Vol. 04, No. 4 (2022) 397-406, doi: 10.24874/PES04.04.002

Proceedings on Engineering Sciences

www.pesjournal.net

IMPROVEMENT OF THE PROCESS PERFORMANCE OF A TIRE MANUFACTURING COMPANY THROUGH THE IMPLEMENTATION OF MANAGEMENT TOOLS BASED ON THE MICHELIN MANUFACTURING WAY PHILOSOPHY (MMW)

Marcelo Oliveira[1]
Amanda Tavares
Isabella dos Santos
Gabriela Veroneze

Received 07.06.2022.
Accepted 10.09.2022.
UDC – 005.62

Keywords:

Continuous Improvement; WCM; MMW; Production System; Kaizen; Lean Manufacturing.

A B S T R A C T

Continuous improvement is seen as a great alternative to maintain an organization's level of competitiveness, as the globalized world increasingly requires more capacity and flexibility. This study addresses the implementation of part of a production system, based on lean manufacturing concepts, in the productive sector of a tire manufacturing company. The objective is to improve the performance of safety, quality, costs, and standards and generate impacts in the creation of organizational culture through the use of tools and visual management. Thus, through the results obtained, it was observed that there was a significant reduction in expired products (quality) and in the consumption of knives (cost), resulting in an improvement of 94.50% and 25.30%, respectively.

1. INTRODUCTION

Continuous improvement in products and processes becomes an essential requirement and a differential to maintain the level of competitiveness of an organization. When present in the routine, it is capable of generating good results in the short, medium, and long term. The increase in the two-wheel market since 2021generated impacts on the tire industries, resulting in an increase in demand. As an alternative to meet the demands, it is essential to invest in continuous improvements to reduce incidents and rework, thus increasing productivity and reducing costs.

According to Bessant et al., (2001), continuous improvement is conceptualized as incremental, where there is an improvement from an existing process or product with gradual and regular advances. Continuous improvement integrated into the routine is a necessity for a company to evolve and stand out in the midst of a market of sharp competition (Mesquita; Alliprandini, 2003; Delbridge; Barton, 2002) and emerge as an alternative to

[1] Corresponding author: Marcelo Oliveira
Email: mailto:marcelooliveira@ufam.edu.br

sustain competitiveness and achieve the goals pursued by the company.

This article will present a case study on the Michelin company, whose Manaus unit is in the process of implementing a production system called MMW – Michelin Manufacturing Way based on the principles of Lean Manufacturing. The focus will be on introducing the MDP – Management Daily Performance in a pilot area to analyze the results that would be obtained. The MDP is a management activity that is based on the WCM - World Class Manufacturing and makes up the MMW. The MDP's main objective is to expose the area's problems and prioritize them to accelerate performance through spot management. In addition, it aims to generate cultural impacts, and a new mental attitude (philosophy) through continuous improvement to promote permanent and significant results, not momentary ones.

According to Mello (1998), visual management can transform a work environment, given that it is capable of providing accessible and simple information to workers. And this facilitates communication and even the engagement of the sector, being able to encourage the participation of suggestions for improvements in the area, facilitating decision-making and problem solving, and these factors add to the organizational culture of a company.

In this sense, the main purpose of this article is to improve the safety, quality, cost, and standard performance of a bottleneck sector of the production line using the company concept named Michelin Manufacturing Way (MMW).

2. LITERATURE REVIEW

The following topics cover the academic background that supports this article.

2.1 Continuous Improvement

For Womack and Jones (1998) continuous improvement has an incremental concept and must be part of lean production to obtain good performance. This definition agrees with that of Bessant et al., (2001), who defend continuous improvement as changes that happen regularly and continuously, at a low cost, and when it involves an entire organization, it results in significant contributions. On the other hand, (Juran, 1990; Terziobski, 2002) argues that the role of CM is complementary to radical changes.

Bhuiyan and Baghel (2005) state that CM is linked to organizational culture and that it involves people working together to develop actions to eliminate waste from a process without major investments. And improvements will be achieved through the application of a set of methods and tools.
Kaizen is a Japanese term whose meaning is continually changing for the better. “Kai” means change and “Zen” which means for the better. Its objective is to provide the continuous improvement of activity, through the elimination of losses, in order to add more value to the product with a minimum of investment and focuses on the philosophy where everyone is involved, from the factory floor workers to the high management, as pointed by Hornburg (2009).

Therefore, Kaizen is designed to continually improve so that new problems are visible. The approach emphasizing the involvement of as many people as possible is noticeable. Because when used correctly, it enriches the corporate culture and becomes a philosophy and not just a problem-solving method.

