Application of Lean Manufacturing methodologies to improve productivity: Fedima Tyres case study

Luís Féteira Silva Vieira
Integrated Master in Mechanical Engineering
Instituto Superior Técnico, TU Lisbon, Portugal
luissilvavieira@gmail.com

Abstract
Nowadays, enterprises are subjugated to large challenges, mainly caused by the effects of globalization. Due to the real risk of non-survival, and to overcome the global economic crisis, enterprises are forced to evolve by reducing costs and raising their productivity levels in order to deal effectively with their global competitors. Therefore, it is imperative and essential to define and implement strategies that help business overcome difficulties. In this perspective, emerges Lean Manufacturing, which comprises a set of tools and methodologies designed to assist and achieve a correct diagnosis of the production lines in order to detect any waste, as well as in the process of seeking solutions to reduce or eliminate it. As a case study, takes place the diagnosis of Fedima Tyres "Production Line 1", applying the methodology of times and methods study, culminating with the presentation of the value stream map of the current state. Identified waste, solutions were proposed with the aim of reduced or, if possible, eliminate them, mainly using the method of SMED and Kanban system. The results showed structural changes in the current way of working, revolutionizing the productive thinking, a new approach, allowing the company to become more efficient, more competitive facing the future with optimism and sustained.

Keywords: Productivity, Lean Manufacturing, Methods and Time Study, Value Stream Map, 5´S, SMED, Kanban.

1 Introduction

Nowadays, enterprises are currently subjected to great challenges that are, objectively, an adaptation to the "Global World". Faced with this challenge, grow steadily focusing on quality of products and services, is the answer that is imposed.
Lean Manufacturing assume as a revolution that has the potential to improve, in fact, the productive capacity of any enterprise, contributing with a set of tools and measures adopted at present in response to the huge current crises, in a growing number of companies, encompassing the whole types of industries.
The current work, has the function to demonstrate, using the methods supplied by the philosophy, the current mode of operation of Production Line 1 of the enterprise Fedima Tyres contributing with new concepts that enable a new and different approach as the epitome of waste elimination and continuous improvement. In this sense, appear the Lean methodologies, as tools for detecting and eliminating waste.

2 Historical Background

The industrial revolution started in England in the eighteenth century brought great changes to mankind. Hitherto unknown realities were for the first time faced, such as the placement of machines in places of workers.

2.1 Mass Production

In the beginning of twentieth century, with the industrial revolution implemented globally, appeared Henry Ford, founder of Ford Motor Company. He set a new production system called "Mass Production" where he develop the first production line, in 1915 (Bhagwat, 2005).
Ford grew rapidly and effectively, until, in 1940, appears the Second World War that changed the behavior of general industry. In the postwar years, there was an urgent need to rebuild what was destroyed. However, companies had a small respond capacity, and were forced to improve its efficiency. For companies with mass production, they only improved, creating large inventories, forgetting their negative effects and the variety of products (Riezebos et al., 2009). Then arised the necessity to develop a different system with less inventory waste and that would guarantee the possibility of working with diverse products.

2.2 *Toyota Production System*

The birth of Toyota Production System was based on the desire to produce a continuous flow not dependent on long production cycles, or high stocks to be efficient, precisely the opposite of Mass Production (Melton, 2005).
The two pillars of TPS as Jidoka, automatic fault detection based on Sakichi Toyoda´s loom, and JIT, based on Kiichiro Toyoda who once stated that the best way to work would be to have to have the right part, at the exact moment and in a precise quantity.
In 1950, Eiji Toyoda took over the firm´s management, and after a visit to the U.S., quickly realized that Japan could not implement the system of “Mass Production” by being a smaller market with less potential.
Eiji Toyoda gave to Taiichi Ohno, a mechanical engineer coming from the weaving industry, the responsibility to create a different production system that produced with grater diversity, with less inventories, reaching out the wishes of the customers. Ohno believed that his vision without preconceptions would be an asset to the implementation of a new production system. He quickly realized that the flexibility of a production line was a key feature in the development of a company and promoted a reduction of the lot sizes to produce in a growing variety and, for that reason, he had to improve the non productive times associated at this operation. Shigeo Shingo further developed changeover reduction. Other methods, like Kanban, have been developed and emerged with the objective to give flexibility to the production line of Toyota (Holweg, 2006).

