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PROPOSED REDUCTION OF DIES CONSUMPTION FOR TIRES IN A MULTINATIONAL INDUSTRY

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ABSTRACT

The use of Lean approach to achieve control of the consumption of dies in the drawing process, and consequent reduction of waste, is crucial for organizations in today's competitive scenario. This work aims to discuss the production and shipment process improvement of a large automotive industry company, serving on tires Market sector. Through the use of Kanban and Value Stream Mapping (VSM), were obtained reduction from raw material consumption, greater flexibility, and especially better control through a pull system, decreasing waste along the production flow. The methodology includes literature review and a case study research, as a way to describe the events and their relations with found results. Therefore, document analysis, employees interviews, and direct observation were done.

Keywords: *Lean Production, Process, Manufacturing, Value Stream Mapping.*

1. INTRODUCTION

The achievement of companies demand stability was obtained, in part, by exclusivity of production technology and the high demand of the consumer market. This scenario stimulated the adoption of management strategies that promoted productivity based on the fixed costs dilution through a large volume of production, and high stocks level maintenance. Any cost increase was immediately passed to the finished good final price, and the market accepted this fact without incurring large losses.

With the opening of global markets, the competition increase and the dissemination of production technologies, consumers now seek a broader range of products, and in smaller quantities. This scenario does not allow that processes be focused solely on large-scale production because consumers currently do not accept absorb the fixed costs generated by this type of production (Silva *et al*., 2009).

In this context, it is essential one production management model that guarantee flexibility in customer service, with cost savings and improved quality, assuring delivery times.

The goal of Lean production, supported by the Toyota Production System, is to raise the service level by eliminating losses, with increased profitability. The loss, or waste, is any activity that does not contribute to operations effectiveness and, therefore, does not add value to the product or service.

Shingo (1996) identifies seven forms of waste, which are: overproduction, waiting, transportation and handling, the process waste, inventory, defects, and unnecessary work. These inefficiences that originally are born in manufacturing have been expanded to other enterprise areas. Thus, faced with an increasingly competitive market, the company must avoid the various losses types on its current production system, and make that the system respond with more flexibly and agility to market fluctuations.

According to Ballou (2001), within the Supply Chain Management (SCM), transportation is usually the most important element in logistics costs. The focus should be on the structure and services that make up the transportation system, on the rates (costs) and on the enterprise transport processes performance. Thus, it becomes possible to examine alternatives to the transport services characteristics that lead to optimal performance.

Another important element of Lean Production is the Value Stream Mapping (VSM). Rother and Shook (2003) argue that whenever there is a product to a customer, there is a value stream. The VSM is a tool that allows us to understand the current state of a production operation system through the materials and information flows, identifying sources of waste, and eliminate them through the implementation of a value stream in a future state flow, which can become a reality in a short period of time.

For Abdulmalek *et al.* (2007), value refers to the final consumer is willing to pay for the product or service he receives. This value is perceived from the perspective of the end customer. In this sense, Caffyn (1999) states that the value is obtained through incremental improvements, element present in the lean principles. Taj and Morosan (2011) complemented, indicating that with lean production principles application, there are waste reductions, and performance improvements gain importance.

For Ohno (1997), kanban is the means by which lean production flows smoothly in order to produce only what is necessary. The word Kanban can be translated as "card" or "visible record" control of production and inventory, in general, it is a production control system. The implementation of the production balancing requires a reduction in the replenishment time (lead time), which means, a reduction in the period from the generation of a necessity until the actual delivery, and deployment to use.

The main objective of using the Kanban system is to minimize work in process inventories, producing in small batches just at the required quantity, with quality, productivity and at the right time. This tool helps to identify problems in production processes, seeks to eliminate stocks between successive processes, and minimize equipment, facilities or labor idle time. The system can also be seen as a strategy tool to enable improvements in productivity, quality on products, services and processes (SHINGO, 1996).

2. METHODOLOGY

Initially was done a literature review, looking for theoretical needed concepts in order to obtain success in the case study. Based on this research was carried out the value stream mapping of work areas involved in the project. As a result, the current and future state map were generated, which were used for the company kanban system metric definition, focus of this study.

After structuring the adopted improvements, involved operators and supervisors have been trained and then placed the application of the new integrated production model pilot. The pilot was developed in two months.

The model validation was carried out through analysis of previous productivity levels, and also after the project implementation. Throughout the whole process, a company staff team supported the project.

Based on the previous analysis of the currently used system, and also on the existing literature, this study established a new process between the areas of manufacturing and shipping to allow the application of lean production, mainly by reducing losses in transportation and storage, stated by the Vlaue Stream Map (VSM), and also on other lean tools, like the Kanban System.

3. LEAN PRODUCTION

The interest of the Toyoda family for the automotive industry also began early in the century. Sakichi Toyoda, founder of Toyoda Spinning & Weaving and Toyoda Automatic Loom Works Ltda. went to the US for the first time in 1910, when the automobile industry was on its early stages (the Ford Model T was in the market for two years). The popularity of the cars was high and many companies wanted to produce them. Toyoda remained in America for four months, and by his return to Japan, he said they were then in the age of the automobiles (OHNO, 1997).

