IMPROVING PERFORMANCE IN ROMANIAN GARMENT INDUSTRY BY USING THE LEAN SIX SIGMA METHODOLOGY

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ABSTRACT

Product quality is essential for textile and garment companies, and product diversity is also a critical concern. The variations in the garments' production process are unacceptable, contributing to the appearance of defects, higher production costs, lower profit, and unsatisfied customers, respectively. Improving the level of quality for textile and clothing products is steadily increasing at global level. Due to the strength and competition of today's business climate, many major garment companies have been looking for ways to increase product quality. Lean Six Sigma approach can be applied by clothing companies to improve the quality of goods and operations, including production, reducing the number of mistakes and developing new products. Aiming to provide pertinent improvement proposals for the production process of a typical Romanian garment company, a research was conducted by applying the DMAIC process. Subsequent to the analysis of the company history, an evaluation of the production process was carried out and the causes that cause dysfunctionalities in the production cycle were identified. Finally, a series of improvements were proposed that would lead to the improvement of the activity in the company and generate a revival of this sector of activity.

KEYWORDS: *Garment industry, Lean Management, Six Sigma, quality, textiles.*

1. INTRODUCTION

Lean Six Sigma represents a methodology based on customers' satisfaction and a permanent desire for qualitative processes. Therefore, one of the main methodology's objectives is to eliminate all kinds of wastes as well as reducing variability (Bugheanu and Dinulescu, 2018).
Previous research has demonstrated the successful application of Six Sigma methodology in various fields, such as the automotive industry (Bilgen & Şen, 2012; Fadly Habidin & Mohd Yusof, 2013, Erbiyik & Saru, 2015), small and medium-sized enterprises (Antony et al., 2005; Timans et al., 2012; Timans et al., 2016) or services (Antony, 2006; Delgado et al., 2010; Furterer, 2016). For the textile and clothing industry, product quality is essential and product diversity is also a critical concern. The variations in the production process of the garments are unacceptable, contributing to the appearance of defects, respectively higher production costs, reduced profit and dissatisfied customers (Dima, 2018). Improving the quality level for the manufacture of textile products is constantly increasing. Because of the intensity and the competitive pace of today's business world, many large clothing organizations have been looking for strategies to improve the quality of the products (Dobrin et al., 2015).
The correlation between Lean and Six Sigma appeared in the early 90s (at AlliedSignal and Maytag), and with time, it became popular, especially due to Michel Georges, under the name of Lean Six Sigma (Dinulescu et al., 2017).

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The term "lean management" was first used to describe the Toyota Production System, by Womack et al (1990) in their book *The Machine that changed the world".* Authors like Holweg (2006) approve that one of the most extensively cited book in operations management is the one mentioned above.

Figure 1 shows an evolution of the quality systems, from the first implementation's steps, till the appearance of Lean Six Sigma:
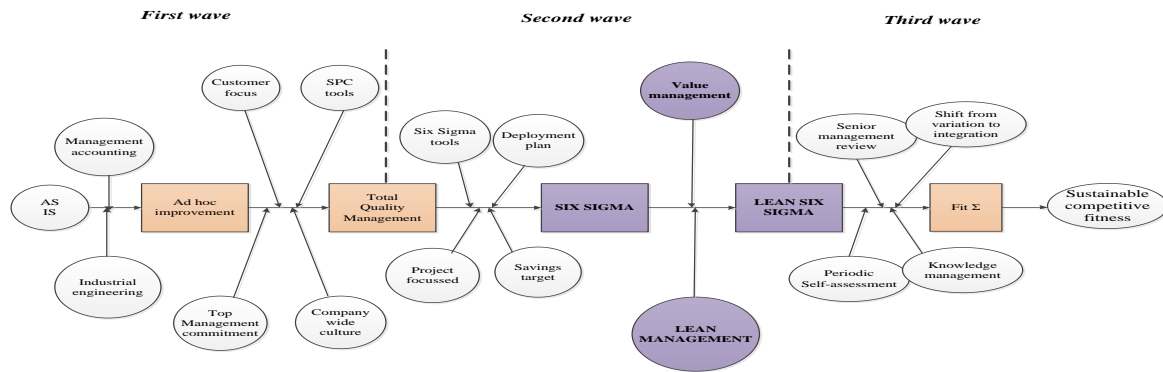

Figure 1. Evolution of quality systems
Source: adapted from Basu (2008)

The main focus of Lean management is to eliminate all kinds of wastes, mostly by reducing the inventory level, while the Six Sigma methodology deals with reducing all sorts of variability that could determine uncontrolled processes. Therefore, in his book, Ohno (1988) analyzes seven types of wastes: overproduction, time on hand, transportation, over processing, inventory, movement and defective products. Later on, the economy's evolution added a new type of waste (visible in most enterprises, no matter the industry field) – human waste (for example, decisions are taking by the manager, without taking into consideration employees' opinions).

