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An initiation of a Lean journey in a clothing company

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ABSTRACT

This paper presents the introduction of Lean Production in a clothing company. This company had never before heard of Lean Production but it was curious, embraced the challenge and agreed to have a researcher in its facilities to evaluate the work environment and the Lean implementation viability. In conclusion, the research has shown that, in addition to the company interest, the implementation of some of the proposals overcome problems identified in the critical analysis of the company´s production system. The solutions proposed to the problems identified are based on Lean principles and tools. The chosen procedure includes the presentation of the proposals, revealing that the modifications suggested for the finishing sector, will allow the simplification of material flow and control of production, the reduction of Work-in-Process as well as the reduction of waste associated with transportation activities between work stations.

Keywords: Lean Production, Clothing Industry, Waste Identification Diagram (WID)

INTRODUCTION

The Textile and Clothing Industry (TCI) has an important role in national economy due to positive contribution to the Portuguese trade balance. However, this industry has experiencing great challenges and difficulties with the increased competitiveness from the liberalization of markets worldwide. In addition to this, TCI is a sector strongly influenced by seasons, trends and fashion and climate changes, adding the challenge to meet the constant modifications in customers demand in a very short time (Maia et al., 2013a). The authors experience in a clothing industrial environment shows that this is an industry where many wastes can be found. Although being considered as irrelevant activities by the companies, these activities adds no value to the final product in the customers' viewpoint and should be eliminated (Womack & Jones, 1996).

Therefore, the implementation of Lean Manufacturing principles and tools (Womack et al., 1990; Womack & Jones, 1996) are becoming increasingly important to eliminate wastes in production systems to reduce costs and optimize productivity, deliver on time quality products, improve processes and to get a smooth and efficient flow (material and information) of activities. To visually identify these wastes, some tools like Value Stream Mapping (VSM) (Rother & Shook, 2003) and Waste Identification Diagram (WID) (Dinis-Carvalho et al., 2014), are useful. WID is a recent tool developed by Dinis-Carvalho et al. (2014) that immediately shows the imbalance of each workstation and between workstations even the most complicated production units.

The work presented in this paper was developed in the context of a Master Thesis of the Industrial Engineering degree at the Department of Production and Systems of University of Minho. Thus, a research in a Portuguese Textile and Clothing company shop floor was conducted to apply Lean Production principles and tools in order to improve the production system current conditions. This project aimed to: (i) organize the flow of material and information, (ii) reduce or eliminate waste and waste symptoms, (iii) reduce the overburden of the workers and the risk of occurrence of musculoskeletal disorders, (iv) normalize working procedures and to (v) enhance the productivity and flexibility of the production system.

The work developed followed the Action Research methodology, i.e., a type of research, also known as participatory research, characterized by an active involvement of the researcher and from its focus in solving real problems (Saunders, Lewis, & Thornhill, 2011). This methodology is composed by five steps (O'Brien, 1998): (i) diagnosis, (ii) action planning, (iii) action taking, (iv) evaluation and results discussion and (v) learning specification. Among the different sections in the company shop-floor, the analysis assumed great importance in the finishing sector in which had its focus. A study concerning operating times and the current configuration of the layout was carried out in this sector in order to identify problems as well as potential improvement situations.

Consequently, this paper details preliminary findings from an initial intervention of applying Lean principles and tools in the finishing sector of a Textile and Clothing company in order to eliminate waste from processes and progressively improve the efficiency of the production system. Among the actions taken during the diagnostic phase, it stands out the application of a new tool for waste identification, Waste Identification Diagram (WID), as well as a layout study, to identify problems in this sector. Solutions were proposed to reduce transportation activities and to improve working conditions that will be detailed described in the paper.

This paper is structured in five sections. After the introduction in section 1, the section 2 provides a brief literature review on Lean Manufacturing principles and its tools. Afterwards, on the third section, the finishing sector of the clothing company and the problems identified during the analysis stage are described, along with the solutions proposed to overcome these problems and improve the current situation. In the section 4, the results obtained from the proposals implemented in the finishing sector and their discussion are presented. Lastly, in section 5, some final remarks about the project are delineated.