2.2 WCM and Lean Manufacturing

The WCM (World Class Manufacturing) is composed of 10 pillars and aims to improve the competence of manufacturing and the entire company, focusing especially on quality, productivity, costs, and logistics. Its objective is to continuously improve the performance of a production by having several concepts about problem-solving, defect analysis, improvements in the workplace, processes, and quality controls.

According to Lima et al., (2010) the pillars of the WCM are focused on safety at work, cost deployment, focused improvement, autonomous activities, professional maintenance, quality control, logistics, early management, people development, and the environment, and Veiga (2018) presents the technical and managerial pillars of the WCM is his paperwork, shoeing the main conceptual structure related to this philosophy. For (De Felice et al., 2015) the WCM is a set of best manufacturing practices that involve all employees to achieve the best strategy among the most diverse production processes. Therefore, the main objective is to optimize production.

According to Werkema (2012), “Lean Manufacturing is an initiative that seeks to eliminate waste”, on the other hand, this means that we must deliver greater added value to the customer and optimize processes to have leaner production. The Lean philosophy contemplates the format of producing more with less, in this way it guides organizations in the elimination of their waste. The Lean concept emerged and was applied at the Toyota Motor Company in the 1950s, where it was known as the Toyota Production System (TPS) which was developed by a young engineer named Taiichi Ohno. The model stood out worldwide and drew attention at the time due to Toyota's ease in dealing with crises, as it sought to produce at the lowest cost and mainly eliminate waste (Ohno, 1996).

2.3 Visual Management

Greif (1991) sustains that visual management promotes agile, fast, and clear communication when it is close to those who are interested in it, promoting a more familiar work environment due to the ease of information in everyday life.

Mello (1998) describes visual management as a system of easy understanding and visualization of the data/indicators published there. The main objective of visual management is to relate and connect data, indicators, and information in general related to a sector in a visual way. This contributes to the implementation of lean production (SCHULTZ, 2017; Schroeder & Robinson, 1991).

Visual communication is an ally for maintaining lean principles, as it can help control deadlines, indicators, and cause analysis without the need for investment in software. It is an ally for continuous improvement, as it can make problems visible and thus prioritize to accelerate performance.

3. METHODOLOGY

The present research is classified as applied, as it seeks to generate knowledge for practical application and as for the method, it is a case study in a sector that was the bottleneck of the company. The target company of this study has more than 60 industrial units around the world and has a team of more than 127 thousand employees. It is one of the world leaders in the manufacture and marketing of tires, services, and experiences.

The study was carried out at the Michelin company located in the city of Manaus, State of Amazonas. With around 1200 employees, the Manaus/AM unit is responsible for the production of bicycle and motorcycle tires. The first step was to learn about the company's own production system (MMW - Michelin Manufacturing Way), which is based on the Toyota Production System, and Michelin tools. Then, it was decided to implement MDP (Management Daily Performance) in the station which was the bottleneck of the factory.

4. CASE STUDY

The company in question has its own production system and a set of Michelin tools that are based on market tools. Based on the company's internal theoretical framework (confidential), what the MMW and MDP are will be briefly presented.

MMW (Michelin Manufacturing Way) is the production system adopted in the industry, which is Michelin's version of the "Toyota Production System". It was created in 2006 at Michelin North America with the aim of making homogeneous products around the world and is currently used in all 62 Michelin plants.
MMW is based on the principles of WCM and is a dynamic and visual management modality that aims to guarantee daily performance in 6 pillars: Safety, Machine, Quality, Availability, Cost, and Standard (SMQDCP). In addition, it assists in continuous improvement in these areas, periodically updates/improves the respective objectives, and is consistent with Michelin's approach to strengthening with the aim of developing the willingness and ability to assume responsibilities in the different work teams.

In the MMW system, there is a management act, the MDP (Management Daily Performance), and this has a systematic structure, which ranges from the operational level of the shop floor to the managerial level. This representation follows the following structure: N3 (Level 3) is composed of the Management, N2 (Level 2) is composed of the Supervision team and N1 (Level 1) is composed of the Operational team. At each level, it holds a brief and objective daily meeting in a visual way in the sector to analyze the daily SMQDCP performance, the main causes of deviations, and generate perennial actions for the return of the objectives.

Daily Performance Management (MDP) is implemented in most of Michelin's industrial sites. A huge job has been done. The balance of the MDP deployment shows important differences between the sites, whether in terms of speed, quality, depth of application and expected and realized gains.

Current experience shows that the application of a certain number of good practices is essential for the good functioning of the MDP and to develop its full strength, in order to guarantee daily performance and be the engine of continuous progress in our sectors, departments, and sites. industrial.

