Application of Lean Manufacturing Philosophy to Improve Occupational Safety Results in a Mining Company

Elida Maria Rafachine[1*], Fellipe Breno Bergamini[1], Luiz Gustavo Gobbi Firmino[1], Carlos César Ribeiro Santos[1], Jonata Souza Santos[1]

[1]SENAI CIMATEC University Center; Salador,Bahia, Brazil

The importance of lean manufacturing applications in industrial organizations grows as scientific research points out its main results: productivity increase and waste reduction. When we refer to the direct observation of the work in the safety area, we notice the need for the same efficiency in managing risk scenarios in the activities. The objective of this article is to demonstrate how the Lean Manufacturing philosophy contributes to the understanding and connection of the leaders and also of the executors to the risks associated with the execution of their routine activities in order to mitigate and/or eliminate them. This article was conducted through a case study in a mining company located in Espírito Santo and identifies and analyzes the improvements obtained in process management through the application of the Lean Manufacturing philosophy and its tools, especially FMDS (Factory Floor Management Development System) in the subject of occupational safety. The main result obtained is the reduction of work accidents measured through the Accident Frequency Rate – TRIFR.

Keywords: Lean Manufacturing Philosophy. Safety. Risk Scenarios. FMDS. Accident Frequency Rate – TRIFR.

Introduction

In 2016, the challenge of understanding how safety indicators were managed began in order to seek efficient actions to improve results. Therefore, the research problem of this article is: how can Lean Manufacturing tools help reduce the Total Frequency Rate of Occupational Injuries (TRIFR) in the company that is the object of this case study?

The general objective of this study is to present the use of Lean Manufacturing tools to reduce the work accident rate.

The specific objectives of this work are as follows:

1. Technically confirming the importance of FMDS (Factory Floor Management Development System) for the improvement of the occupational safety indicator,
2. Proving the importance of proactive management for the reduction of occupational accidents,
3. This case study aims to implement improvements that mitigate/eliminate the risks associated with their activities to demonstrate the importance of involving the company's employees.

Literature Review

In the 50', lean manufacturing emerged in Japan through Eiji Toyoda and Onho, where the main objective was to align the best work sequence to add value to the products requested by the customer. Thus, they made it impossible to copy the production model of the American system, which demanded a wide variety of products, thus giving birth to what is known as the Lean Production System or Toyota Production System (Lean Manufacturing / Lean Production).

According to Toledo (2002), lean thinking can be understood as producing more with fewer resources, focusing on customer needs, and being able to offer what they really wanted, generating immediate value to the work and eliminating waste [1].

According to Campos (1996), everything that does not add value in the direct transformation of the product is considered waste, the main ones being: transport, movement, inventory, excessive processing, waiting, rework, and overproduction.

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Address for correspondence: Elida Maria Rafachine. Avenida Wilson Alvarenga, 1040 – Carneirinhos – João Monlevade – Minas Gerais. Zipcode: (5527) 99311-2464. DOI 10.34178/jbth.v6i2.304.

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All of these increase production costs, decreasing the possibility of increasing profits since the customer is unwilling to pay for them [2].

Process Management

For Falconi (2013), achieving good results is one of the most significant sources of human motivation. However, we can fail by not directing the goals correctly due to a lack of technical knowledge, non-compliance with action plans, or circumstances beyond our control [3].

According to Albertini (2016), mapping processes makes it possible to visually represent the activity, generating the opportunity to see the improvements, simplification, and streamlining of processes [4].

According to Liker and Meier (2007), people are visual creatures, and they need to look at their work and be able to quickly detect some abnormality in their process, with well-planned graphics placed on the wall can perform good discussions and raise opportunities in the activities [5].

As the same authors, we can classify eight considerable losses in a process: overproduction, waiting, transport, overprocessing and overcapacity, unnecessary displacement, defects, and failure to use employees' creativity.

The control of the process allows the management of the entire production chain; having indicators that clearly show the reality of the routine in the operations helps in the execution of actions so that the established goals are not lost over the agreed periods. The main point of effective process management is the base (shop floor) involvement in solving problems even when they are somewhat "small'.