BRIEF LITERATURE REVIEW

Lean Production (LP) has its origins in the Toyota Company at the end of World War II with the implementation of the Toyota Production System (TPS) (Monden, 1983). The designation Lean Production appears lately in the famous book "The Machine That Changed the World" (Womack et al., 1990).

According National Institute of Standards and Technology (2010) Lean Production was defined as *"... a series of tools and techniques for managing your organization's processes. Specifically, Lean focuses on eliminating all non-value-added activities and waste from processes. Although Lean tools differ from application to application, the goal is always incremental and breakthrough improvement. Lean projects might focus on eliminating or reducing anything a final customer would not want to pay for: scrap, rework, inspection, inventory, queuing or wait time, transportation of materials or products, redundant motion and other non-value-added process steps."*

Lean Production key idea is "Doing more with less" where less means less space, less inventory, less human effort, less transports, less movements, etc. LP is concerned with people and environment hence it promote the regularity to avoid the overburden, the stressful conditions, the consuming processes that are waste symptoms. For this, a careful attention is given to the people training and involvement that are trained to solve problems, to use their creativity, to reduce wastes of all kinds, to become thinkers (Alves et al., 2012). At the same time, respecting the environment means training also the consumers (costumers) to become Lean adopting Lean solutions in their behaviour (Womack & Jones, 2005).

Lean Production becomes a way of life and thinking that Womack & Jones (1996) defined in five principles, called Lean Thinking principles. They are: 1) Value; 2) Value Stream; 3) Flow; 4) Pull system and 5) Pursuit perfection. This last principle means a continuous improvement, always searching solutions for the problems identified. Attending to these principles, a company will deliver value to the customer that it is the final goal of Lean.

Nowadays, many companies are implementing Lean to improve processes, increase productivity and reduce costs by eliminating wastes. This implementation is happen in companies of all kind of goods and services (Melton, 2005; Alves et al., 2011; 2014). According to the committee for Foundational Best Practices for Making Value for America (Donofrio & Whitefoot, 2015), companies and communities must take action to upgrade America's ability to "make value." to prosper in the 21^{st} century and one of their recommendations is *"Manufacturers should implement principles and practices such as Lean Manufacturing that enable employees to improve productivity and achieve continuous improvement."*

Lean implementation is not an easy or simple task because it involves changing the mind-set, the culture of a company. It demands a new paradigm and a congruency between the thinking and the doing that in most organizations is failing (Flumerfelt et al., 2014). To achieve this, it is important to follow a methodology to guide this implementation. Each industry or organization has its own work pattern and requisites and, sometimes, a dedicated or focused methodology is better than a general one. This is the reason why it is possible to find in the literature many methodologies (Maia et al., 2011).

The Textile and Clothing industry is a peculiar industry with many contextual differences that is always knowing a lot of changes caused by the context and market and some methodologies had been proposed for Lean implementation (Hodge et al., 2011; Maia et al., 2012a; 2013b). Before implementing Lean in this industry, it is important to infer about work conditions and environment (Maia et al., 2012b; 2014a; Eira et al., 2015a) because traditionally is an industry with low wages, family based structure, poor ergonomic conditions with many employees unsatisfied. Additionally, the need to change must be felt to overcome the resistance to introduce a different paradigm (Maia et al., 2014b; Eira et al., 2015b).

INDUSTRIAL APPLICATION

Within the research developed in the scope of a Master's Thesis in a clothing company, the finishing industry sector has undergone an exhaustive process of comprehensive analysis to identify problems in the production system. The wide variety of models (of garments) that have to be produced, often in small amounts, and the growth and diversification of the client portfolio required to the sector an urgent need to restructure the production process to increase its flexibility and responsiveness to demand. Firstly, this requirement has been overcome by creating a highest leadership position with managerial functions in the sector related to the production planning and process control. This measure, although has enabled better organization of the flow and increase production capacity, proved to be insufficient to overcome some of the gaps.

Thus, given the Action Research methodology, the first action carried out involved an analysis of the finishing sector in order to know and to understand the current conditions of the production system exposing major problems. The other steps of the methodology were followed and are described in the next sections.