MDP is a dynamic, visual management mode that allows procurement teams to ensure day-to-day performance and identify issues to address for continuous progress. It is a methodology that ensures a coherent breakdown of the activity's objectives across departments and production sectors, down to the level of each machine. On the other hand, important issues that cannot be dealt with by the operators themselves are reported to the higher level and, if necessary, to the Management Team.

The MDP affects all levels of a factory and in the MMW system, this management act is located in block 2 of Figure 1. The figure presents the structure of the MMW, which are the steps and tools applied in a process to reduce variability and increase performance.

The present research is classified as applied, as it seeks to generate knowledge for practical application and as for the method, it is a case study in a sector that was the bottleneck of the company. The target company of this study has more than 60 industrial units around the world and has a team of more than 127 thousand employees. It is one of the world leaders in the manufacture and marketing of tires, services, and experiences.

In the present research, documentation and data provided by the company were investigated, in order to seek to meet the demand for information necessary for the preparation of the research and practical study developed from such data. In view of the proposed concepts, the present study

can be classified as quantitative research, as statistical methods and techniques will be applied to measure the effectiveness of the implementation of the MMW that is based on the WCM methodology in the workplace.

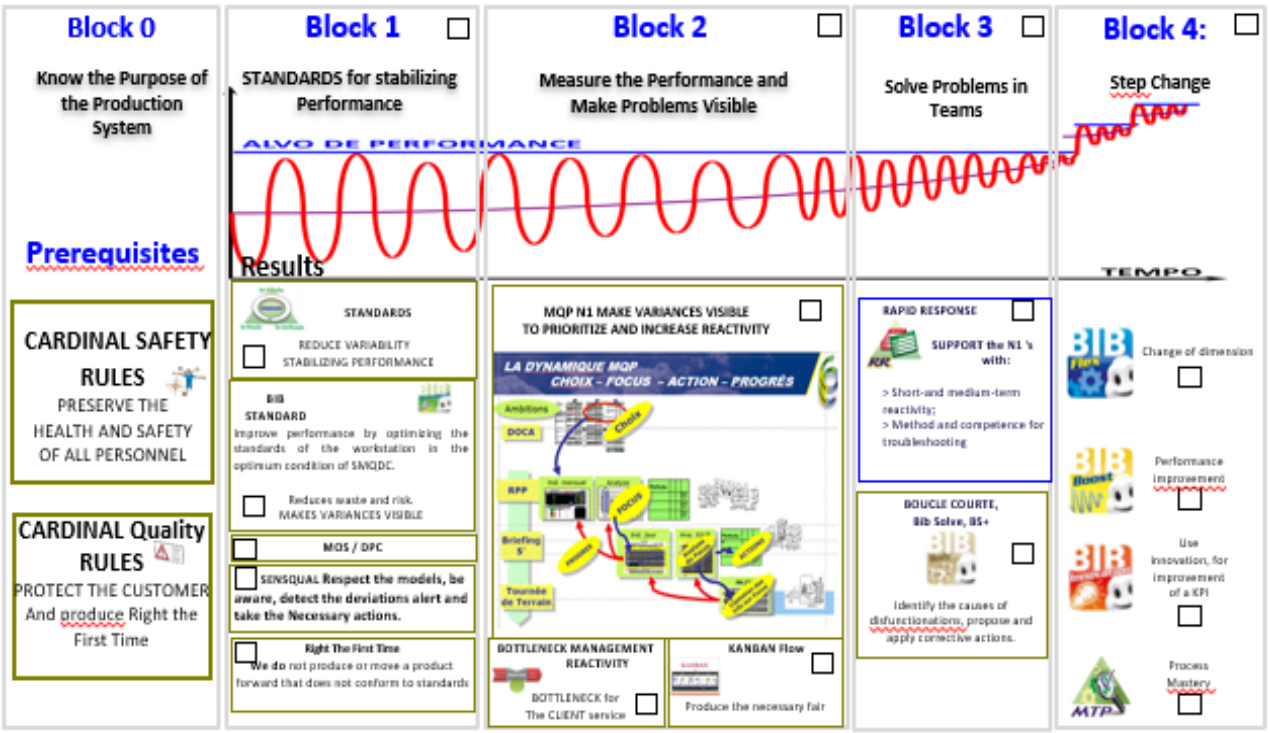

Figure 1. MMW Steps (Source: Confidential)

The four blocks of the MMW contain the summary of the main tools, routines and expected progress of this system. It is notable the reduction of the red curve, which represents the variations existing in a process. We can observe the variation of results over time. The results fluctuate because at the beginning the process is not stable and for that, we need to master the Production System over time to keep the business results sustainable. But, before taking action to stabilize the results, it is necessary to have the prerequisites. The following is a brief explanation of what happens in each block.

