Ergonomics and lean manufacturing: a case study of A3 as visual management tool for ergonomics in a Brazilian paper and pulp industry.

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Introduction: Ergonomics is a dynamic discipline, and has interface relationship with various areas and disciplines in industry. It’s placed in an industrial environments using tools to adapt the workstation to the human worker. And in the industrial context, there is the need to keep the balance between ergonomics and the effort for production, searching for provide health to the workers. But ergonomics can intertwine at some point, with the work organization and the production system. The use of tools for process improvements can be integrated to the ergonomic analysis tools and become useful for ergonomist. On the other hand it is also useful for the production, once can understand the ergonomic issues in a practical way, making an efficient communication.

Method: In this context is presented this case study, about the use of the A3 report, a lean manufacturing tool for visual communication, to address ergonomic issues, in a paper and pulp industry, located in the south brazil, aiming to improve the ergonomics performance, as well the production performance, facilitating the comprehension of the ergonomic diagnosis.

Results: An A3 report of ergonomics was made, containing the diagnosis, causes and improvements recommendations of the studied situation.

Discussion: The findings of this study appoints to an improvement in communication between ergonomics and production. The visual management provided by the use of A3 method optimized the understanding and the implementation of improvements in the workstations.

Keywords: Ergonomics; Lean Manufacturing; A3; Visual Management.

1. Introduction

Ergonomics evolved parallel to industrial production. As defined by the International Ergonomics Association (2000), Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and the elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and the system performance. Lean manufacturing system (lean production) seeks to optimize the production by reducing waste, rework and activities or tasks that do not add value to the product or service. Under this point of view, the lean manufacturing reaches a point where it can find the ergonomic premises. It uses its tools to diagnose problems and propose solutions and improvements. And the ergonomics use the same systematic.

The Lean Manufacturing System has stood out among all the production management systems, for its expansion and results among various industrial branches (COMM and MATHAISEL, 2000). This study aims to adapt one important tool of the lean production system, the A3 method, to the work of the ergonomist, in order to provide a visual management to ergonomic, aiming to identify ergonomics risks and their resolution in a paper company and Brazilian pulp.

2. Theoretical Development

This topic will be discussed relevant issues in the context studied, such as the evolution of industrial production, ergonomics, lean production system and where these areas are converging.

2.1 Consequences of Industry Evolution
After the industry revolution, the increase in production volume brought an increase in the workload, reflecting directly on the worker conditions. One of the consequences of this context is the emergence of the occupational disease.

Studied extensively after the 50s with the advancement of ergonomics, worker’s illness has become a cause for concern in industries because it harnesses costs and absenteeism. History shows that occupational diseases affecting the worker for centuries, however, these disorders have widened dramatically with industrial expansion (OLIVEIRA et al, 2009).

The impact of this revolution on the life and health of people have been the subject of several studies. (FIGUEREDO and MONT’ALVÃO, 2005a).

The same authors relate that “apparently the mechanical work aggravated the problem of the occupational diseases by imposing the work pace of the machine to man, leading, in most cases, a series of repetitive movements, monotonous and at high speed” (FIGUEREDO And MONT’ALVÃO 2005b, p.46).

2.2 Ergonomics

According Iida (2005), ergonomics is the study of labor to man adaptation.

The most recent definition, adopted in August 2000, the International Ergonomics Association (IEA) is as follows: Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. (Ferreira, 2008, p. 91).

Also according to Ferreira (2008, p. 91), “the goal of ergonomics is to understand the problems that hinder the interaction between workers and the working environment.” Abraham and Pine (2002, p 47) say that ergonomics: search two fundamental objectives. On the one hand, produce knowledge about work conditions and man's relationship with the work, on the other, develop knowledge, tools and principles susceptible to rationally guide the action of changing work conditions, in an attempt to improve the man-work relationship. The production of knowledge and the action of streamlining therefore constitute the main axis of ergonomic research.