3 Lean Manufacturing

The concept of Lean was for the first time described in 1990, when Womack, Jones and Roos published the book “The Machine That Changed the World”, describing the concepts and methods used by TPS, justifying this new production system (Shah, 2007).
Lean Manufacturing was born on the refusal to accept waste (“muda”, in Japanese) (Pool et al., 2010).
Taiichi Ohno, in 1988, defined seven types of waste:

1. Overproduction – More production than there is actually demand;
2. Waiting – waiting around for the next step in production;
3. Transportation – Moving of products that is not really needed;
4. Over Processing – Extra operations due to defects;
5. Inventory – Represents the raw material, the WIP, and the finished product not being processed;
6. Motion – Consists in people or equipment moving more than the necessary;
7. Defects – Final products that are not with the required specifications by the costumer.

Womack and Jones also identified an eighth waste, in 1996, that has been designated by underutilization of people, specifically their ideas and creativity (Hicks, 2007).

3.1 *Lean Thinking*

In 1996, Womack and Jones published the book “Lean Thinking – Banish Waste and Create Wealth in your Corporation”. This book comes as informative guide to creating a Lean enterprise (Hicks, 2007). These concepts are fundamental and revolutionizes a new era:

1. Specifies Value;
2. Value Stream;
3. Flow;
4. Pull;
5. Perfection.

These concepts establish how to apply Lean to the enterprises in a pratical way, taking the reduction or elimination wastes its main objective and developing strategies to the continuous improvement process.

3.2 *Methodologies*

Lean Manufacturing is an implementation of a set of techniques and tools that aim to reduce waste along the production line (Sherrer-Rathje et al., 2008).

3.2.1 Methods and Time Study

They are fundamental tools for understanding the operational production lines for each company, contributing to a qualitative and quantitative analysis of them.

3.2.2 Value Stream Mapping

The value stream map represents the set of all operations (value added and non-value added time) that are necessary to bring the product or batch of products through the production line, starting at the arrival of raw material and ending with the costumer.
This tool, allows perceiving quickly and effectively the state of the production line, according to the reality of each one, allowing the detection of waste and looking to the improvements that can implement the system, based not only on the material flow but also in information flows (Abdulmalek et al., 2006).

3.2.3 5´S

This methodology provides a labor organization aimed at developing a clean, organized, flows with clearly identified with the materials information readily available with the standard

operating procedures where one can observe an error or defect immediately be outside the norm. The development of these new habits and work rules significantly reduced damage and loss of time in usual activities.
The methodology of 5´S is the basis to the implementation of Lean's philosophy (Parrie, 2007).

3.2.4 SMED

This process is based on timely preparation changeover, causing it to stop its production the least possible time, thereby increasing the productive time of it. It is of paramount importance to eliminate all unnecessary activities contributing to the overall improvement of production lines (McIntosh et al., 2001).

3.2.5 Kanban

Japanese word "kanban" means "card" or "label". One of the main characteristics of the Kanban system is to contribute to the concept that allows the costumer to pull the product that he wants. Used in a careful way, Kanban prevents the development of high levels of stocks, because the material only enters in the production line after release signal that requests it, thereby maintaining the balance in the relationship between stocks and requests from customers (Chan, 2001). It was developed by TPS in order to control stock levels, production and supply of components cooperating with the concept of JIT (Jackson et al., 2010).