In Block 0, the necessary prerequisites are the Cardinal Safety Rules and the Cardinal Quality Rules. These are non-negotiable and must be respected by all employees because they will protect the health and safety of all people and protect the customer, and they are at the heart of our organization. It is the purpose of the MMW. After we have our people and customers protected. Let's think about the four blocks to mastering the production system.

In Block 1 is presented a pattern to stabilize performance. In this block, mastery of the pattern is required to reduce variability and stabilize performance during the process. We use known best practices on the workstation to optimize and standardize the method. The tools we use in this block are:

- **Standard:** it is defined as the standard way of working, a visual way of checking, and a standard way of reacting when there is a variation in the process.
- **Bib Standard:** This is a Michelin tool based on 5S and Kaizen that aims to improve performance by optimizing the standard of the workstation, reducing waste and risks. Once we have the pattern in control and stable, let's move on to the next block.

Block 2, is shown the purpose of this block, is to make issues visible to improve prioritization and reactivity. So, this phase is driven to manage the defaults, but we make them visible and visually control them using the following tools:

- **MDP** - The purpose of MDP is to make problems visible, identify priority issues, improve performance and continually develop people.
- **Bottleneck management** to visually manage the most important machine in the factory. This machine needs to work well to protect customer service.
- **The Kanban stream** is a scheduling system for lean manufacturing and just-in-time manufacturing for customer service.

So, in Block 1, we control the patterns. In Block 2, we made the visual issues. Once we have these blocks in place, we start with Block 3. The purpose of Block 3 is to deal with methods and team issues, removing obstacles to make the job easier. In this block we have:

- **Quick Response:** The purpose of this tool is to support Level 1 (N1) workers quickly with methods and competence, using WIN (What's Important Now) cards.
- **Troubleshooting:** The purpose of this step is to identify the problem, measure the problem, protect customers and people quickly, analyze the problem, define the root cause, launch actions to resolve the problem, and control to eliminate the problem.

When the variation is eliminated and has control of the process, the methodology goes through Block 4, which is the step change. The objective of this block is to rapidly advance business results using specific Michelin tools. With the correct application of the prerequisites and blocks, we will have a sustainable reduction of variation and improvement of business results:

- **Bib Boost:** to increase performance – Based on Kaizen.
- **Bib Flex**: to reduce dimension change time - Based on SMED.
- **Bib Energy:** to reduce energy consumption.
- Bib Innovation, to innovate by reducing costs.
- **VSM:** to design the flowchart to identify and reduce waste in the process.

5. RESULTS AND DISCUSSION

Among the six domains mentioned, SMQDCP, the study initially consisted of improving four, namely: safety, quality, cost, and standard. The main focus is to develop employees in the area so that they are engaged and present alternatives, exposure, and prioritization of problems before proceeding with the solution, through the tools of the Michelin Production System. And the expectation is put that such behavior helps in the creation of the organizational culture so that the work environment is improved, and generates greater accountability for the sector.

The actions that will be presented in this topic were conceived from the MDP area and in conjunction with other Michelin tools. The MDP area is where the daily operational meeting takes place to expose problems in the work zone. It is a delimited area, painted, works with visual management, and has a hexagon for the display of indicators, causes analysis, and action plans for each SMQDCP domain. The information contained in the hexagon is released by the operation, daily pointing out problems that prevent the achievement of objectives and unfolding actions to increase the safety of the area, reduce non-conformities of products, minimize costs, increase productivity and standardize the area. The indicators are presented daily at the MDP N1 meeting (operational level). It is the ideal time to launch, monitor, and close troubleshooting actions in the area. The meeting is made up of the area leaders, maintenance technicians, quality technicians, and sometimes, the supervision of the sector. The aim is, through the MDP management act, to develop the area in terms of problem-solving, defect analysis, improvements in the workplace, processes, quality controls, and continuous improvement, as shown in Figure 2.

Figure 2. MDP N1 Area (Source: Confidential)

5.1 Safety

Safety is the first domain of the Michelin Manufacturing Way. Working safely means being responsible for constantly improving the working environment and eliminating potential accident conditions.

The hexagon indicator followed the risk of accidents in the area, thus, gains linked to safety were obtained due to the indicator, the team started to carry out risk hunts daily and numerous actions were raised and carried out. For example, installation of safety rails, removal, and signaling of crushing points, installation of cable trays to eliminate exposed wiring, readjustment of buttonholes, area employees were recognized for proactive initiatives regarding safety approaches, the number of OCS (Observation of Safe Behavior) started to be controlled and increased significantly, contributing to the behavioral development of employees in the area. OCS allows an approach and behavioral coaching linked to the perception of safety by employees in the area. The results are presented in the following figures (3 to 7).