Diagnosis and critical analysis

To proceed with the critical analysis, the diagnostic tool Waste Identification Diagram (WID), developed at the University of Minho, was chosen. WID allow a rapid identification of waste associated with productive activity. The use of WID assumes the determination of variables like the Cycle Time (CT) operations, the Takt Time (TT), preparation time of the tools and the level of WIP. Also, include the determination of the transport effort required between WS, as well as the occupancy rate of the workers' time with activities, distinguishing between those that add value and those that do not add value to the customer, in a Lean perspective. Given the scheduled production, 4 different product models were considered in the analysis of the production flow in the finishing sector. In this sector, products are sequentially processed over 4 workstations (WS) with different operations: WS1 - ironing operation, WS2 - folding operation, WS3 - labeling operation and WS4 - packaging operation. This set of operations is intended to give a careful and commercial appearance or marketable quality to garments parts and they will then dispatched to customers and then sold on the market. The indicators obtained from the diagram was elaborated and shown in Figure 1.

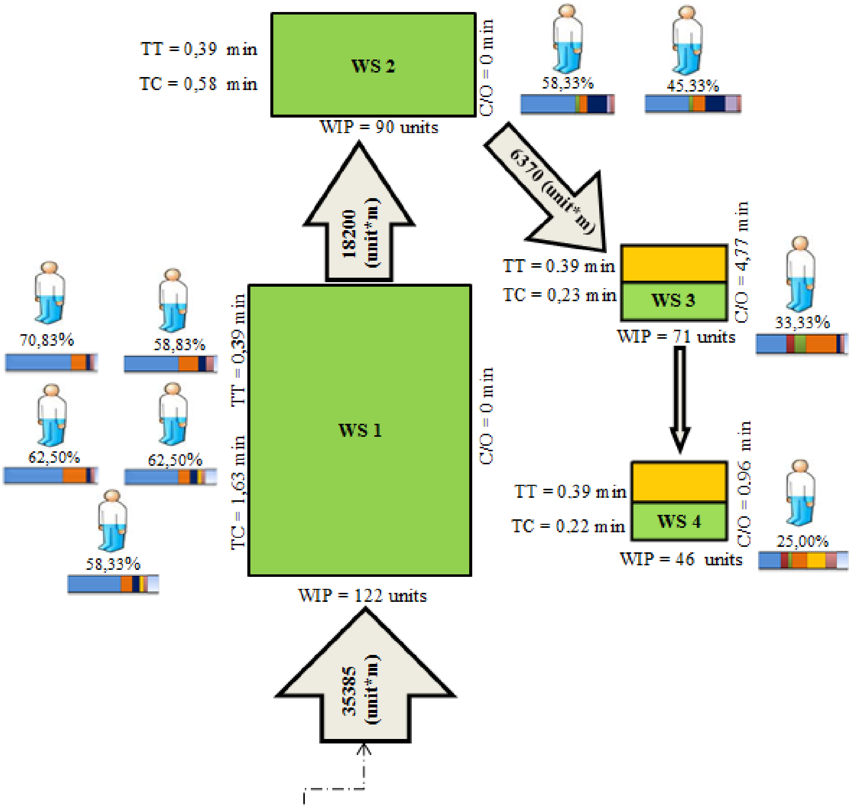

Figure 1 - WID of the productive process in the finishing sector

The diagnosis of the finishing sector allowed drawing important inferences:

- There is a discrepancy between the CT on workstations - lack of balancing the production flow;
- The CT exceeds the TT in WS1 and WS2;
- The TT exceeds the CT in WS3 and WS4;
- Large amounts of WIP;
- Great effort in the transport of products between workstations;

- For workers, high occupancy rate with activities that do not add value.

The waste with the higher incidence in the sector was the time that employees spent on transportation activities for moving products between different workstations along the production process. Despite the distance travelled is not particularly long, it was found that there was a strong tendency for displacements throughout a workday. Therefore, a more detailed study on the transport activities was made by a layout analysis to determine the causes of existing waste. Figure 2 illustrated a schematic layout of the finishing section, highlighting the flow of materials between the WSs (OP# are the operations performed in each WS).