3.2.6 Poka-Yoke

Poka-Yoke is slang Japanese word meaning "mistake proof". This methodology proposes to use automatic devices to prevent defects or errors. The system aims to establish limits on the practice of an activity in order to oblige the proper execution of the operation (Al-Araidah et al., 2009).

4 Application of Lean Manufacturing

This study was conducted with the purpose of studying the Production Line 1 of Fedima Tyres enterprise, according to the Lean philosophy.

4.1 Diagnosis

The diagnosis consists in presenting the actual situation of a Production Line 1 in order do identify the critical sectors as well as existing waste. It was considered the production of the first quarter of the current year to give the information about typical values of demand corresponding also to the average production by day.

4.1.1 Initial Inspection

This is the first production sector of the productive line. Has a function, and responsibility, of examine the casing and determining if can be retreaded.
Through the methods and time study, it was found 72.75% of occupation rate for producing 680 units. It is a production sector that has 33% of non-productive time.

4.1.2 Scrape

This production sector is responsible for removing the rubber of the casing in order to obtain the composite that will be reused for a new tyre.
It was found 55.63% of occupation rate and it works with 45% of non-productive time.

4.1.3 Glue Application

It is responsible for spraying glue in the composite to allow a more consistent link with the new rubber.
It was found 61.5% of occupation rate and it works with 33% of non-productive time.

4.1.4 Extrusion

This operation is characterized by the application of rubber, in his pre-cured state, in the surface of casing.
It was found 71.78% of occupation rate and it works with 24% of non-productive time.

4.1.5 Balancing

Involves the application of small strips of pre-cured rubber ensuring a uniform distribution of mass in the future tyre.
It was found 64.32% of occupation rate and it works with 37% of non-productive time.

4.1.6 Lateral Rubber Application

This operation is defined by the application of rubber pre-cured strips on both sides.
It was found 98.63% of occupation rate and it works with 41% of non-productive time.

4.1.7 Vulcanization

This sector is responsible for applying heat and pressure to the tyre, giving him his final form.
It was found 65.37% of occupation rate and it works with 37% of non-productive time.
It is also important to note that this sector is not flexible compared to the other. It has a larger production times and have specifications that cause significant limitations in the production line.

4.2 Value Stream Map of current state

With the purpose of planning the structure of a production line, presenting the value stream map, in Figure 1.