Figure 3. Before X After Security grids (Source: Confidential)

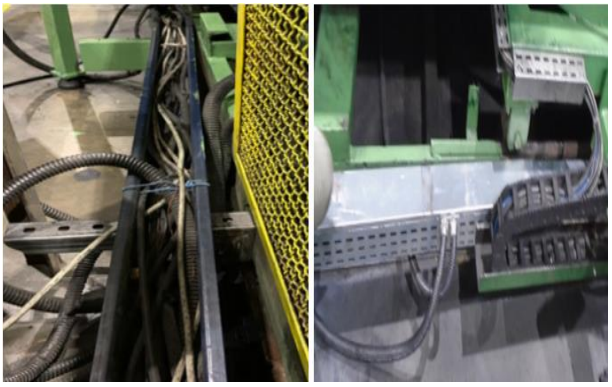

Figure 4. Before X After Exposed wiring (Source: Confidential)

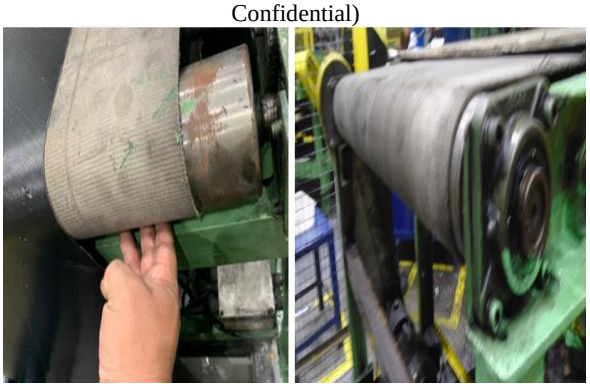

Figure 5. Before X After Crush point elimination (Source: Confidential)

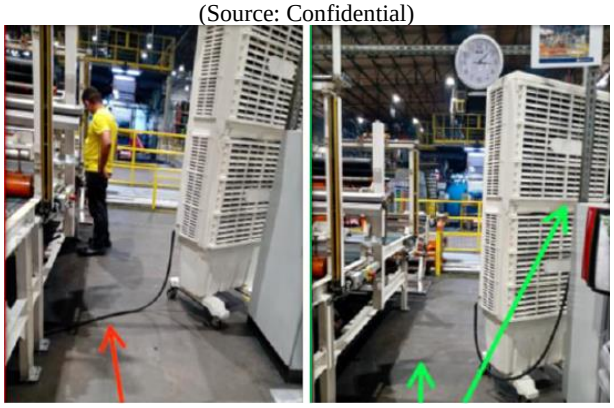

Figure 6. Before X After Removing the wire from the path (Source: Confidential)

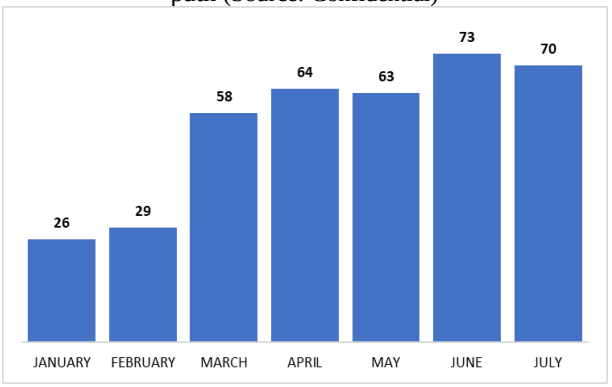

Figure 7. Evolution in the realization of OCS

5.2 Quality

The Quality domain proposes to obtain products with zero defects by building quality in the internal part of the process. For this, it is necessary to ensure quality products for customers by minimizing costs and defining the conditions of the production system in order to prevent the appearance of non-conformities. This is the ideal concept, but for a pilot area of implementation of a Production System, it is still necessary to make corrective actions and adjustments in the process before starting to treat the zero defect.

The non-conforming area (NC) of the sector in question was showing high rates of expired tarpaulins due to the lack of control in the entry and exit of non-conforming materials, rework, and out-of-schedule (process leftovers). The place had no flow to treat the materials, they were inserted into the area without criteria and ended up being lost due to errors in the process and disorganization of the area, as a consequence, the material lost its validity, leading to scrap.

In order to minimize the volume of scrap in the area, actions were taken to make adjustments to the process, to the flow of materials, and to maintain data control. The use of FIFO (First In First Out) was applied along with a visual pattern of the priorities of the week indicated by colors per week identifying the canvas cars, the implementation of quality indicators, control of non-conforming products, and redefinition of the layout was carried out. of the area. The results are presented in the following Figures (8 to 12).