In 1929, Kiichiro Toyoda, son of founder Sakichi, went in a technical visit to Ford plants in the United States. With the prospect that the automotive industry would soon become the focus of world industry, Kiichiro founded in 1937, Toyota Motor Company.

Toyota entered the automotive industry, specializing in trucks for the military, but with the firm intention of entering in the large-scale of passenger cars and comercial trucks production.

However, the claims of Toyota were postponed due to the involvement of Japan in the World War II. With the end of World War II in 1945, Toyota has taken over its plans to become an auto manufacturer. Indeed, the number of workers employed by the American major competitors was extremely higher than that of Japanese firms.

The successful Fordist mass-production system inspired several initiatives worldwide. Toyota Motor Company, for several years, tried unsuccessfully to reproduce the organization and the results obtained in the production lines of Ford, until that in 1956 the chief engineer of Toyota, Taiichi Ohno, realized, on his first visit to Ford factories, that mass production needed adjustments and improvements in order to be applied in a discrete market and varied product demand, as was the case of the Japanese market (GHINATO, 2000).

Ohno visited, in the US, plants of General Motors, Ford and of other companies. But his biggest impression was with the prevailing system of supermarkets in America, which had come to Japan around 1950. He then made a connection between supermarket and Just in Time (JIT), resulting in the idea of Kanban system, which took ten years to fully be implemented at the Toyota plant. In 1963, was set up the external kanban, which means, with parts delivered by suppliers.

The crisis of 1973, followed by a recession, affected the entire Japanese economy, which experienced zero growth from 1974. However, on the Toyota Motor Company, there was growth in the years 1975, 1976 and 1977, and this led people to looking for what have made at Toyota.

Recognition of the Toyota Production System (TPS) as a production model spread quickly, especially with the publication of the book "The Machine that Changed the World" in 1992, the result of five years of research led by Massachusetts Institute of Technology (MIT). In the study, it became clear that the TPS unfolded much more efficient, flexible and responsive than the traditional mass production system, to indicate that radically different approach. This new production system was later named as lean production (MARCHWINSKI and SHOOK, 2007).

Panizzolo *et al.* (2012) and Jadhav *et al.* (2014) explain that in the last decade, even these industries in emerging countries such as China and India are transforming their processes, switching them from production based on low cost and intensive labor usage, to production with high added value, and flexible, based on the application of lean production concepts. Stone (2012), on the other hand, adds that lean principles are also used as a performance enhancing mechanisms, beyond the scope of manufacture.

Lean manufacturing can then be understood as one of many names that are adopted to convey ideas, whose common origin is on the Toyota production system, comprising a set of recommendations, principles and techniques that industrial companies should follow in order to become leaner and more agile, thereby be more responsive to the current market dynamics (WOMACK and JONES, 2003). In addition to cost reduction, the adoption of lean production results in system flexibility to adapt the company operations to changes in demand, to rapid customer service attendance due to the reduction of lead time, and the production of quality products. Once these requirements have become customers orders winning criteria, many organizations are seeking to adopt this philosophy in their production environments.

Lean Manufacturing is primarily focused on identifying and eliminating waste, which are activities that absorb resources, but do not add value and therefore must be eliminated. According to Shingo (1996) and Ohno (1997), thses losses are classified into seven categories: Losses by overproduction, waiting, transportation and handling, the process itself waste, inventory, defects, and unnecessary work.

Excess production, or losses due to overproduction, occurs by producing beyond the needs of the process or customer. It is the worst form of waste even it contributes to the occurrence of the other six. On the other hand, waiting time refers to materials that are waiting in queue to be processed, that is, comes from a time interval in which no activity is executed.

The loss on transportation is generated by unnecessary movement of products. The carriage typically hold a large part of the total manufacturing time of an item, so that process changes obviate or eliminate the material, should be prioritized. The loss on movements relate to unnecessary movements made by operators in the execution of an operation. Such a loss can be eliminated by improvements based on time and motion study.

Keeping larger inventories than the minimum required for a controlled pull system is another form of waste. Stocks were seen as a "necessary evil" but the Toyota Production System showed that inventories are a result of problems in the system / process. Processes that have steps that could be eliminated without affecting the basic features and functions of the product / service, are having losses on the process. They are also classified as losses in the actual processing conditions wherein the process performance is below the optimal condition.

Losses by corrections concern the waste generated by manufacturing defective products, that is, means waste materials and labor, handling of defective materials, need for inspection and rework.

Increased productivity by eliminating waste is obtained through the two pillars that support the Toyota Production System, which according Ohno (1997), are the Just in Time (JIT) and Jidoka. The Jidoka is also sometimes called autonomation, which means, automation with a human touch. This pillar is defined by Marchwinski and Shook (2007) as the ability to supply the machines and operators and the ability to sense when an abnormal condition has occurred, and immediately stop the work.