As a scientific discipline, Ferreira (2008) reports that the ergonomics officially appeared in England at the end of World War II in 1948, the date of the Ergonomics Research Society institution, and was the result of the joint work of engineers, psychologists and physiologists to reshape the cockpit of the British fighter aircraft. (FERREIRA, 2008, p. 89).

However, were the Industrial Revolution demands that made the search for understanding man's job performance were initiated. Almeida (2011) reports that since this event, man's relations with the job came changing progressively, because the work pace demanded to the workers a new perspective involving the tasks to be performed, and also greater dedication to achieve the productivity goals imposed by the industrial system.

Ergonomics has become an object of study from the moment the man felt the need to adapt himself to new working patterns, generated by increasing changes in production processes. You could say that ergonomics has been passing through various stages of evolution, always proposing solutions to accompany technological advances. (ALMEIDA, 2011, p. 112).

2.3 Lean Manufacturing

It was in the 1950s, in Japan after the war that emerge the Lean Production System as a result of the study of engineers Taiichi Ohno and Eiji Toyoda. This followed after a visit to the Ford plant in the United States, which used the mass production system. The conclusion was that the Japanese copy or improve the Ford system was not feasible. It would be necessary to create a new production form. This manufacturing management was also known as the Toyota Production System (ELIAS and MAGALHAES, 2003).

According to Liker (2007) the main wastes appointed by the production are:
- Overproduction: the loss by producing beyond the scheduled or required
- Hold: The waste with the waiting time originates from a time in which no processing, shipping or inspection is performed;
- Transportation: Transportation is an activity that does not add value and can be seen as loss, requiring measures to minimize it;
• Processing: These are portions of the processing that could be eliminated without affecting the basic features and functions of the product/service.
• Stock: It is the loss in the stock form of raw materials, material processing and finished product.
• Handling: These losses relate to unnecessary movements made by operators in the implementation of an operation;
• Defective Products: Loss by manufacturing defective products is the result of processing products that have some of their qualitative characteristics out of a specification or standard established and thus did not meet usage requirements.

2.3.1 Third level heading (ARIAL 11-point, flush with margin, italics, bold, line spacing 1.5)

According to Sobek and Smalley (2010), the A3 method, also called A3 Report, is a "tool that establishes a framework for implementation of the PDCA cycle management (Plan, Do, Check and Action)"; this tool helps processes members in reporting and understanding problems, and to glimpse the question solution.

In this context, A3 method was developed. Example of report structure in Figure 1:

Figure 1: A3 Report. Source: Mateus Junior, 2013.

• Step 1: Theme: general thematic categories, creating the theme;
• Step 2: Problem Situation: Background; Current Situation; discrepancy; extension; justification
• Step 3: Target: What to do, when to do, how to do;
• Step 4: Cause Analysis: Potential causes; Checking; results; 5-Whys; Causal Chain; Root Cause;
• Step 5: Countermeasures: short term; long term, why recommend;
• Step 6: Implementations: What actions should be taken; Who should take every action; When each action needs to be completed; Action Results;
• Step 7: Follow-up: How to check; When check; Recommendations.

The use of this tool can opens ways for ergonomic improvements objectively. In the industrial environment can be an important mechanism in the ergonomist and the health and safety sector hands in the implementation of improvements targeting a homeostasis in the workplace.

In this context fits the presented study, seeking results using the A3 from the Lean System tool in disease prevention, attacking absenteeism analyzing the related indicators. The visual management of ergonomics tasks using de A3 can optimize the communication between the health and safety sector and de production sector.

2.4 Lean Manufacturing and Ergonomics
Considerations about lean production and ergonomics were presented by Mateus Junior (2014), noting the following:

- Maintain ergonomics next to the concepts of lean production helps ensure that the company is not removing waste production through the establishment of overloads for their employees;
- To ergonomics go along with lean production is of fundamental importance to have its indicators established next to the company's strategy and its countermeasures are proposed with systems thinking;
- Ergonomics has a significant role within the Lean Production goals by reducing waste associated with reducing handling and errors (improving quality);
- Ergonomics is important for lean production as much as the Lean Production is to ergonomics.