Figure 8. Before X After Flow creation for the input and output of NC material (FIFO) (Source: Confidential)

Figure 9. FIFO Visual pattern (Source: Confidential)

Figure 10. Before X After Remodeling the framework for visual management of NC Products (Source: Confidential)

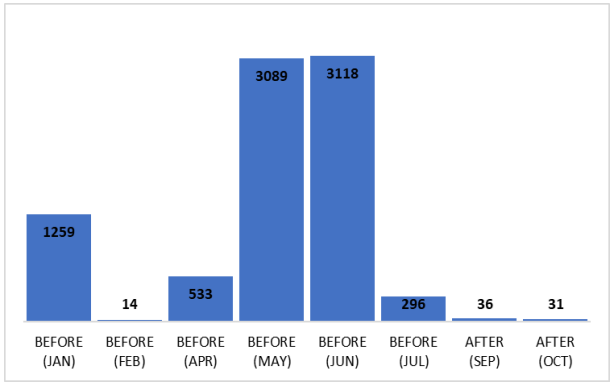

Figure 11. Before X After Results of expired products actions

It is possible to verify that there is no information about the months of March and August due to the lack of control over non-conforming products and according to the quality of the area, part of the information on expired products is not properly pointed out in the month that governs it. Part of a month's scrap is recorded in the following month, due to lack of flow, as shown in Figure 12.

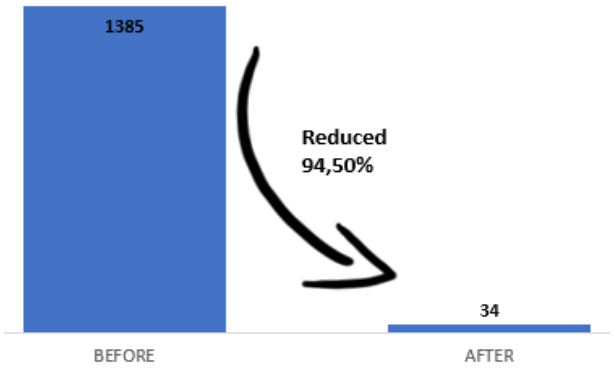

Figure 12. Comparison after performing actions

5.3 Cost

The Cost domain seeks to identify and combat the causes of losses and waste in the production system. To correctly prioritize the resources available in our work zone, we need to know precisely what waste and losses exist in our process. Because taking into account that making the measurements of waste and losses more and more accurate is the fundamental point of cost breakdown.

The sector where the studied area is located is called FIP (Internal Product Phase) and is composed of four stations: Banbury, calendars, cutters, and complexing. The FIP was presenting high costs linked to the consumption of knives. Due to this, the focus indicator of the Cost Domain of the cutters started to visually monitor consumption in the MDP area.

The indicator was created simply and clearly. It consisted of informing the daily amount of knife use, and whenever there were changes above the established daily goal, a cause analysis was carried out jointly by the quality and maintenance technicians in the area, and progress actions were later launched.

It was detected that one of the reasons that most impacted the consumption of knives was the breakage due to tangling. Among the actions taken to minimize these impacts, we have insertion of rollers to detach the canvas from the carpet (figure 18), the adjustment in the installation of the knives by part of the maintenance that started to make the adjustment in both ends of the machine and not only in one, adjust the height of the roller (figure 19) to help with the separation between the canvas so that there is no tangling in the belt between the coils and opening of the support cables, distancing the tangle zone.

The action aimed to eliminate possible folds on the edges of the tarpaulins and ensure the separation between them. After implementing the actions, there was a reduction in the use of knives. The results are presented in the following Figures (13 to 20).

Figure 13. Knife Breakage due to entanglement (Source: Confidential)

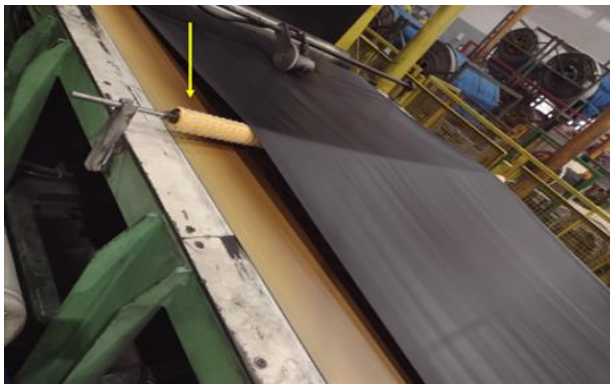

Figure 14. Installation of the roller to take off the canvas (Source: Confidential)

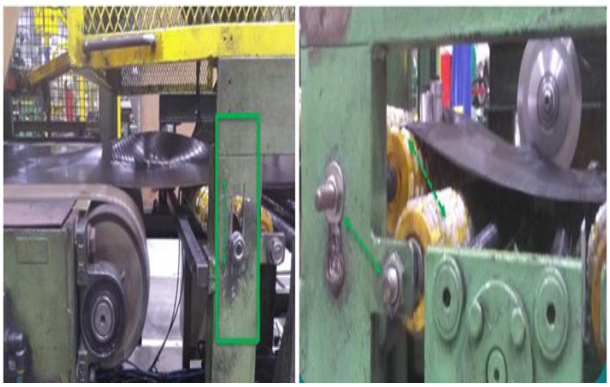

Figure 15. Before X After Opening in the roller for height adjustment (Source: Confidential).