Furthermore, in order to better express the differences and similarities between Lean and Six Sigma, Nave (2002) proposed the following table:

Table 1. Analogy between Lean and Six Sigma

Program specification	Applicability indications	"Label" or indication	Focus on:	Main benefits	Secondary benefits	Critics
Lean Management	1.Value identification 2.Value flow identification 3.Flow 4."Pull" system 5.Perfection	Elimination of waste	Flow	Flow' acceleration	Less waste; Less stocks; Better quality.	Statistics or system analysis are unused.
Six Sigma	1. Define 2. Measure 3. Analyze 4. Improvement Control	Reducing variability	Problems	Procedures' stability	Less variability; Accelerated flow; Less stocks; Better quality.	Lack of interaction between systems. Processes are independently improved.

Source: Nave (2002)

2. LEAN SIX SIGMA IN THE GARMENT INDUSTRY

The textile and clothing industry is one of the oldest and largest export industries, generating billions of dollars in sales globally each year. It is divided into the production of clothing and textiles, having as main characteristics the development of fashion trends, brands, the development of the distribution network through the shops and the optimization of the logistics from production to stores (Girneata, 2013). Due to the technical and technological developments from the last decades, new methods and procedures have been implemented in the garment and textile industry which have led to increased productivity and the emergence of new textile products on the market (Girneata & Dobrin, 2015). In this way, the companies in the industry manage to satisfy the complex desires of the consumers, the demands and the global trends of the fashion. The trend in terms of growth rate, design, fashion, use and size of a certain assortment is given by the major consumer centers, respectively the ones located in highly developed countries.

The textile and clothing industry has become a global phenomenon and, due to its complex connections with several other fields, including manufacturing, advertising, raw material production, transportation and retailing, the huge profits that are foreshadowed in the fashion industry can determine companies to adopt unethical behavior. Currently, the garment industry around the world is facing a similar problem: the inability to capitalize on the entire production of clothing. The latest economic crisis has led to a steady decline in production, the loss of markets which has led to the dismissal of large numbers of employees, the closure of non-performing enterprises or the shift of production to countries with low paid labor force.

To cope with the high competition and changes in the market, the developed states have adapted, intensifying their research of automated systems of technological processes, therefore leading to the progress in the field of automation and robotics, as well as the invention of new smart sewing machines. Thus, the automation of the production processes becomes inevitable for the survival of the companies in the new world economic context. The constant variation of fashion trends, the emergence of new materials and technologies, but also more and more demanding clients imply the need for flexible production, adaptable to the vast changes in production parameters for innovative and trendy clothing items (Colovic, 2012).

However, there are significant differences in production tasks, the role that industry plays in each country, but especially in international trade. The dynamics of garment exports shows significant progress on the global China apparel market, whose garment industry plays a very important role both nationally and globally.

In order to improve the quality of products and processes, including manufacturing, reducing the number of errors or developing new products, companies in the garment industry can apply the Lean Six Sigma methodology. Before applying the Lean Six Sigma methodology, it is important to observe why the two methods need to be applied together. Table 2 presents the reasons why the two methodologies are better used together:

In the Romanian garment industry, the Lean Six Sigma methodology, as Taghizadegan (2006) mentions, represents a data-driven approach for identifying the root cause of problems (deficiencies), by using the DMAIC process (define, measure, analyze, improve, maintain and control) to coordinate the operating activities.

Table 2. Analogy between Lean and Six Sigma

Why does Lean need Six Sigma?	Why does Six Sigma need Lean?
There are situations when Lean methodology is not able to explicitly prescribe the culture and infrastructure used for accomplish and preserve results.	For analyzing and dealing with all sorts of wastes.
Lack of centrality regarding the Critical-to-Quality of customers' needs (from a Lean Management perspective, when an employee develops a value stream map, he will also decide if that action has a value added or not).	To increase the speed of processes as well as improving the cycle time (Pull system, for example, is not used in Six Sigma methodology).
The variation's effects are not perceived by the Lean Management methodology (the tools for eliminating the variation level are not included in the Lean approach but for Six Sigma eliminating variation represent a fundamental goal, thus is uses various tools for limitation the process variation).	Six Sigma presents a deficit regarding the use of speed tools (on the contrary, Lean management has a variety of speed tools which bypass a process' performance).
	Six Sigma quality could be obtained easier if Lean management would eliminate the non-value added activities.