Process Improvement

Continuously improving processes is necessary to achieve growth and reach goals and challenges, in addition to the company's competitiveness in the market. For Paim and colleagues (2009), improving processes is necessary for companies to maintain themselves in the market where they operate, which constantly changes [6].

Chiavenato (2000) states that: "change is everywhere: in countries, in organizations, in technology, in cities, in people's habits, in products and services, in time and weather, in everyday life" [7].

During this inevitable constant change, companies seek evolution through creativity and innovation of their operations, relying on the ideas and suggestions of their employees to solve problems raised through process management and maximum use of the employees' abilities and learning capacity. Chiavenato (2000) also points out that creativity and innovation allow the company to remain in perfect harmony with the business world, where creativity provides new ideas and innovation puts them into practice to create a new company [7]. The kaizen circle is a tool used in the pursuit of continuous improvement. It aims to improve the individual capacity and ability of those involved, increase self-confidence and preparedness for problem-solving, and work better in teams because it creates a proactive and integrated environment by expanding the systemic view of the business, according to Kishida (2009) [8].

Factory Floor Management Development System (FMDS)

As an advanced visual management tool, FMDS (Factory Floor Management Development System), developed by Toyota in 2006 in Japan in the context of the company's global expansion, was implemented in Brazil in 2008 at the Indaiatuba plant.

The primary purpose of FMDS is the development of the base employees through exposure and solutions to problems that hinder the achievement of results, in addition to improving communication between leader and subordinate, making daily management a continuous movement of corrections and improvements, reducing losses in the processes.

Since then, many companies seeking to implement the Toyota Production Model have

used the FMDS (Factory Floor Management Development System) tool as a reference in the management of their indicators.

Materials and Methods

This work has an applied purpose and exploratory objectives. According to Gil (1995), applied or practical research arises from the desire to know something to make it more efficient or effective [9].

For the author, exploratory research aims to increase familiarity with the problem under study to make it more explicit or formulate hypotheses.

The main objective of this type of research is to improve ideas or discover intuitions. Regarding procedures, the present work can be considered participant field research since the researcher and the participants are involved in solving a collective problem.

The research can be framed as qualitative and also quantitative. According to Marconi and Lakatos (2008), qualitative research analyzes and interprets the complexity of human behavior. Through qualitative research, it is possible to describe behavior, attitudes, habits, and preferences [10].

On the other hand, for Berelson (1952, p.18), quantitative research is the "objective, systematic and quantitative description of the manifest content of communication" [11].

This work was also done by bibliographic survey, which, through technical-scientific information, at some point in the history of humankind, an individual had the concern to register his knowledge of the subject. As the name implies, the bibliographical survey involves researching bibliographies written by others.

The article is also characterized as a case study whose objective was to apply a research method on the subject, allowing the deepening of knowledge on the theme. This scientific research strategy analyzes a current condition in its actual context, considering the variables that influence it.

The present work was developed and analyzed from January 2017 to December 2020.

Data Analysis

The railcar management at the company that is the object of this case study consists of 12 supervisors responsible for all the maintenance processes of the fleet of wagons of the EFVM (Vitória-Minas Railroad), currently having 439 own employees. Throughout the research, data will be presented to allow a comparison between the previous and current scenarios of the company regarding the risk situation of its activities.

From this case study, it was found that the main bottlenecks that prevented the improvement in the results of the work safety indicators were: The indicator accompanied by TRIFR rate (Total Frequency Rate of Occupational Injuries) did not generate engagement of the base; The employees could not understand what needed to be done to leverage the results; The action plans were only elaborated from the occurrence of accidents; The managers had difficulty in seeing the risks of their routine operations; The management could not direct investments to the principal risks and the Operational procedures did not specify the risks of the activities;

Figure 1 presents the visual demonstration of the equation of treating accidents from the TRIFR rate indicators (Total Frequency Rate of Occupational Injuries). After the results were achieved, a cause

Figure 1. Previous demonstrative equation.

Source: Authors.

analysis was performed to search for non-repetition of the occurrence, that is, a reactive vision, the reaction of the result always happened after an accident and/or event.

Case Study

It was noticeable that the results of the work safety indicators needed to be improved about the other process indicators. Therefore, it was clear that a change in managing such indicators was necessary.

Using the visual management tool FMDS (Factory Floor Management Development System), it was possible to monitor the risks with the highest potential severity at each activity level, bringing more simplicity to the exposure of problems (Figure 2).

