoring a detailed view of the current state in the sphere of research for subject matter. It can develop an important theoretical basis to carry out the analyzes that are indispensable in the following activities. The main concepts will be presented captured from this research process, being of maximum relevance for the accomplishment of the work.

### 2.1 LEAN MANUFACTURING

When Lean philosophy emerged it had as its priorities the manufacturing environments, focused on combating the wastes that were seen and physically known in manufacturing [1]. The initiative of the search for the elimination of waste that is of no value to the customer is aimed at transferring speed to processes based on the Toyota Production System, which in the 50s through the executive Taiichi Ohno created and implemented a production principle where its priori was find the waste and eliminate, with the main objective to reduce costs and increase delivery time while maintaining product quality for the customer, this system became known as Lean

Production, produce more with less. Following the origins of Lean Manufacturing the essence of Lean Manufacturing is the reduction of 7 (seven) wastes: defect (in product), overproduction (overproducts), stock (products in standby), processing (unnecessary), transport (unnecessary of machines), waiting (of the employees for processing equipment and / or previous activity [3].

The effects of improvements in the manufacturing area have raised the need to take these lean concepts to the administrative areas, but to migrate this concept has required more attention in the identification of waste because they are not tangible. In the administrative areas most of the activities being generated of information consist of complexity in their identification. In the offices how to identify a wait? It can be identified as a report waiting for an analysis that may also have another wasted stock, already produced and stopped waiting for analysis. The Lean Office [4] or the Lean Office are applications in the administrative areas with the intention of improving these processes using the principle of lean thinking in the accomplishment of non-physical activities, since in this case a flow of value of information and knowledge, its focus is to eliminate the costs of these processes of the organization, in order to guarantee the leaner operation of the business [5]. In order to improve processes, the Lean concept can be applied from small businesses to multinational companies, because perfecting the processes is the solution to improve the organization's productivity and performance, this realization may be possible using the Lean concept [6].

## 2.2 VALUE STREAM MAPPING - VSM

Value Stream Mapping (VSM) is a business strategy tool where you can and can see the whole of the process. Properly showing the opportunities for improvement in each stage of the process. Performing Value Stream Mapping is also able to identify delays and bottlenecks in activities in the process stages [7]. With this it is possible to be able to understand which are the phases that do not add value in the process, with this vision to present a current state of the process, where each phase and its activities are described in detail so that the possible wastes in the process can be analyzed [8].

The future state is presented with the improvements [9], where one of the most important purposes allows to go beyond individual improvements, a systemic form. The appropriate tool to look at the processes of value association horizontally, emphasizing the activities, actions and their connections in order to indicate value and makes it run from the suppliers, the beginning of everything and including the final customers. The industries have different production capacity variations

per operation, finding which of these processes are the most difficult and their impact on the outcome at the end, thereby adapting the information they need to more effectively manage the industry and the process as a whole [10].

Using the Value Stream Map (VSM), there are benefits that make it possible to more accurately find the various activities and interests that do not add value in the process. Eliminating these wastes brings greater productivity to the process, allowing the company to be more flexible and competitive.

## 2.3. CONCEPT 5S

The concept of 5S aims to improve the organization as a whole by means of easy-to-conceive fundamentals and the ability to present significant results [11]. It is a tool based on simple concepts and that can bring great benefits to organizations, the principles of 5S is based on 5 (five) Japanese words with the initials that names the program are the words: Seiri being the sense of Use, Seiton sense of Organization, Seiso sense of Cleanliness, Seiketsu the sense of Self-discipline. The Sense of Use (SEIRI) denotes applying materials, tools, equipment, data sensibly and with good judgment [12].

In order to reject or reallocate everything considered unnecessary to carry out the activities, the effects of the use of the Sense of Use are promptly demonstrated with space utilization, favors cleaning and maintenance of the site, improved inventory control, reduced costs and favored environments for the good use of the other senses of the 5S program.

For [13] Organization Sense (SEITON) considered so that all things are available so that they are within easy reach for immediate use, standardization through labels, panels, shelves and furniture that facilitates and improves practical and fast reach. With this reduced time, easy access to tools, reduction of expendable and unsafe points.

Sense of Cleanliness (SEISO) a very specific sense in the elimination of dirt and residues, objects that are foreign or dispensable to the place. Maintain floor cleanliness and furniture. This sense of cleanliness goes beyond the physical aspect, involving the personal relationship, preserving a work environment with transparency, justice, sincerity and consideration, this sense results in healthy local, accident reduction, better tool conservation and improved relationship.