Source: adapted from George (2003), pg.46

3. METHODOLOGY

The current research was based on both quantitative and qualitative methods. The qualitative method was applied for the analysis of the specialized literature, in order to present the Lean Six Sigma methodology, to select the important tools from the specialized literature analysis in order to efficiently functionalize the analyzed elements and to develop proposals to improve the registered deficiencies. The quantitative method was applied for statistical calculations of the process performance measurement during Lean Six Sigma application.

The research was conducted on a Romanian textile fabric, with a business of over one million euros registered in 2018. Therefore, the research focused on applying the DMAIC process, by identifying the eventual losses that appeared during a three months period between June 2019 and August 2019. By examining the company's history, a detailed analysis of the causes that led to the present situation can be carried out. The company was founded during the communist period when there was an intense concern for the country's industrialization, when many high capacity factories in the field of textiles and clothing were built. The factory was endowed with machinery, installations and technologies, but the production of the financial and human efforts has not been put in the foreground in parallel with the intensification of the interest for commercialization, so a gap between the textile production and clothing and foreign trade has been created. Initially, the resulting products were exported mainly to the neighboring socialist countries, and following the events of 1989, the company faced a strong competition from those from Asian countries, that provided a much lower price. After the fall of communism, the company was privatized, but at the same time numerous export and intermediary companies with foreign capital appeared on the market. Communication with foreign markets has been facilitated, diversifying business relationships and applying marketing strategies especially for clothing products. However, the company competed with European or global producers, some of them with unfair practices or benefiting from vast resources of raw materials for the textile industry or whose development was supported by state policies, as was the case with Turkey, China, India, Mexico, etc. The 2005

radical changes in international trade, by eliminating the quantitative restrictions, led to a significant increase in exports from Asian countries to the markets where the company was a major supplier of clothing (Girneata, 2015).

Between 1990 and 2000 the number of competitors in the country increased significantly, and their main advantage was that they could adapt to the demands of the market and consumers faster. Due to increased competition on the European market, large retailers have resorted to relocating production to developing countries whose main advantage was reduced labor costs. This type of international contract in which a subcontractor performs the workmanship of a product at the request of the beneficiary on the basis of a technical documentation and the materials required for an established remuneration, is called lohn. Thus, one way to ensure the company's competitiveness on the market at that moment was to produce in the lohn system the orders destined for export. The main immediate advantages of the company regarding the production in the lohn system were that it reduced its expenses with the supply and the possible adjacent risks, being delivered the raw materials directly by the contractors; exported orders to foreign markets without making any effort to prospect markets; benefited from the transfer of know-how from foreign partners, being able to utilize the gained knowledge to improve labor productivity or the performance of the workforce and modernized its equipment, thus improving the technological process.

However, lohn production did not allow the company to have its own identity, and the main criterion based on which it was chosen by the partners was the cheap labor force, an unsustainable long-term advantage. In other words, only labor and logistics were used at low prices for the sole purpose of manufacturing. The company benefited from these short and medium term contracts, the factories being equipped with new equipment and technologies, being able to operate at maximum capacity and having access to other markets. However, in the long term, the lohn proved to be unprofitable for the company, because the revenues obtained only from processing are much lower than if they had marketed the product under their own brand, the company losing its identity, its name not being visible on the product labels, there is always the risk for the importer to transfer its production to other countries that provide cheaper labor.

Hence, the company benefited from minimal financial advantages. Also, because it did not produce under its own name, the company had no visibility on the external market and could not conclude contracts with other retailers. Another problem that arose was the delay in the supply of raw materials, which often stagnated the production processes and subsequently delayed the delivery of the finished products.

The period before Romania entered the European Union was the beginning of the decline for the clothing company. One contributing factor was the liberalization of the European market in the field towards Asian exports and the depreciation of the national currency against the Euro. Production in the lohn system, which implies the lack of a complete value-added chain, without the essential part of personal contribution, was transferred by large companies to other states that offered cheaper labor (Dobrin et al., 2017). Currently, the company is trying to stay competitive on the market by introducing its own brand and has specialized in clothes dedicated to women, mainly T-shirts, jackets, dresses, skirts.

Subsequent to the analysis of the company history, an evaluation of the production process was carried out and the causes that cause dysfunctionalities in the production cycle were identified. Finally, a series of improvements were proposed that would lead to the improvement of the activity in the company.