The Just in Time is aimed at total elimination of waste to achieve the best quality with the lowest possible cost, in less time production and delivery lead times. Its main feature is to provide the necessary supplies to achieve manufacturing assembly line only at the moment and will be used only to the extent necessary, or at different stages of the process, only to produce the next step calls in amount and at the time she needs. Production planning JIT system should enable the establishment of a continuous flow of material and this is the basis for the concept of pull production, where production in a previous step only starts from the need for a subsequent step, which will trigger the entire production line.

Were developed techniques able to identify and eliminate activities, actions or inventories that not add value. Value Stream Mapping is an important tool to achieve the continuous flow, because lets visibility of the process flows, and broadly information, facilitating the identification of the causes of existing waste, and possible improvements to be applied.

It is understood typically as 'value' the inherent content of a product or service, according to the client's judgment, reflected in its selling price and market demand. In a production process, there are tasks that add and that do not add value. According to Marchwinski and Shook (2007), the value-adding activities are those which, if eliminated, would cause the customer judge the product less valuable. Those that do not add value, in turn, are the activities that, according to the customer's perspective, generate costs, but do not add value to the product. However, sometimes they are necessary due to the project configuration, and manufacturing process.

Thus, the value stream includes all action that adds value or not, required to bring a product for all key flows in their production processes. According Rother and Shook (2003), considering the value stream perspective means considering the broadly process, not focusing on individual cases that optimize only parts, but improving the whole.

Rebelato *et al.* (2009) agree with this approach, and add that initially must be mapped the processes to identify the sources of inefficiency, and then take action to correct the underperformances. Additionally, the definition of increasing targets assists in maintaining current performance levels, and inform where the company can reduce waste.

Hines and Taylor (2000), on the other hand, define five principles essential to eliminate losses, which serve as guide for the lean transformation:

- Specify which activities creates or no value for customers and the company;
- Specify all necessary steps for the production and / or logistics operations, in order to identify the flow losses, or non-value added activities;
- Take actions to create value stream without interruption, detours, delays or waste;
- Carry only what the customer expects, without the application of additional effort or overproduction;
- Constantly evaluate the flow and draw new sources of waste as far as they are discovered.

Likewise, Liker and Meier (2007) show the four (4) "P" principles that underpin Lean:

- Phylosophy: philosophy is the basis for the long-term vision. Leaders must see SC as a channel, or vehicle that adds value to stakeholders (customers, society, community, employees, partners);
- Process: certain processes lead to certain results;

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- People and Partners: continuous development of employees and partners, long-term, as a way of adding value;
- Problem Solving (Troubleshooting): a continuous solution of the root cause of problems leads to organizational learning and strengthens the company.

To Spear and Bowen (1999) there are four basic rules that guide the development, operation and improvement of activities, interconnections or flows associated with any product or service:

- 1st rule: tasks must be fully defined in terms of content, sequence, time and result. Thus, the details assist in creating a basis for the improvement of these activities;
- 2nd rule: all customer-supplier relationship must be direct. You must specify precisely the employees and customers involved, the form and quantity of the products and services, how requests are made, and the estimated time of service;
- 3rd Rule: the flow traveled by each product or service should be simple and straightforward. This rule states that goods and services flow to a developer, or machine set. Thus, it is possible to identify whether there are capacity problems in particular work center, and you can solve such problems;
- 4th rule: any improvement must be made using a scientific method, at the lowest organizational level possible. This method comprises the clear formulation of hypotheses such as "what-if", ie "if we make these changes we will obtain the following results."

Wee and Wu (2009) state that one of the lean production tools used efficiently by Japanese is the VSM. In this sense, Rother and Shook (2003) and Abdulmalek and Rajgopal (2007) argue that the VSM, if applied to processes, make possible the identification and elimination of all types of losses in the production processes.

The Value Stream Mapping (VSM) is a relatively simple tool and is basically a drawing of a map of the current state of the material and information flows, which will serve as a basis for the development of a future state map, that is, how the value should flow.

The material flow is drawn at the bottom of the map, from left to right. In so far as it traverses the material flow of a product Family, can be found places where the stock accumulates. These points are important to be drawn on the map of the current situation because they show where a flow interruption is occurring. In turn, the information flow is drawn on top of the maps, from right to left. This is stocked with information considering the time when each process is informed about what to do, and when do for its client process. The movement of materials can be identified, which are pushed by the manufacturer and not pulled by the client (QUEIROZ, RENTES and ARAUJO, 2004).

Therefore, it can be seen that the VSM is a very important tool for the visualization of the current situation of the organization process, and be base for construction of the future situation. Additionally, it helps to identify more than the waste, the sources of it.

According to Rother and Shook (2003), the practical application of value stream mapping must follow the steps shown in Figure 1.