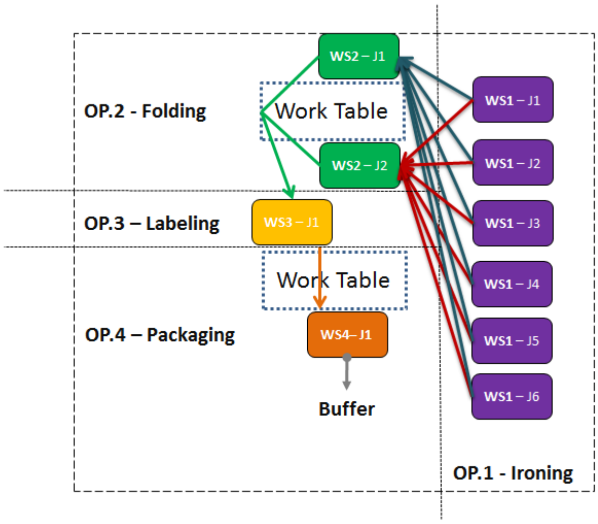

Figure 2 - Spaghetti Diagram of the finishing sector

The layout analysis showed a very confusing material flow, especially between WS1 and WS2. This is explained by the constant need that workers have to move to get work to the precedent workstation and then return to their workstation manually transporting the pieces to be processed in the next operation. Notice that, between these two workstations the workers traveled on average a distance of 10.57 meters in round-trip travels.

With the purpose of determining the average distances travelled and the average lost time per working day, with transportation activities in the workstations supplies, observations and counting were conducted during 3 working days. The results obtained are shown in Table 1. It was found a high average number of occurences, even losing on average per working day, about 0.27 hours (equivalent to 16 minutes) with transport activities in the sector. Based on the manpower cost (per hour), an annual cost of 522€ associated with these activities was estimated. These activities don´t add value to the product, so, it is important to reduce the frequency which these movements occur on the one hand, and on the other the distances covered to mitigate costs.

Table 1 - Results obtained from the assessment of the transport activities in the finishing sector

	Nº of occurrences (by day)	Distance travelled – product (meters/day)	Distance travelled - worker (meters/day)	Time spent with transportation (hours/day)	Cost of labour (€/hour)	Cost with transportation (€/day)	Cost with transportation (€/year)
WS1–WS2	78	410,28	821,34	0,1697	8,14 €	1,38 €	320,16 €
WS2–WS3	83	177,73	355,47	0,0762		0,62 €	143,84 €
WS4-Buffer	69	62,4	124,8	0,0312		0,25 €	58,00 €
TOTAL		650,41	1301,61	0,2771			522,00 €

Planning and taking action

Thus, it was proposed a change in the layout, in the form of workstations (WS) supply and current production organization in order to: i) simplify and to bring more agility to the materials flow, ii) facilitate the production process control; iii) balance operating times in WS; iv) reduce the WIP level; v) reduce/eliminate waste associated with transportation activities and incurred costs.

To reduce the travelled distances between WS1 and WS2 a new form of supply of the WS was defined which employees in WS2 can only move to the WS in WS1 relatively closer to get work. Moreover, a change was made in the provision of work table and workstations were strategically relocated allowing a closer and better flow between WSs. Following the proposal for the workstations' supply, a standardized way of organizing the production was also defined: divide the different sizes of clothes orders by the two production flows (identified in Figure 3 in blue and red). This solution was designed to facilitate the production control by the chief of the sector and to avoid the recurrent problem of mixing sizes throughout the process. The configuration of the new layout proposed for the finishing section is shown in Figure 3.