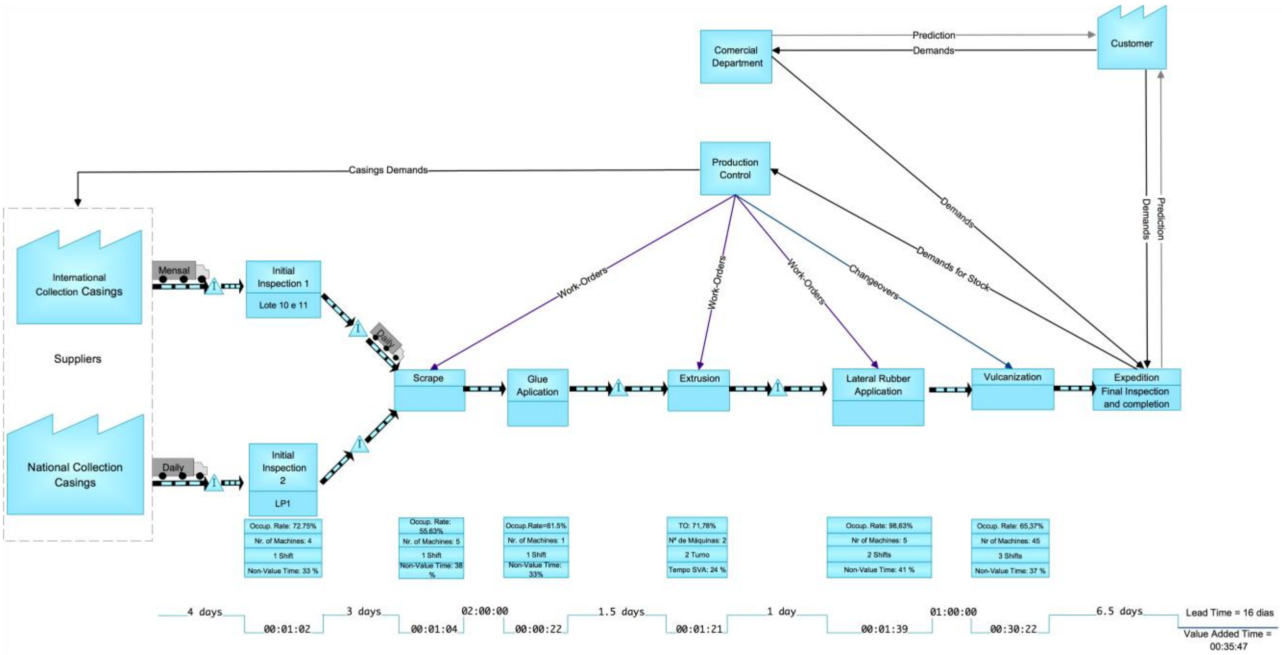

Figure 1 – Value Stream Map of current State.

Through the analyses of value stream map, can identify, according Lean´s philosophy, the following problems:

- Push production;
- Non existence of communication between production sectors and between the production and commercial department;
- Existence of two initial inspection sectors;
- Manual information;
- Excess of inventory;

In order to solve these problems, Lean Manufacturing contributes with several methodologies that aim to improve the system.

4.3 Solutions

After diagnosis, it is necessary to apply methods that solve the waste in a sustainable way or defects found in the analyses of Production Line 1.

4.3.1 SMED

This methodology aims at rapid and effective exchange of mold. It is suggested to optimize the steps performed by the operator and all operations pertaining to this process.

The major benefit of this methodology is to bring flexibility to the sector of vulcanization, and therefore, to the entire production line. Allows reducing non-productive time associated to the changeover, streamlining the process. In this case, led to a decrease of 82.63% to setup time with a reduced investment by providing a new productive capacity.

4.3.2 Improved Layout

It is suggested a change in layout in order to solve numerous unresolved problems, particularly associated with a incorrect material transport, unnecessary movements of workers, the coming of all types of casing to the Production Line 1, where they will occupy unnecessary space in the factory and a provision which leads to confusion, Figure 2.

It is also suggested that the new layout should be accompanied by a plan supported by the 5´S philosophy in order to further contribute to a clean, organizes, practical and simple making the presence of operators in the workplace more pleasant, thus contributing to a greater overall satisfaction with the company.

It is expected from this change to release, nearly 35% of factory space.

4.3.3 Kanban

This methodology brings a new mindset by promoting the pull production at the expense of unnecessary stocks, contributing to the significant reduction of lead time.

This application promotes a improved communication between productive sectors, promoting an inter-active relationship, contributing to the fluency of the material in the system. Kanban cards are responsible for putting the material in line, adjusting and balancing stocks. Each product demand will result in the card, contributing to an improved management, avoiding inventory excess and large queues.

With this application expects 65.73% in lead time reduction.