Sense of Standardization and Health (SEIKETSU) set lighting standards, colors. Locating boards among others that can be standardized. Its results are to facilitate the localization with identification of objects and tooling,

good physical and mental sense, focus on the improvement of common areas and safety.

Sense of Discipline or Self-Discipline (SHITSUKE) achievement and individual commitment with previous senses. Combined ethical and moral standards of each person. Fulfill activities without the presence of leadership. The effects are daily activities performed pleasantly, valuing the implementation of functional and administrative methods [14].

## 2.4 ANALYSIS OF TIMES AND METHODS

For decision of the Standard Time of an operation it is necessary to discuss with the ones involved the method of work to be executed, seeking the collaboration of those involved in the process [15]. Determine the method of operation and divide the operation into elements, carry out training with those involved to carry out the work according to the defined method, make necessary notes for observations sheet for final improvements, organize a schematic representation of the product and the location perform a preliminary timing with time sampling to obtain the data needed for analysis, perform the timekeeping and decide the mean time (TM). Measure the operation rhythm factor and set the normal time (TN), yield tolerances for fatigue and personal obligations, allocate the measured data in control chart to examine its quality, set the standard time of operation (TP). For [16] chrono-analysis is advised when the precision of the activities (process) is to improve productivity, to achieve in detail what happens in the process, authentic process capability, balancing action, inefficiency targets, mutual influence between activities of work and waste of time [17].

## III. TOOLS AND METHODS

Due to the difficulty that the team was facing to improve the attendance of maintenance calls, a study of the current situation was started. The administrative of the sector was in the external part of the Manufacturing, the person responsible (call center), for receiving the calls and registering the Maintenance Orders (OM), example in Figure 1, this administrative team all away from the Manufacturing, the employees responsible for executing the so-called technical team were in manufacturing pending the Oms.

Fig. 1: Sample Maintenance Request Form, Source: [18].

The OMs were requested by telephone, radio or by e-mail to the call center, which registered in bases: (excel, sap and backlog) in the system for the indicators to generate the indexes, the supervisor waited for release of the excel worksheet by the call center. With the spreadsheet released he distributed to the technical team, with the OM sheet in hand the technical team checks the material to be used and the appropriate tools for the execution of OM.

Technical team moves to the service location, performs the service and returns to the maintenance sector with the OM completed, due to the administrative sector is far from the maintenance sector, the completed OMs are archived, these have not been closed in the worksheet nor in the system that generate the indicators, at the end of the day the OMs were still open generating an indicator with service not performed by the sector, Figure 2 shows the software used.

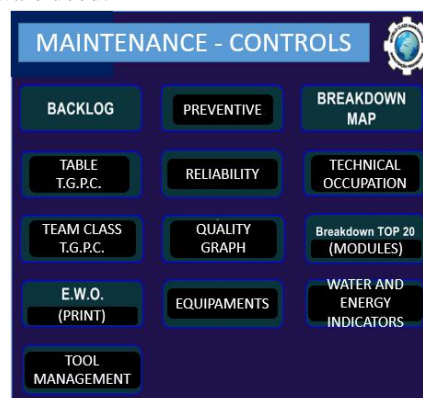


Fig. 2: Example of Maintenance Control.

The backlog is a time indicator that is used in Maintenance Management, it measures the accumulation of pending completion activities. Delay in finalization generated an unfavorable indicator for the sector, this

does not mean that necessarily all the activities that make up the backlog are delayed and this generates a bit of conflict. To evolve the processes it is necessary to understand all the procedures of the organization mapping, measuring and recording, then the best tactic must be identified to reach the goal of improvement.

With the help of the VSM, shown in Figure 3, the entire process was mapped, its activities in details of the call, service provider to the final customer, making it possible to identify the delays and bottlenecks in the service activities, understand where and what activities do not add value in the process. This way you can make the necessary improvements in the flow.