Figure 16. Before X After Inserting a roller on the take-up table (Source: Confidential).

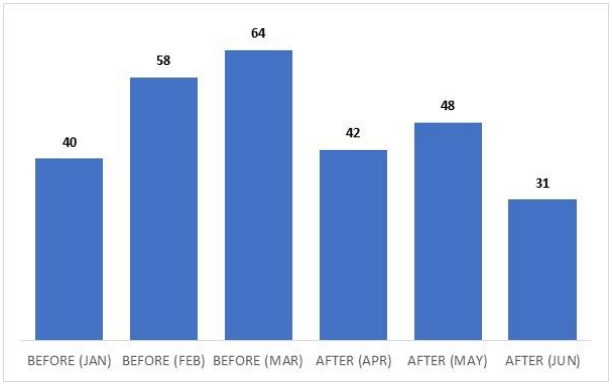

Figure 17. The number of knives consumed monthly

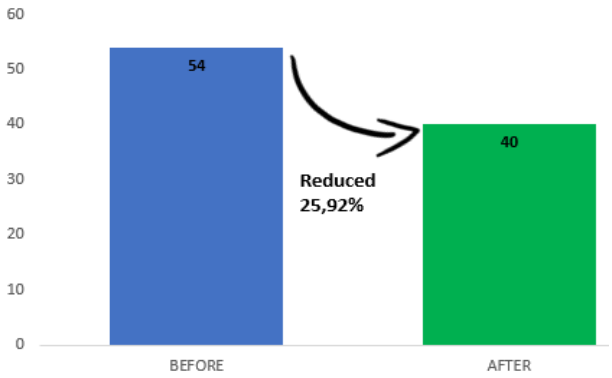

Figure 18. Comparison after performing actions

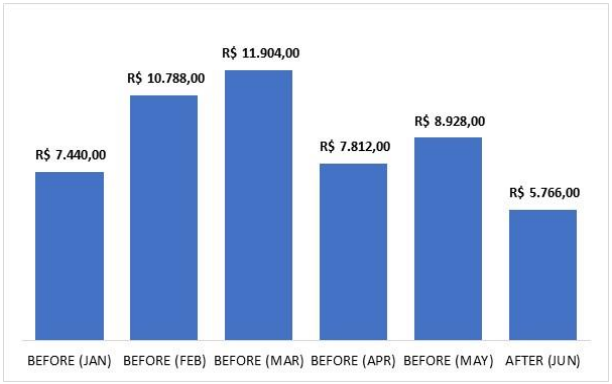

Figure 19. The monthly cost of knife consumption

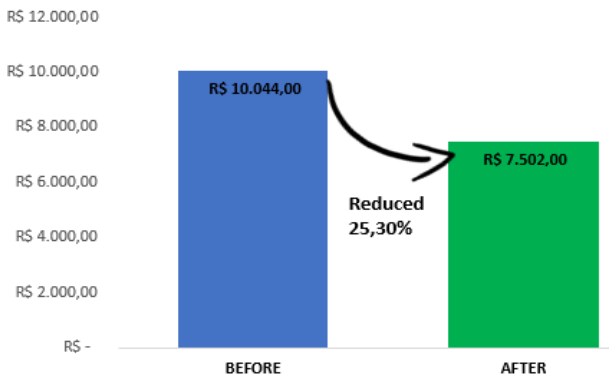

Figure 20. Comparison after performing actions

5.4 Standard

The purpose of this domain is to create a workplace standard that guarantees the safety and well-being of people, the quality of the functions performed, and maximum productivity through the development of standards and the engagement of the team. The Bib Standard, a Michelin tool based on 5S and Kaizen, was applied in the area of cutters.

Written standards were revised and updated, visual standards were created in as many places as possible, and minimums and maximums were determined. One of the ways of support to maintain the permanence of actions linked to the organization, cleaning, painting, and systematization of the area was through the MDP via indicators. The hexagon was piloted to monitor audit notes and daily deviations in terms of standardization put in the area. The results are presented in the following Figures (21 to 22).

Figure 21. Comparison after executing actions (Source: Confidential).

Figure 22. Operating mode installed near the point of use (Source: Confidential).