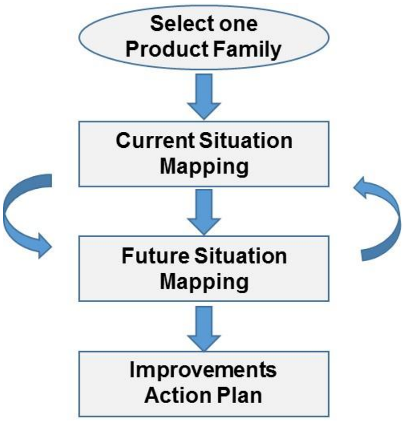

Figure 1: Steps of the VSM Tool (Source: ROTHER and SHOOK, 2003)

The first step should be the selection of a product family from flow value. A family consists of a group of products that go through similar stages of processing and use similar equipment in their processes. After

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establish which products will be the focus of the studies, it is necessary to begin the process mapping. To do the maps, are used specific icons to represent each step of the flow.

In VSM, the entire map is performed and analyzed in order to observe the lead times, inventory points of material and value adding processes.

You must first collect information on consumer demand, then all production processes that are part of the selected product family are identified, and some basic information about them is collected. The next step is to identify stocks locations, and know their average amount. The material flow is mapped as the control system that determines its movement.

The flow of information is also mapped and includes programming processes, the frequency with which applications are made, predictions, and material requests. Figure 2 illustrates an example of a map of the current state.

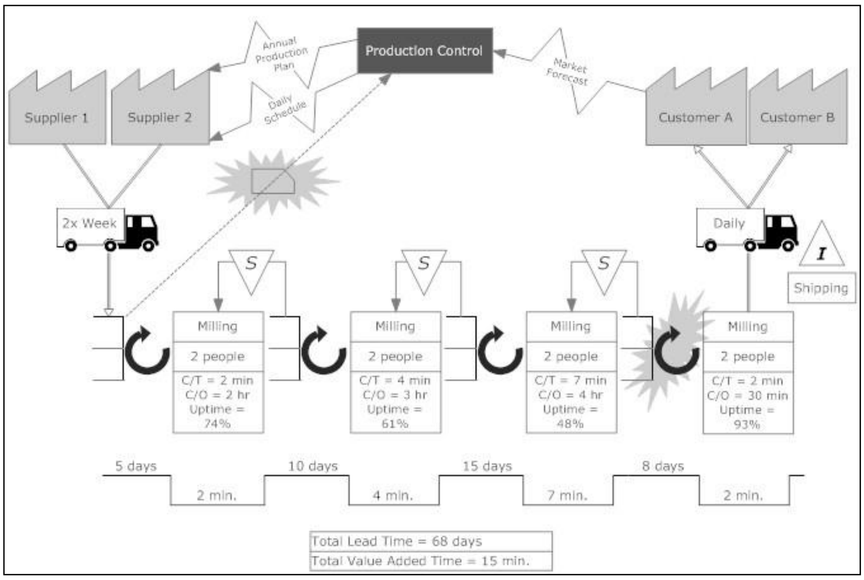
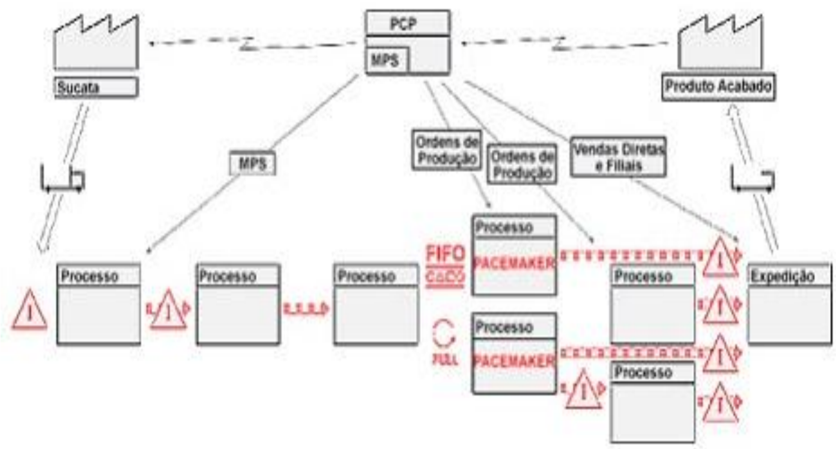