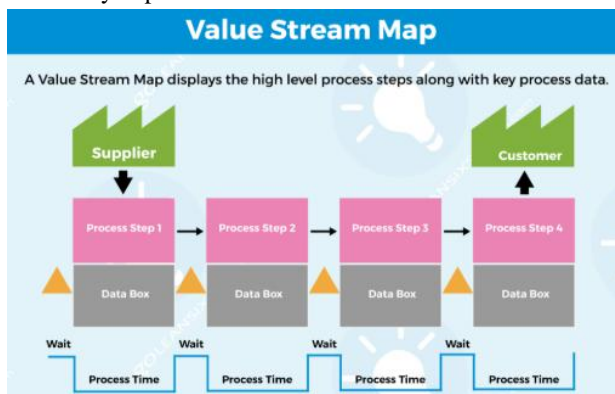


Fig. 3: Example of VSM, Source: [19].

In order for the service to have adequate improvement, timing of the steps was performed with the technical team involved, in order to standardize and train the team to perform the service according to the best method for carrying out the activities. Time samples were taken from each step of the activities and recorded for future analysis, as in the example of Figure 4, chronoanalysis was used.

Process Capacity Sheet		Approved by:  R. Quan	Part # 25-59001			Application JN-01		Entered by: Wayne Xi	Date May 06, 2007	
			Part name			Number of parts 1		Line Machine Shop #2		
		Step	Step name	Machine #	BASIC TIME			TOOL CHANGE		PROCESSING CAPACITY/SHIFT
			MANUAL	AUTO	COMPLETION	CHANGE	TIME			
1	Out	C100	6	32	38	500	2 min.	720 p		
2	Rough Grind	GR100	7	12	19	1,000	5 min.	1,440 p		
3	Fine Grind	GR200	7	30	37	200	5 min.	724 p		
4	Measure Diameter	TS100	8	4	12	—	—	2,325 p		
			Total	28						

Fig. 4: Example of timing sheet, Source: [20].

The flow of the product through the production lines must be controlled so that the programs are fulfilled on the dates previously established. The standard operating times

Provide the Production Control with the means to calculate the time required for the manufacture of the

product, as well as the coordination of labor, material and equipment [21].

In his work [22] he considers chrono-analysis as the method used to time and perform analyzes of the time that an operator takes to perform a task in the productive flow, allowing a time of tolerance for the physiological needs, possible breaks of machinery, among others. An example of chronoanalysis is shown in Figure 5.

		Queue	Booth
General Clinic	Mean	00:06:22	00:02:09
	Std. Deviation	0.00187	0.00073
	Minimum	00:00:00	00:01:06
	Maximum	00:10:19	00:05:15
Specialty Clinic	Mean	00:03:32	00:01:05
	Std. Deviation	0.00310	0.00039
	Minimum	00:00:00	00:00:32
	Maximum	00:10:16	00:01:50

Fig. 5: Example of Chronoanalysis, Source: [23].

According to [22], the use of chronoanalysis is indicated when there is a need to improve productivity and to understand in detail what occurs in the production process. Through it is possible to identify the inefficient points of the process as well as the wastes of time. This makes it easier to carry out a process improvement study and increase productivity.

After an exhaustive attempt to improve the service, a planning of the construction of the sector for maintenance was requested alongside the tooling to allocate the next administrative team of the technicians team, place with warehouse, rooms, tools and equipment for corrective, preventive and predictive maintenance. Implemented the 5S with the administrative team, technicians and managers in the new area aiming to install only what was necessary for the daily activities and schedule of the sector.

Team of Technicians and Administrative Staff with the support of managers to conduct a study focused on improving the handling of maintenance calls resorted to Lean Office. In order to have maximum understanding before starting the project, a training was conducted with those involved in the project, directing the knowledge of the Lean concept and aiming maximum use of the tools, that the gains with the information be reversed in attitudes that facilitate the implantation, encourage them to be continuously exercised.

#### IV. IMPLEMENTATION OF VSM IN THE COMPANY

For the implantation of the lean thought in the administrative area a work team was formed, composed by: the own collaborators of the area, a Champion in Lean Office and a Master Champion.



Scheduled team meeting involved in the study of the current situation with experts in lean thinking, so that a plan of activities could be traced, to start the study was carried out by the champion the training to knowledge of the application and necessary tools and disseminate the knowledge of the methodology Lean.

#### 4.1 LEAN OFFICE

Training with the team involved in the project so that everyone can have the vision of how an administrative environment can be identified and optimized, informing the tools used to apply lean office concepts, fundamentally the VSM tool and Timing. The seven wastes that need to be seen in the mapping to be eliminated or reduced: Super Production, Waiting, Transport, Misfeed, Stock, Unnecessary movement, Defects, Creativity Void

For the planning phase were traced and divided into steps with their respective responsible: Prerequisites, initiation, development, completion and closure. Where reported on how the identification of the problem was conducted.