Based on the preliminary risk analysis of the management, it was performed in the field the deployment of all the moments that such risk could be materialized, now every employee can see clearly in their operational procedures the risks associated with each step of their work, allowing employees to make improvements to eliminate and/or mitigate the risks of their activities.

Given the clearly and comprehensively mapped risks, management evolved to manage safety indicators proactively. As a result, a ceremony was created to recognize the employees who implemented improvement work, where they changed the risk classification on the visual management board of the FMDS (Factory Floor Management Development System) and the entire management leadership (Figure 3).

Figure 2. FMDS pillar for management safety.

Source: Fellipe Breno Bergamini (2019) (Author).

Figure 3. FMDS weekly follow-up meeting.

Source: Fellipe Breno Bergamini (2019) (Author).

Current Scenario

With the practice of applying the FMDS (Factory Floor Management Development System) tool, a new visual management of safety indicators was elaborated, which allows better results, such as Employees understanding the risks of their activities clearly during their work day; Actions directed to eliminate or mitigate the risks of the activities, in order to prevent accidents from happening; Control measures developed for non-materialization of accidents; Managers with established routines for checking the risks in their operations, allowing to see opportunities for improvement with the performers; Investments directed correctly to the risks with higher probability and severity and Employees making improvements naturally without the need for direction from managers.

Figure 4 follows a visual demonstration of the equation of the treatment of safety results from the mapping of risks and exposure through the FMDS (Factory Floor Management Development System) tool, focusing on the strategy of seeing the problems before an accident and/or unwanted event occurs.

Figure 5 presents the management risk indicator used nowadays, in which each color indicates the severity of the risk, being:

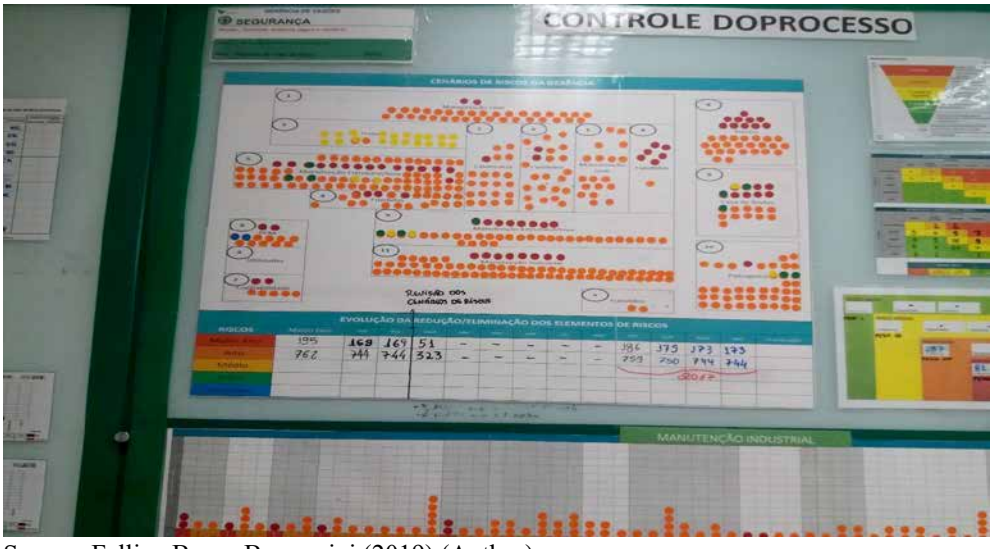
- Red Color: Very high risk;
- Orange Color: High Risk;
- Color Yellow: Medium Risk;
- Color Green: Low Risk;
- Color Blue: Eliminated Risk;

Figure 6 shows the history of the Total Occupational Injury Frequency Rate (TRIFR) indicator used by the company, which shows a significant reduction in accidents after implementing the lean manufacturing philosophy.

Figure 4. Post demonstration equation.