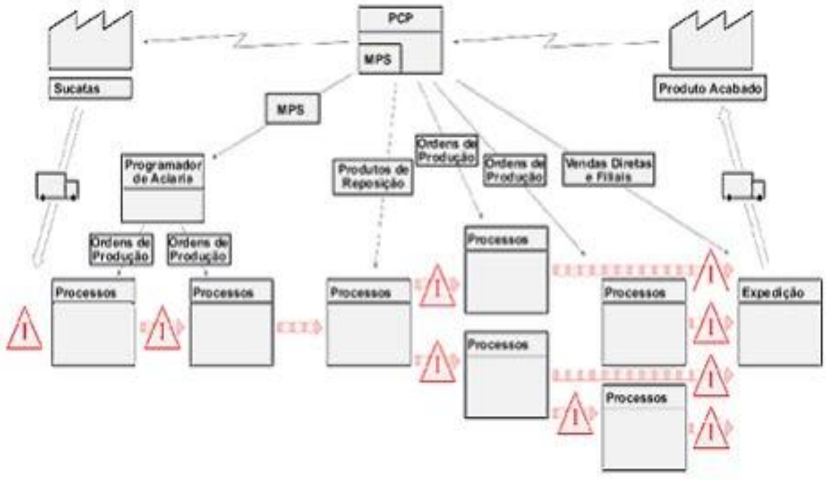
Figure 2: VSM Map – Current State

The objective of mapping the flow is to highlight waste sources and eliminate them through the implementation of a value stream in a future state, what may become a reality in a short period of time.

The goal is to build a production chain where individual processes are articulated to their customers or through a continuous flow or pulled, and each process approaches as much as possible to produce only what customers need when they need (ROTHER and SHOOK, 2003).

A future state map, as shown in Figures 3 and 4, unfolds the opportunities for improvement identified by the current state map, to achieve a higher level of performance in the future.





Figures 3 and 4: Future State VSM Map.

However, Rother and Shook (2003) state that, in order to effectively achieve the lean value stream through the future state map, it is essential to follow some procedures considered key issues for success.

First, it is necessary to synchronize the pace of production to keep it aligned with sales, and that means to produce according to the takt time. The takt time is a reference number that gives the rhythm of the notion that each process should be producing, to meet customer demand, without managing overproduction. Its calculation is done by dividing the available working time by customer demand volume. Additionally, it is also necessary to develop a continuous flow, where possible. This means producing a piece at a time, with each item being passed immediately to a process stage to the next, without stopping, and thus without waste.

Another important point is to concentrate the customer to schedule only one process, that is, the client sending scheduling information only to a production process, called pacemaker process. It gets its name because the way the production controls whether this process sets the pace for all previous cases.

After identification of the pacemaker process, one must distribute different products to produce uniformly over time in pacemaker process. This is step is called the leveling of the production mix.

After identification of the pacemaker process, one must distribute different products to produce uniformly over time in pacemaker process. This is step is called the leveling of the production mix.

The more you equalize the mix in the pacemaker process, it will be better able to respond to different customer requirements with short lead times, while maintaining a small inventory of finished products. It is then necessary to level the volume of production, that is, create an initial pull with the release and removal of only a small and uniform increment in the pacemaker process. The calculation of volume level is done by removing the work incremente in the pitch, calculated by multiplying the takt time by the amount of transferred finished goods on the client process (QUEIROZ, RENTES and ARAUJO, 2004).

Often there are points on the value chain where the continuous flow is not possible, making essential to manufacture in batches. In these cases, it is necessary to install a pull system based in supermarkets, where the client process go to the supermarket and only takes what it needs, and when it is required, being the supplier process producing only for replenishment. These withdrawals are controlled by the Kanban system.

Some companies may confuse the concept of Kanban with the concept of Just in Time, both of which can be related to stocks. In fact, the kanban system can be considered as a part of the JIT Environment (PEINADO, 1999).

Kanban is a simplified production control system, based on cards movements, which informs to all production cells, components, quantities and the required production times.

Correa *et al.* (2001) state that the kanban system follows the logic of pulling production, producing only what is necessary, in appropriate amounts and periods the demand of productive sectors, consumers or end products.

The target of this system, according to Ohno (1997), is to balance production, eliminate waste, control the replacement according to demand stocks, constituting a simple and practical method to visually control the processes.

Ohno developed the Kanban system based on the American supermarket, where the shelves were replenished when emptied. Since the space of each item was limited, more items were only brought when there was need (MOURA, 1996). One of the main peculiarities of the Kanban system is the existence of a certain amount of parts in warehouses between workstations.

More precisely, the availability of sufficient parts for the formation of products in a given period of work is ensured: the subsequent process, seen as a customer, goes to the preceding process, supplier, to acquire the necessary parts ready-made, seen, therefore, as commodities. The above process, in turn, produces the exact quantity removed, replenishing the storage understood as a supermarket. Operating within this rule, theoretically, there will never be overproduction larger than the small amount established in these warehouses, and automatically creates a undeviating connection between what customers (internal and external) want, and what the company is producing (LAGE and GODINHO, 2007).

Was watching the exchange of goods in American supermarkets, during his visit to the United States, that Taiichi Ohno began creating the concept of pull production. He noted that a supermarket is where a customer can get what is needed, when it is necessary and in the required amount. Meanwhile, supermarket operators are responsible for replacing the consumed items that are always available (OHNO, 1997).

In pull production, the production in a previous step starts only from the need for a subsequent step, that is, nothing is produced by the process supplier without the flow client has indicated the need.