6. CASE STUDY

As can be seen, the scope of the MMW production system involves the structuring of the entire company, from the factory floor to the top management, aiming at the implementation of tools and management acts to reduce waste daily and question whether the standards are established, being fulfilled and if they are efficient.

The objective of the MDP is to use the daily meeting to analyze the daily performance, not in an open way, but following the SMQDCP method. In this way, we guarantee a greater scope for the definition of problems, therefore, the main deviations and, finally, generate assertive actions. In this way, problems are exposed, prioritized, and resolved. As a result, the area became very responsible, as the operational team matured, became more engaged, and soon began to have a greater perception of raising opportunities for improvement within the process with greater ease.

In addition to developing the leadership and gestational side of the operation, managing to demonstrate that they should not only be concerned with the production number of the day but that they can contribute to short and medium-term progress actions, where a large part comes from the operation, this being the best way to make them permanent, as it generates the feeling of being the owner of the business.
However, the MDP continues to be a tool that needs to be accompanied by people and they will be responsible for keeping it alive and driving the change process.

The objectives were achieved: mobilizing the team to understand the production system, and making them see that this system needs to work for the collaborators, and not the other way around. Engage priority actions to return to the objective and eliminate the causes of non-performance and develop the creation of culture in the sector.

The MDP played a fundamental role in giving visibility to the area's problems, with the objective of communicating and providing all relevant information for the performance of the group and the company.

Acknowledgment: Special thanks to the Graduate Program in Production Engineering (PPGEP) of the Federal University of Amazonas (UFAM) for the support of its professors in the research carried out. This study was carried out in partnership with UFAM within the scope of the PPGEP. The authors thank the Fundação de Amparo à Pesquisa do Estado do Amazonas (FAPEAM) for supporting this work within the scope of the POSGRAD Project (Resolution No. 008/2021-POSGRAD).

References:

Bessant, J., Caffyn, S., & Gallagher, M. (2001). An evolutionary model of continuous improvement behavior. *Technovation*, *21*(2), 67-77.

De, F., Petrillo, A., & Monfre, S. (2013). Improving operations performance with world class manufacturing technique: A case in automotive industry. In M. Schiraldi (Ed.), *Operations Management*. InTech. https://doi.org/10.5772/54450

Greif, M. (1991). *The Visual Factory: building participation through shared information*. Portland, USA: Productivity Press.

Hornburg, S. (2009). *Method for Gemba Kaizen Events*. Dissertation (Master in Production Engineering) – Postgraduate Program in Production Engineering, Federal University of Santa Catarina, Florianópolis.

Juran, J.M. (1990). *Juran in leadership for quality*. São Paulo: Pioneira Editor.

Mello, Carlos H. P. (1998). *Ongoing Audit: Study of the Implementation of a Monitoring Tool for a Quality Assurance System Based on NBR ISO9000 Norms. 1998*. Dissertation (Master in Production Engineering) – EFEI, Minas Gerais, 1998.

Mesquita, M. & Alliprandini, D. H. (2002). Essential competencies for continuous production improvement: A case study in companies in the auto parts industry. *Management & Production Magazine*, *10*(1), 17-33.

Michelin – MQP Good Practices Reference. Version 2, (2006). Confidential.

Ohno, T. (1997). *The Toyota Production System*. Porto Alegre: Bookman.

Schroeder, D. M., & Robinson, A. G. (1991). America Most Successful Export to Japan - Continuous Improvement Programs. *Sloan Management Review*, *32*(3), 67-81.

Schultz, A. L. (2017). Integrating lean and visual management in facilities management using design science and action research. *Built Environment Project and Asset Management*, *7*(3), 300–312. https://doi.org/10.1108/BEPAM-05-2016-0020

Werkema, C. (2012). *Lean Six Sigma: An Introduction to Lean Manufacturing Tools*. Rio de Janeiro: Elsevier.

Womack, J. P.; Jones, D. T. (1998). *The Lean Mindset in Business: Eliminates Waste and Creates Wealth*. Rio de Janeiro, Campus Editor.

Amanda Tavares
Federal University of Amazonas,
Manaus,
Brazil
amandacmt12@gmail.com
ORCID: 0000-0002-4617-6090

Isabella dos Santos
Federal University of Amazonas,
Manaus,
Brazil
santos.bellaalves@gmail.com
ORCID: 0000-0002-4293-2944

Gabriela Veroneze
Federal University of Amazonas,
Manaus,
Brazil
gveroneze@ufam.edu.br
ORCID: 0000-0002-1978-9190

Marcelo Oliveira
Federal University of Amazonas,
Manaus,
Brazil
marcelooliveira@ufam.edu.br
ORCID: 0000-0003-2496-646X