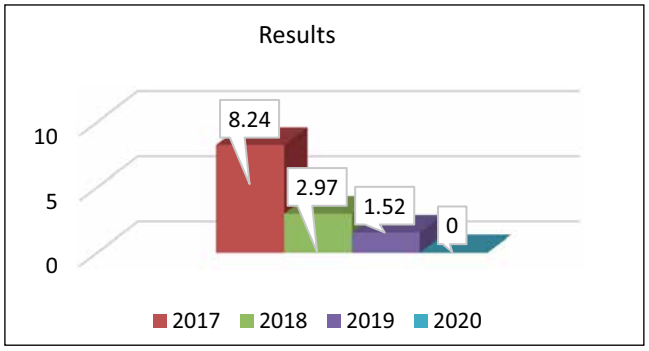
Source:Authors.

Figure 5. Management risk indicator.



Source: Fellipe Breno Bergamini (2019) (Author).

Figure 6. TRIFR rate from 2017 to 2020.



Source:Authors.

Given the research problem: how the Lean Manufacturing tools can help in reducing the Total Frequency Rate of Occupational Injuries (TRIFR), and the general objective of this study which is to present the use of lean manufacturing tools to reduce the rate of occupational accidents, it was found that the lean tools applied most often to eliminate waste and increase productivity also applies in improving the results related to occupational safety, considering the implementation cycle (Figure 7).

Conclusion

Implementing the Lean Manufacturing system tools, especially the FMDS (Factory Floor Management Development System), served as a model for achieving the objective. The methodology, when well adapted, can be used in any business.

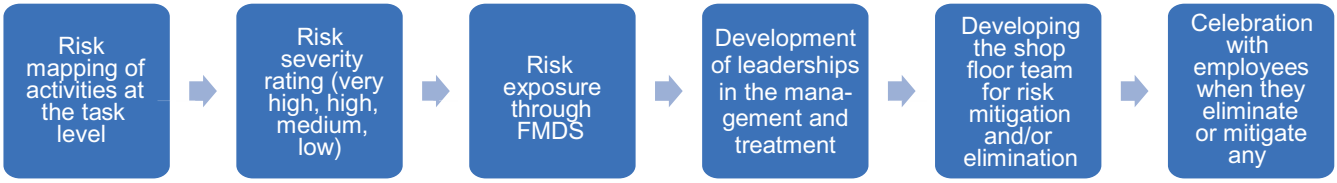
With the new visual management model of the safety indicator for the management of freight cars, it is noticeable the involvement of employees in solving the risks of their activities. With this, they begin to be treated proactively, allowing all employees to solve the problems effectively.

Routine management was one of the most challenging points due to the diversity of activities performed, but it is clear that planning and prioritization make it possible to execute. Furthermore, the visual management system helps a lot in self-knowledge and decision-making that no longer stays only at the managerial level but reaches the shop floor where things happen, and people are more prepared to identify the root cause of problems to expose and solve them, making the processes more sustainable.

References

1. Toledo JC. Conceitos sobre custos da qualidade. São Paulo: UFSCar, 2002.
2. Campos VF. Gerenciamento da rotina do trabalho do dia-a-dia. Belo Horizonte: Fundação Christiano Ottoni, 1996.
3. Falconi V. Gerenciamento da Rotina. 9. ed. Minas Gerais: Editora Falconi, 2013.
4. Albertini MR. Gestão de Processos e técnicas de produção enxuta. Curitiba: InterSaberes 2016.
5. Liker JK, Meier D. O modelo Toyota: manual de aplicação. São Paulo: Bookman, 2007.
6. Paim R et al. Gestão de processos: pensar, agir e aprender. Porto Alegre: Editora Bookman, 2009.
7, Chiavenato I. Os novos paradigmas: como as mudanças estão mexendo com as empresas. 5. ed. São Paulo: Manole, 2000.
8. Kishida M. O círculo do kaizen para sustentação do lean. Lean Institute Brasil, 2009. Disponível em: <https://www.lean.org.br/artigos/118/o-circulo-de-kaizen-para-asustentacao-do-lean.aspx>. Acesso em: 19 jun. 2017.
9. Gil AC. Como Elaborar Projetos de Pesquisa. 3. ed. São Paulo: Atlas, 1995.
10. Marconi MA, Lakatos EM. Metodologia Científica. 5. ed. São Paulo: Atlas, 2008.
11. Berelson B. Content analysis in communication research. Glence: Free Press, 1952.

Figure 7. The cycle of the case study.



Source:Authors.