Thus, the supermarket, an integral element of the Toyota Production System, is responsible for supplying the pull system. The location of supermarkets is usually next to the supplier process, to help understand the client process needs (MARCHWINSKI and SHOOK, 2007).

According to Ohno (1997), with the implementation of supermarkets targeting the Just in Time, the greatest difficulty was to develop a method that could prevent problems there in the original case when a final process to withdraw large amounts of parts at once. For synchronization of production, a system was developed that enabled the pull production: The kanban system. Thus, when an item is removed from the supermarket, a signal to manufacture more (as a kanban card) is sent to the supplier process.

The literal translation of Kanban is "visible record", but more generally, Kanban has come to mean "card" (MOURA, 1996). Kanban cards are the best known example and common signaling. Often they are simple cards, containing information such as the part name, the code, the external supplier or internal process supplier, the place of storage and consumption. In addition to cards, Kanban can be a triangular metal plate, colored balls, electronic signals, or any other device that provides the necessary information while avoiding erroneous instructions (MARCHWINSKI and SHOOK, 2007). According to Ribeiro (1989), Kanban card is responsible for communication and activation of the entire production process. There is a standardized model card. It should contain the information necessary for seamless operation, given the characteristics of each company. The original kanban system works with two cards: card production and handling card (or withdrawal card). According to Moura (1996), the production design is one that authorizes the production of parts to restore the required for use in subsequent seasons. Since the drive card is used to authorize the movement of parts of the feeder stations to the point of use, as a material work request. It is customary to use standardized icons, illustrated in Figure 4, Kanban card to identify within the process maps.

Production and movement kanban must work together in order to create a pull system. According to Moura (1996), the company may also choose to work with the kanban as a single card, which would correspond to the movement card. The system of a card uses the same philosophy to pull deliveries, used in dual card system. The differences in the system of a card, are the kanban numbers used, the space needed for storage and kept inventory. The parts are produced and applied according to a daily schedule and deliveries for the subsequent process following the procedure of pulling. In other words, in the kanban system with a card, all the parts are ordered and produced according to the daily schedule of production, and all processes ask the previous steps the necessary parts, when needed.

Analyzing the two cards and single card systems, it can be concluded that when using a single card, it uses less Kanban and consequently less storage space, besides being less stock inventory process.

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Each company, to deploy its Kanban system, prepares their own cards according to their own information needs. In general, the Kanban card has 4 functions in-floor factory: identify the item, trigger the production, authorize the handling and control the level of stock. The number of kanban cards limits the batches to be produced and does not allow two or more batches of the same product be produced simultaneously. Thus, the number of Kanban cards is directly related to the consumption rate on the assembly line, and with the repleshment time required to supply the batches. And the batches sizes are carefully calculated based on accurate manufacturing and production cycle needs (MARÇOLA, TONETTO and ANDRADE, 2009).

The traditional Kanban system employs signaling panels or frames, the kanban-called door panels, together with storage points throughout the production, in order to signal the movement and flow of consumer items from the attachment of the cards in these tables.

Each section or manufacturing cell must have its Kanban pannel. The orientation is that they are allocated near to production cells and input / output areas. There is no single model of kanban board. Figure 6 shows a typical example of kanban board, identifying the items to be produced by this specific area, the service priority bands and the number of cards per track. The picture presented in Figure 5 is an example of drills production flow of a company with the use of Kanban cards.

Figure 5: Kanban board example. (Source: http://www.diamante-sign.com.br/prods_html/quadros12.htm)

As supermarket customer to remove the production card, pieces accompanying the boxes are brought into the process and supplier are placed in the boxes. Thus, the boards must show the line which the item is to be produced first and which the lot size to be produced. These tables are divided into three groups: green, yellow and red.

In Green track, the amount of cards corresponds to a production batch, and cards in this range means that there is no need to produce the item. The number of cards in the Yellow range is relative to the supermarket spare time, and the meaning of cards in this range is that it is necessary to produce the item. In the Red track the amount of cards corresponds to the required protection (safety stock) and cards in this range mean that the protection is being consumed. As the cards they reach the frame is first placed on the green band, then yellow and finally red.

When the parts are being produced the cards are first removed from the red band, then yellow and finally the green. Thus, Kanban can be considered a procedure, a method, a technique and an information system. Kanban is a procedure that uses cards to operate a control handle system material, which interconnects all the supply operations to a final assembly line. It is a method that reduces the waiting time, reducing inventory, improving productivity and linking all operations in a continuous uniform flow. It is a short time interval programming technique that uses cards to trigger the need for a process materials to the other. It is an information system designed to coordinate the various process departments, interconnected within a factory (MOURA, 1996).

Peinado (1999) states that for a Kanban implementation project to be successful, it must take into account several other required needs, for example, cleaning systems and organization, such as 5S, multifunction officials systems, systems quality, machine maintenance systems, etc. These other needs should be addressed in future state VSM, which should contain measurable goals and a plan to support the implementation of the various tools that are necessary to ensure the success and maintenance of the implemented improvements.