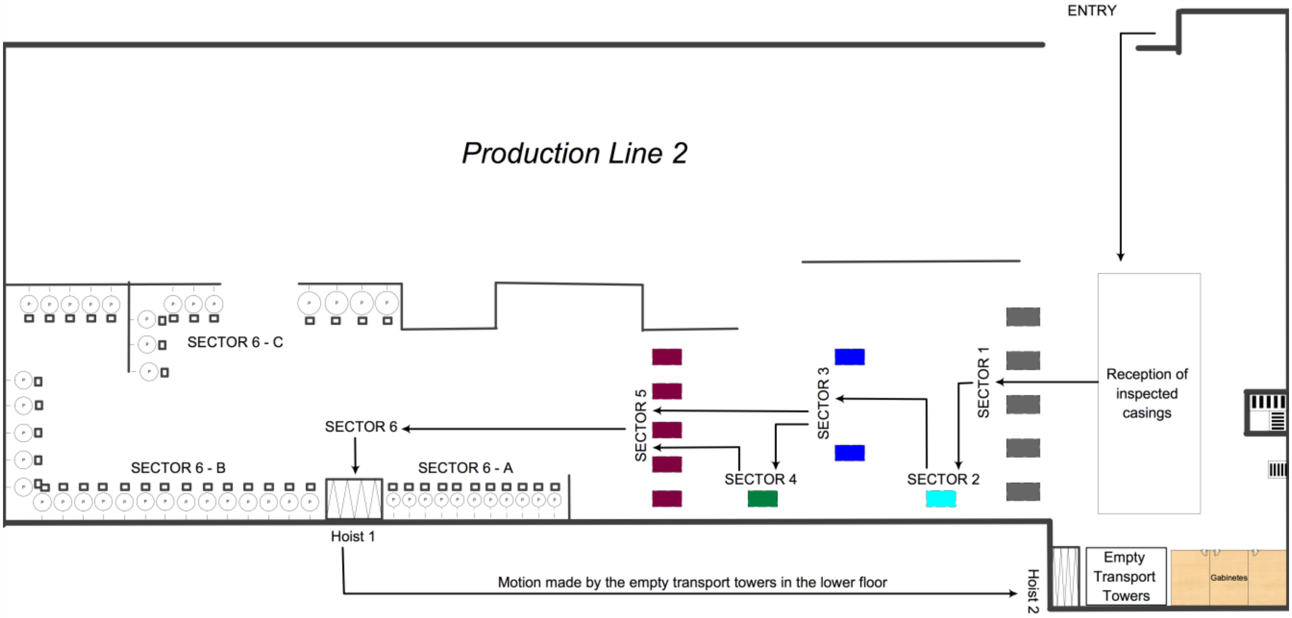

Figure 2 – Re-arranged Layout.

4.3.4 Experimental project of advanced model of communication and management

This model comes with the aim of unifying the entire production line promoting a software facilitating communication between the productive sectors and self-regulation of the work orders. Can be seen his purpose in the Figure 2.

4.3.4.1 Poka-Yoke – Simple prevention system

To ensure a correct reading of the software data, it is suggested a system of errors prevention, in order to check the veracity of the receive values to make a correct management of the work-orders.

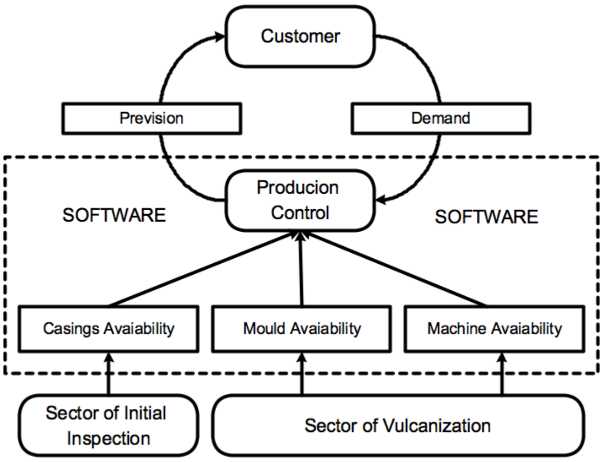

Figure 3 – Management Software.

4.4 Value Stream Map of future state

According to the methodology of value stream mapping, presents, in Figure 4, the value stream map relative to the future state. This map is not an end of this study, it should be a beginning of a new project to eliminate waste, after a new diagnosis. This is one important concept of Lean, trying to achieve perfection in a concept of continuous improvement, called Kaizen.