Both, ergonomics as Lean Manufacturing presents tools for their development. Ergonomics to assess the human situation at work. The lean manufacturing in general, tools for process optimization, aiming to work more efficiently. The integrated use of these tools can be a differential for the ergonomist align itself with production. One of the tools in this context is the A3 report.

3. Methodology

This study is classified as action research. The method used to conduct the study is qualitative research.

The research was conducted in a Brazilian paper and corrugated cardboard packaging industry, specifically in the packaging sector, divided into sub sectors: carton, corrugators, maintenance and dispatch. The research was conducted in a Brazilian paper and corrugated cardboard packaging industry, specifically in the packaging sector, divided into sub sectors: carton, corrugators, maintenance and dispatch. The subject or target of the intervention is the medical certificates number, representing great damage to the company and is evidence of prevention problems regarding occupational health.

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4. Results

The steps of making the A3 contemplated:

- Meetings and brainstorm to study the indicators and understand the initial situation;
- Understanding the root causes through the use of tools such as Ishikawa diagram among others;
- Development goals and expected results with the problems identified resolution;
- Countermeasures development proposition to solve the exposed and studied situations;
- Indicators monitoring schedule after adopted countermeasures and resolved the issues raised.

![Figure 2: A3 Report to the situation described. Source: the organization.](image-url)
The preparation of this A3, as already mentioned, had participation of the researcher, Health and Safety sector members and production members, in addition to consulting the continuous improvement sector, in order to reduce the exposure to risk for employees health in order to reduce absenteeism by disease.

The first step, which contextualizes the problem, contains data of the sector workers and the report of the making of the reason.

Next, the current conditions bring together ergonomic diagnosis information. In this topic, are initially shown through images, the working conditions of employees machine. Then the graph of the certificates number for musculoskeletal diseases (ICD M), ergonomic physical risk indices raised with the NIOSH equation and the RULA protocol, and also the result of pain research and bodily discomfort are inserted.

After this stage, there was a root cause analysis using the Ishikawa diagram. The main findings were:

• Causes related to the machine: constant presence of trims; proper maintenance difficulties; difficulty moving to the side of the treadmill.
• Causes related to method: no breaks in the work journey; absence of workers; lack of adequate and standardized procedure; difficulties alternate the use of the upper limbs.
• Causes related to environment: environment without climate control; exposure to cold and heat; excessive dust.
• Causes related to raw material: plates with quality problems.
• Causes related to labor: lack of training; lack of labor in the labor market.
• Causes concerning the measures taken in the process: machine struggling to fine-tune; inefficient knives generating trims.

After these initial steps, a goal was stipulated to draw the action plan: to reduce the medical certificates number, especially ICD M (musculoskeletal disorders).

The fifth step establishes a series of counter measures that could be adopted to achieve the certificates reduction target ICD M.

Finally, set up a monitoring schedule for these countermeasures, and the report A3 in question was sent to the organization management for approval.

From the managerial approval, potential solutions proposed entered in the organization's strategic radar, definitively and objectively. Search up with it, reducing absenteeism rates due to diseases, greater cause of work absence in the organization, as found in this study initial analysis.

5. Discussion

The issue of absenteeism, for years is detrimental to the company and workers. Their complex diagnoses led to the professionals invest their time in order to identify specific problems.

The A3 methodology increased global vision and enabled a diagnosis encompassing the entire unit.

But the great collaboration of this tool is provide visual management of the risks. The visual management provided in the case proved to be of great value in the team communication.

6. Conclusion

The relevance of the union of tools used in everyday life of a lean production system with ergonomic tools is important. The industrial production efficiency is influenced by the human factors, and therefore improvement measures in the workplace should be seen as quality measures.

In the ergonomics point of view, having a practical and functional tool inserted in production context can be an important weapon in the organization objectives alignment. Walking side by side with the production, ergonomics can leverage their results, using an equal communication with production in regard to ergonomics.

The more satisfied the man in your work environment, the better the quality of the final product. This correlation makes it extremely prudent, by the ergonomist, knowledge of production systems and tools, and their use can be the difference between being in synergy or not with the organization.

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