3.1 Define phase

The first stage of the project is the *define phase*. At this point, the quality plays an important role in the Romanian garment industry, therefore, the main objective relies on reducing defects and variations, as well as eliminating wastes, by having a chance to become more competitive on the garment's market.

Nowadays, the Romanian garment industries suffer from an increased rate of defection due to the defects' occurrences and variations. In this situation, the main's project goal is to find ways for reducing the defects' percentage to a minimum level, improving quality and increasing productivity. In the present study, the CTQs (critical to quality) characteristics are represented by the number of defective silk cotton shirts (results recorded on a three months period).The first step, in order to better visualize the process, was to create a SIPOC flowchart (as seen below in figure 2):

Supplier	Inputs	Process	Output	Customer
Etic Textiles	Machinery Needles Threads Buttons Color Unstitched clothes	Fabric components Stitching Printing Pressing Cutting Packaging	Silk cotton T-shirt Dresses Jackets Skirts	Romanian customers

Figure 2. SIPOC flowchart for garment industry
Source: The authors

3.2 Measure phase

In this second phase of the project, the main objective is to map the process by preparing a data collection plan and to assess the baseline performance.

The company manufactures various types of garment products but the research focused on one product in particular, the female silk and cotton shirt. This product was inspected for defects since this was one of the main products (critical product) for the company during the summer season, by having a lot of demand as well as a high profitability margin. Table 2 presents 10 randomly chosen batches and the number of defective items reported depending on the checked pieces, as well as the percentage of defective items.

Batch	Checked pieces	Defective	%defective
1	110	15	1.08%
2	160	12	0.87%
3	140	10	0.72%
4	180	14	1.01%
5	140	8	0.58%
6	165	17	1.23%
7	170	12	0.87%
8	110	13	0.94%
9	110	9	0.65%
10	100	7	0.51%

Figure 3. Number of defective items for the female silk and cotton shirt
Source: The authors

At this point, the Six Sigma level can be presented based on the computations resulted above:

Total	1385
No. of defects	117
% defects	8.45
DPMO	84.476
Sigma level	2.88

Figure 4. Six Sigma level for the female silk and cotton shirt
Source: The authors

The strategic goal of each enterprise willing to adopt a Lean Six Sigma methodology is to get close as much as it can to a 6 sigma level (3.4 defects per million opportunities and a yield level of perfection of 99.99966%).
By examining our data (and taking into consideration that the process was applied for only one item, for a relatively short period of time), the fabric has for the moment a level of 2.88 sigma, with a value for the defects per million opportunities (DPMO) of 84.476.

3.3 Analyze phase
The main objective was to analyze the collected data, illustrated in the measure phase, in order to find the variations' measurement root causes, especially the vital few contributors, from the trivial many.
For this operation, a Pareto chart was created (see figure 5):

No	Defects	Occurrence	% Occurrence
1	Shade variation	12	15.58%
2	Embroidery	5	6.49%
3	Label match	2	2.60%
4	Padlock	6	7.79%
5	Misprinting	9	11.69%
6	Broken	15	19.48%
7	Button miss	11	14.29%
8	Uneven parts	5	6.49%
9	Irregular hemming	4	5.19%
10	Inoperative zipper	8	10.39%

Figure 5. Defects for the female silk and cotton shirt
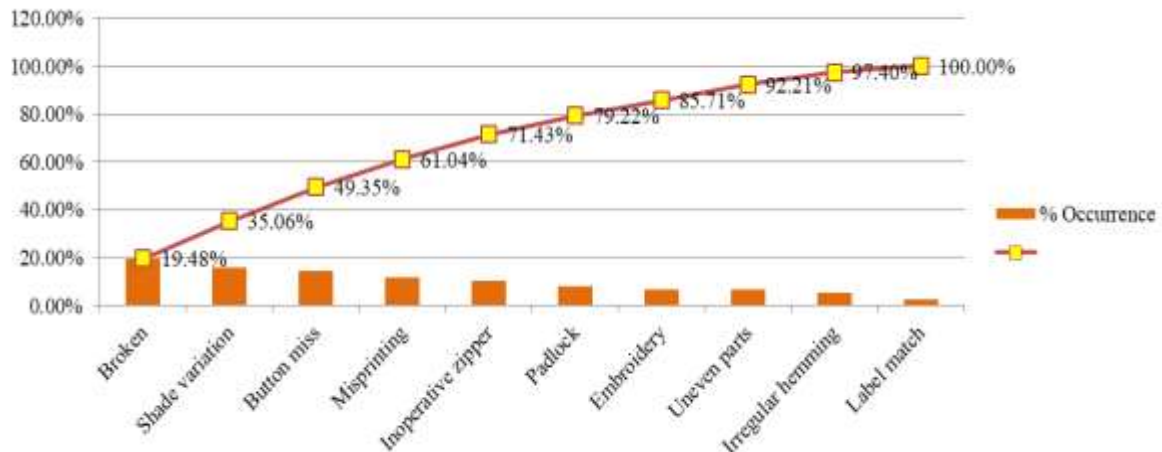*Source:* The authors