After the analyses of the value stream map, it demonstrates the following improvements:

- Pull production;
- Communication between productive sectors;
- Reduction of Lead Time;
- Only enters in the productive line able casings to production;
- Computer support in the management of casings;
- Supermarket system balancing the stocks between the productive sectors;
- Approximation between production and commercial departments;
- Timely planning of production;
- Ability to make specific predictions and agreed;
- Improvement in the sector of lateral rubber application;
- Reduction of stocks with final products;
- Reduction of occupation rate in the sector of vulcanization;
- Standardization of the sector of Initial inspection;
- Contribution to sophistication of production system.

It is possible affirm that forces supporting Lean are always stronger then the opposite ones.

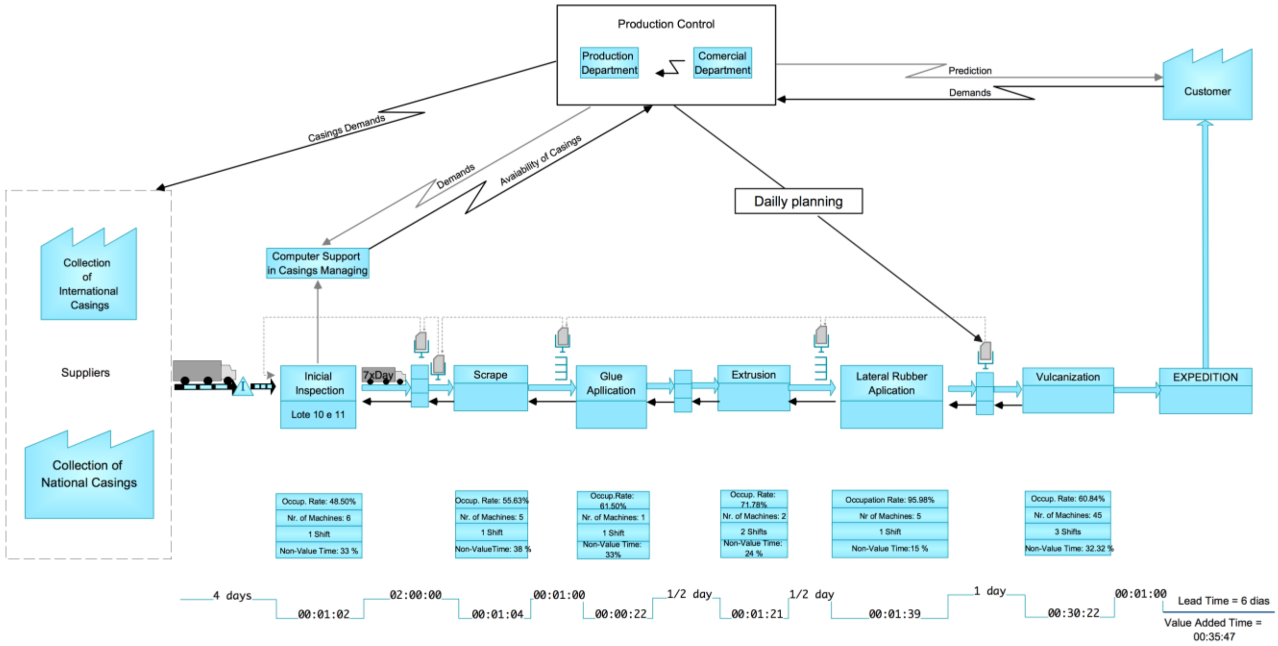

Figure 4 – Value Stream Map of future State.

5 Conclusions

Through the analyses methods applied, several problems were identified, with particular attention to the lack of flexibility of the productive line, for the excesses of stocks, lack of available space in the factory, ineffective communication between sectors as well as gaps in the planning and control activities, which tend to lead to problems of productivity efficiency.
With the suggested solutions, it was possible to deal with the problems in an objective way, bringing a new perspective of productive thinking and a new attitude do the Production Line 1.
With these gains, resulting in a production with less waste and reduced cycle times per unit leading to a consequent reduction of costs, making the company more productive and, conclusively, more competitive.

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