#### 4.2 USING THE VSM

Using VSM as an instrument to analyze the current state of the process of handling maintenance calls that were having difficulty managing open orders, delayed execution, waiting to perform services, accumulation of orders completed, delayed delivery of completed orders to closure, steps that needed to be improved and VSM being the tool that helped identify the activities that were wasted and those that need to be improved in reducing lead time in care. Figure 6 shows a portion of the VSM of the current process.

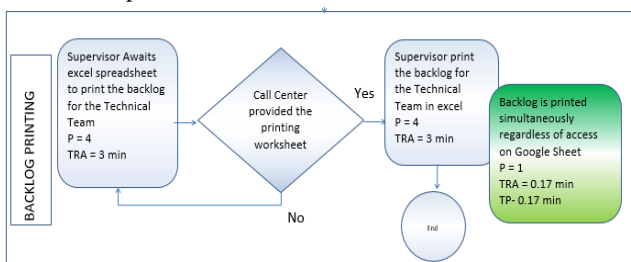


Fig. 6: VSM Current State of Service Process

The concepts of lean mentality become direct skills for employees and this sharing concept are benefits that reduces waste, the team with the vision Lean can see the wastes in the flow.

Based on the observations of the activities and how they were being carried out, it was possible to identify some problems.

In principle, it was seen that those involved did not have a well-defined routine, waiting to send the services generating several wastes such as waiting, transport,

incorrect processing, unnecessary handling, defect and zero creativity.

#### 4.3 CHRONOMETRATION

In order to verify the time, a timing was made to measure the current state and how the calls were being performed, the time used from the time the call was received to the OM closing. Identify possible waste in the current process.

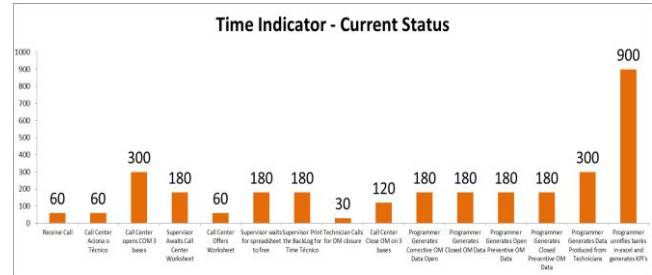


Fig. 7: Current Status Chart

After measurement it was observed that the current state time was high causing the indices to be out of the sector target.

#### 4.4 USE OF 5S IN THE IMPLEMENTATION OF VSM

The sector received an area with strategic location within the manufacturing, this was one of the stages that hindered the attendance - displacement and time, so that the new place has facility in preparation for the attendances.

The 5S implementation was extremely important in order to organize the new area, valuing the execution with functional methods and making the environment pleasant, with the individual commitment of the team.

### V. DATA ANALYSIS

Made the timing of the activities to be based on the time used in the proposed process (future). Follow up of the call center receiving the call and registering the OM until the execution and closing. The scenario: future state.

After measurement it was found that the state of the future state was reduced, so the measurement indicators were in the sector target. The result shown in Figure 8 was time eliminated at the closure of the OMs, bringing a gain of time in the overall process.

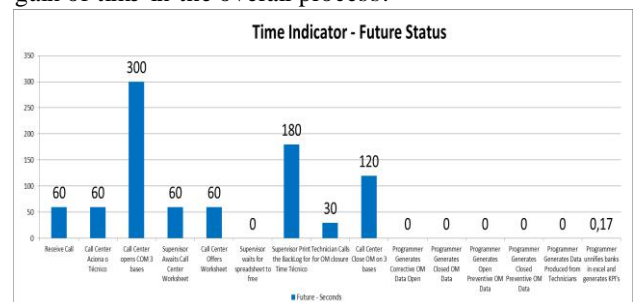


Fig. 8: Future Status Chart

Mapping of the Value Stream (VSM), followed the process from its beginning to the final phase, that is, from the request of the customer, the arrival of the service and its closing, going through all the stages where the activity is developed until completion, which is the attendance, conclusion and closure. Made the presentation of the current state, drawn to the proposal of the future state as it should ideally be with its due improvements shown in Figure 09. Backlog could be printed simultaneously

regardless of access to google sheet, in that phase of the flow we eliminated the waiting time of the team, call center closes the OMs in the bases (excel, sap and backlog) and all the indicators are generated in google sheet, in this phase of the flow we eliminate the time that the programmer had to compile the data for the indicators. Gain of 34.9 minutes. 73% reduction in ART. Reduction of 13, for 7 activities. Gain of 75% Lead Time. Reduction 8 people for 6 people involved.