4. CASE STUDY

The case study is a research method that investigates a contemporary phenomenon on its natural environment, adopting multiple sources of evidence on one or in a few entities, without the use of manipulation or control. The case study can be used to describe a situation in context, generate hypotheses or to test theories. The case study can be classified into three types as to the purpose of the research: descriptive, exploratory and explanatory. The descriptive case study is that which describes the phenomenon in context. Exploratory study comes with little known problems, aiming to define hypotheses or propositions for future research. Finally, the explanatory has the purpose of explaining the cause and effect relationships from a theory. Although the three types can be clearly defined, there is an area of overlap between them. The choice of a particular type of case study depends mainly on the research question that seeks to answer. The aspects to be considered in conducting a case study can be divided into three groups. Planning includes aspects related to the design of research, data collection covers the data collection process, and data analysis considers all aspects of the data analysis process. (OLIVEIRA, MAÇADA and GOLDONI, 2009).

The company, object of this work study, is a multinational automotive industry serving the tire market. The company has several factories and analyzed plant is located in the state of São Paulo, with a staff of about 600 employees. The company manufactures metal strings that go to the blankets of tires. Today are manufactured over 30 different strings.

To study this, a semi-ready product area has been selected, the thin Wiredrawing the previous step to the final product. In this study, the focus i on the control and consumption of dies that go to the machine, fundamental to the qualitative índices (Figure 6).

Figure 6: Rectified Spinnereths

The selection for this study was the use of fine fibers. The company consumes an average of 3,000 fine dies per day. Due to quality specifications, these pieces should be changed according to the product mix. And due to other quality problems, it can be used in more quantity than expected, beyond the unnecessary consumption of the same due to lack of awareness of the operators. These dies are ground by an external company and sent daily, according to the requests that are sent via email.

It can be found 120 diameters of fine ground and dies, used all day. The request is made according to the need and consumption of each diameter, but the need is according to what is supposed needed, causing often miss and the third party need to send another amount, in a hurry.

Flow of the dies is shown in the Figure 7, ranging from the order in accordance with the need of the nozzles to delivery.

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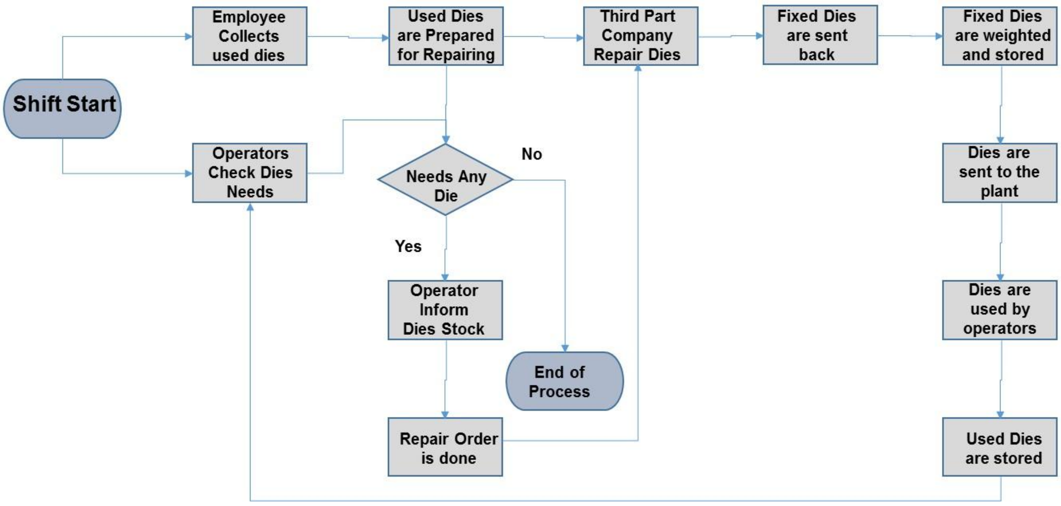

Figure 7: Flowchart of the Dies Factory

In order to monitor and to control the applications, was made a consumption graph of the nozzles, which are made statements to the trading of dies (Figure 8).