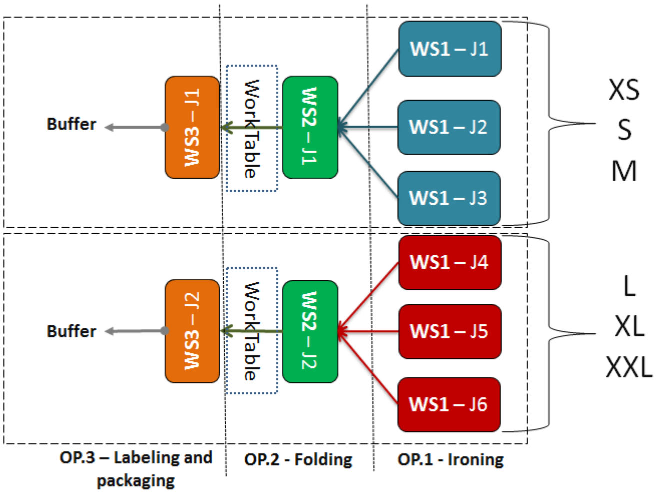

Figure 3 - Proposal for the layout of the finishing sector

A physical arrangement of workers in the sector was also proposed. So, instead of the folding operation be processed on the same working table, the two workers assigned to this task will now be distributed, one worker for each working table available. The responsible workers for carrying out the subsequent operations of finishing parts must stand behind the front line. The reason of the amendment is to avoid or to eliminate the need of materials handling between WS2 and WS3, by having the work done and driven across the table.

Another important change proposed was to group together the two operations of labeling and packaging in order to be performed by one person. Thus, workers who carried out one of the operations in their respective workstation starting now to carried out both operations. This would address one of the problems identified with the analysis of WID concerned to the inconsistency balancing on the production flow. In WS3 and WS4 it was found that the cycle time was less than the Takt Time, yielding an idle value where workers were not adding value to the product. Through the analysis of workers' degree of versatility by a competency matrix, it was found that these workers were skilled to perform both operations perfectly. Thus, in addition of balancing the production flow, this change will allow to reduce monotony at work caused by the fact that they are performing always the same operation over and over the 8-hour day.

Results evaluation and discussion

The results obtained from the rearrangement of layout in the finishing sector along with the modifications in work procedures are shown in Table 1. The values presented represent an estimative since it was not possible to undergo in a new count after the improvements.

Table 2 - Results of the assessment in finishing sector before/after the rearrangement of layout

	Performance indicators		
	Before	**After**	**Reduction**
Distance travelled (meters) with Transport Activities	136,04	34,02	75%
Time spent (seconds) with Transport Activities	102,24	47,35	54%
Annual Costs (€) with Transport Activities	522,00	378,16	28%
Work-in-Process (units)	329	283	14%

It was possible to organize and simplify the material flow and reduce the distances travelled by collaborators between workstations in 75%. This was achieved through two main solutions: 1) new arrangement of the working tables where the collaborators perform their work, they were rearranged to be closer to each other; 2) new way to supply the jobs in workstation 2 (WS2) with work from workstation 1 (WS1) (must go to the nearest jobs in order to get work). Additionally, folding and labelling operations that were performed in different workplace WS2 and WS3, were proposed to both be performed in the same working table. In this way, the transportation activity carried initially to supply work between these stations was eliminated permanently. Accordingly, the time spent by collaborators with transportation activities, which are pure waste, was reduced in 54%. The annual costs estimated with these activities that add no value to the product were reduced, at least, in 28%. Because of these improvements, it is expected a reduction of transportation time, and, therefore, a further decrease in these costs.

Through the utilization of WID was observed a lack of balance in the operating times of workstations (WS). Since there was an idle time of 10 seconds, approximately, in WS3 and WS4, was proposed the allocation of the operations, labelling (WS3) and packaging (WS4), to the same person instead of being realized separately by two collaborators. By assessing their degree of versatility across tasks, it was found, in fact, that they were perfectly capable to perform both functions without compromise the proper functioning of the production system in finishing sector to attend customers demand. The company immediately adopted some of these proposals.

FINAL REMARKS

This paper presented the initiation of a company to the Lean principles and tools. This was a challenge for the company and for the researcher but the authors considered that this challenge was surpassed. After the initial struggles related fundamentally with worker´s aversion to change, it was possible to shape their mentalities in order to be more concerned about their work quality and with the process efficiency.

The company itself was very receptive allowing different studies about the ergonomic conditions and its openness to the change, respectively published in Eira et al. (2015a; 2015b). Some of the proposals were effectively implemented and that was a real motivation for the researcher. The advantages resulting from the implementation of some of the proposals trigger the credibility of Lean potential near the company and the authors hope that this initiates a Lean implementation journey.

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