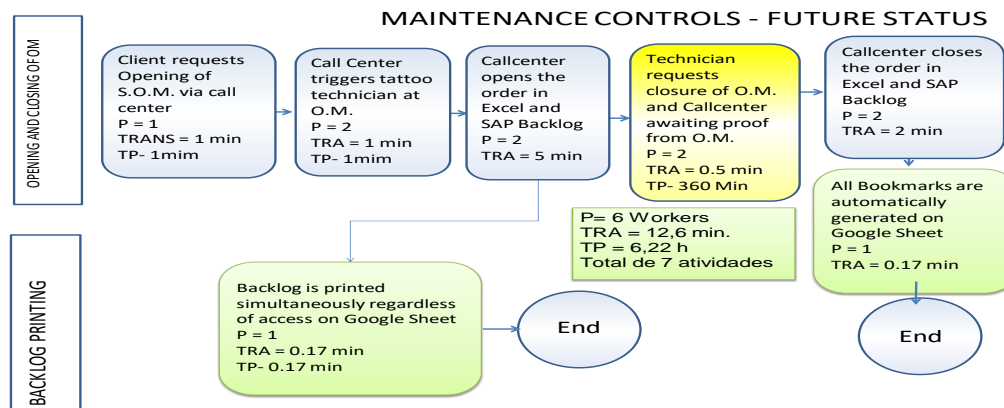


Fig. 9: Value Flow Mapping - Future State

The backlog is a logarithm that discloses the workload in a given period. It is possible to calculate in which periods of the year the maintenance team will have a higher or lower service action. The Sector is responsible for maintaining and conserving so as to sustain conditions according to specifications, making a systemic action to meet the objectives.

Indices of occupation of the Technical Team and their respective activities, the results reflect in cost reduction, employees with the availability to better develop their activities, satisfied operating environment and developing their activities with reduction of interruptions. Equipment and machines with performance and useful life more applied. Trained employees, hygiene and safety at work, a combination of technical and administrative actions designed to maintain, relocate and install and even make modifications to equipment and machinery when necessary.

Reliability Index of a specific machine To achieve productivity with efficiency and with a reduced number of interventions, working preventively, aiming to meet the availability and reliability of the operational equipment following the planning of both the organization and the sector itself, controlling their costs for equipment, analysis of occurrences and abnormalities of equipment and machines, control of performance indicators, standardization, updated history of equipment and machines. Figure 10 shows reliability tracking.



Fig. 10: Reliability Tracking

Sector responsible for generating operational conditions for equipment, machinery, facilities and services to work correctly, to be able to achieve goals and objectives of the organization serving customers at reduced cost and without quality losses. Maintain the life of the equipment by managing the costs through appropriate maintenance systems.

## VI. FINAL CONSIDERATIONS

The study carried out to improve the handling of maintenance calls where we used the Lean Office as a basis for design, had to overcome the lack of knowledge of lean thinking in the administrative areas, where the team considered that the concept only served Manufacturing. After the Lean Office training, the team was motivated with the knowledge of the concept for the administrative areas and determined to create favorable conditions for the implementation of the project.

By presenting the analyzes carried out, one can make sure that the planning of implementation of the lean office

in Maintenance follows the main literary recommendations for the area of knowledge. In the course of the implementation were made the appropriate adjustments and adjustments in the method and following the guidelines of literature and research can affirm that the team was able to assimilate and disseminate the knowledge of the Lean Office in the sector and to be able to comment, the other sectors how much the concept of benefits, with the data of their presented results.

The industry had its indicators checked and the Lean Office was indicated for other projects, because the team assimilated so well the concept that could identify where the Lean Office could be deployed, became the base for the administrative projects. Champion's challenge for the team to retain lean thinking in their administrative areas and to promote improvement continues to cultivate a change-friendly environment with the holistic vision of the Lean Office.

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