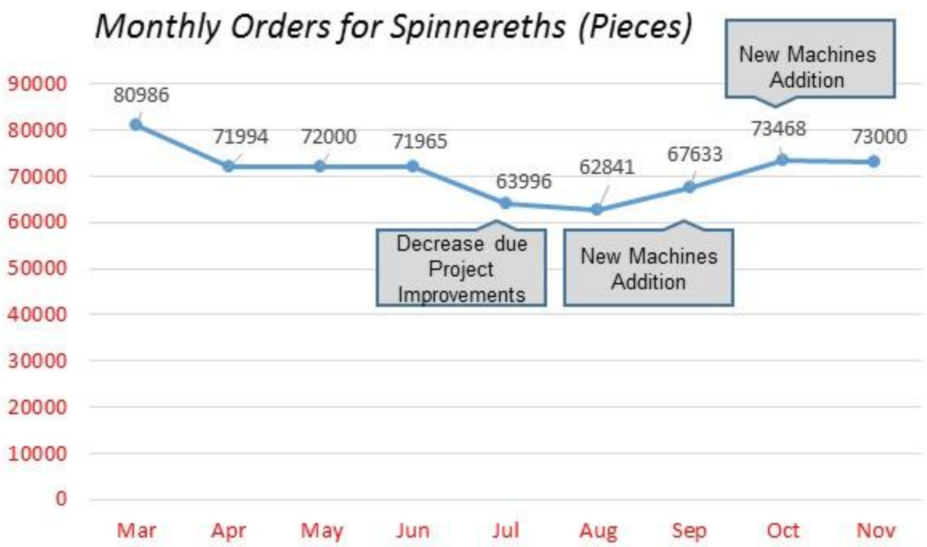

Figure 8: Opening Spinnereth, by month, in 2011.

Based on the theory and, in order to identify the sources of waste in the current process, and eliminate them through the implementation of a value stream in a future state, the mapping of the current status was performed using post-its for easy viewing.

In the current process, the new dies (gross) are sent by a Spanish company, where they are stored in the raw materials warehouse, and are only sent to the grinding company in accordance with the need for it. These spinnerets that have never been rectified have 5 different diameters. The dies can be ground up to 12 times depending on the diameter.

The cycle is closed because, according to the need, the official reconditioning company that works within the company in question informs how much that will be required. This application is reviewed, approved and then sent by the Efficiency and process industry. The request was made to the third party through e-mail is sent the next day, all the separate boxes for diameter. The instant that deliver dies rectified, already send dies used back to the grinding company. This process is known as reverse logistics. When there are a number of dies that have been rectified to the limit, are also returned by grinding company, taking advantage of the transport, that are intended for scrap. The current flow mapping of the dies shown in Figure 9.

The current inventory of dies varies from 1 to 2 days, depending on the diameter as with the variation of the mix needs no variation in the diameters too.

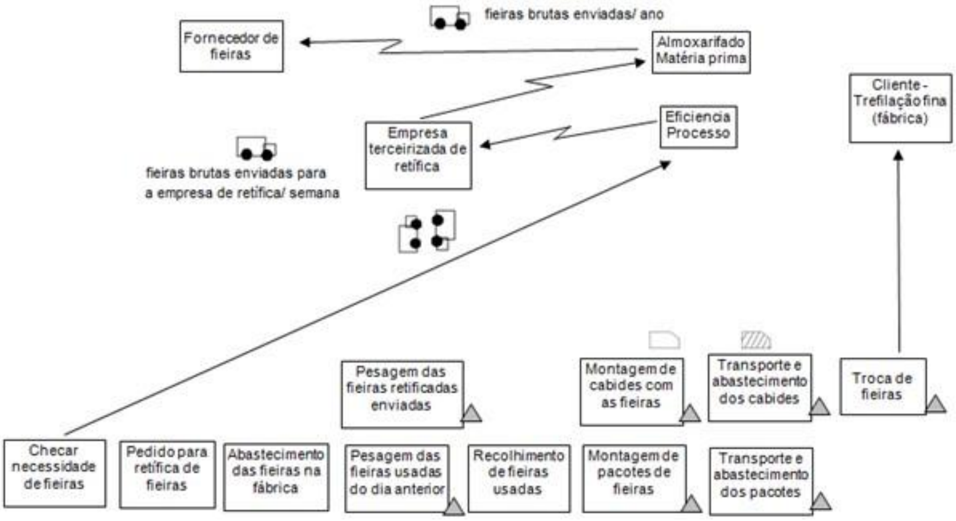

Figure 9: Current State VSM for Die Production.

5. FINAL CONSIDERATIONS

This work was developed in order to present a proposal for improvement in the cycle of grinding applications dies in the studied company. This work was done using the lean system and the tool of the current process flow mapping. By mapping the current state, it can be possible to conduct a study of feasible improvements and it is also proposed a future state, where there should be changes in the flow of applications, to any reduction in consumption and costs.

With the implementation of planned improvements and changes in the process flow in the future state, the production became continuous, that is, dies are only produced and sent based on minimum inventory consumption. This new model was feasible through the development and implementation of the kanban system. The establishment of safety stock levels of each diameter was required because there is no delivery of the nozzles on Sundays, and each stock is set according to the consumption of each diameter.

Through the future flow mapping, the reduction of an employee responsible for the replacement of the nozzles at the factory was possible, because the activities were better distributed.

This design was used in a Continuous Improvement Group of the studied company, involving participants from various sectors. Since it was started, it was noted savings in monthly consumption of approximately R$ 10,000.00, which represents a reduction of over 10% in the average monthly consumption. Were used quality tools to present the project to the company's managers, and this project was classified among the top five in 2011, due to obtained results.

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