Figure 6. Pareto chart for the female silk and cotton shirt
Source: The authors

As a result, the vital few contributors that cause the main percentage of defects are represented by:
- Broken material;
- Shade variation;
- Button miss;
- Misprinting.

Based on these results, for finding the root causes for these deficiencies, a Fishbone diagram was created:
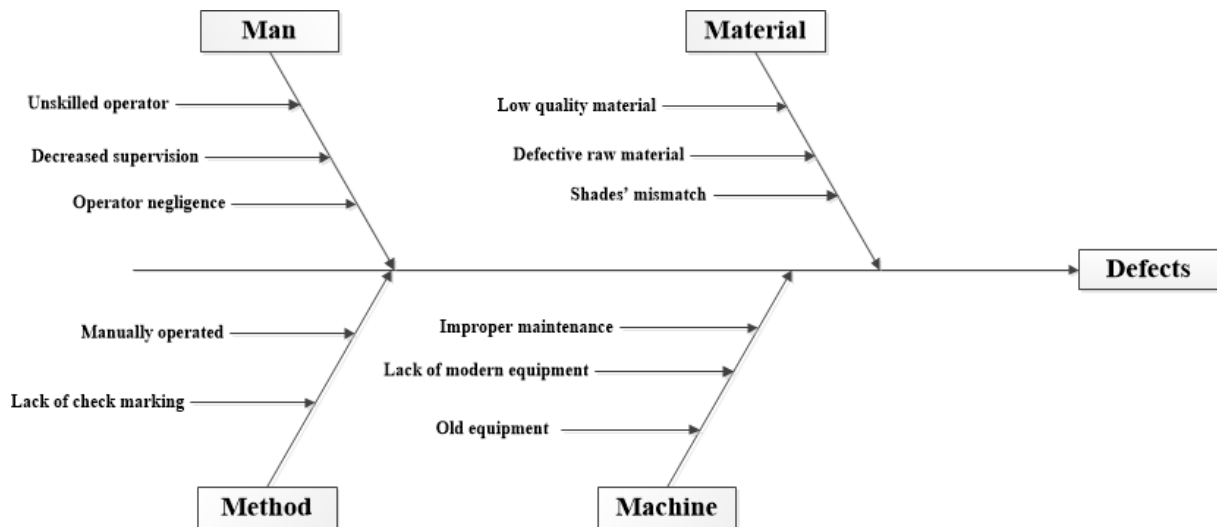

Figure 7. Fishbone diagram
Source: The authors

3.4 Improve and Control phases

Considering the fact that the study is an ongoing research, as future directions, the improve' phase target will focus on promoting solutions for eliminating the root causes that determine a variation level in the process, as well as standardizing those actions, while the control phase will consist on sustaining and debating with the managers the positive actions resulted after implementing the Lean Six Sigma methodology.

Based on the analyzes undertaken, the following ***improvement proposals*** were identified:

- ✓ Modernizing work equipment that has a high degree of physical and moral wear, in order to increase and streamline production;
- ✓ Reducing the production achieved in the lohn system and focusing on the production under its own brand to increase the visibility on international markets;
- ✓ Specialization of production in a segment that is demanded on the market and which focuses on innovation and quality, rather than low cost, for example: the use of new materials and technologies such as: eco-friendly textiles, temperature control fabrics, antimicrobial technology, protection against ultra-violets, etc;
- ✓ Reassessment of technological flows and efficiency of activities by eliminating dead times;
- ✓ Use of production planning methods to eliminate unnecessary stocks of raw materials and finished products;
- ✓ Developing a positive organizational culture and a competent team of employees who are motivated to meet the goals set, to work efficiently and to help improve the organization's performance;
- ✓ The allocation of funds for research and design of products adapted to the current needs of consumers;
- ✓ Implementation of training programs in the workplace and continuous training so that the employees constantly develop new skills and expertise.

4. CONCLUSIONS

In response to the intensity and fierce competition in today's business environment around the world, many companies have implemented Lean Six Sigma methodology along with other continuous improvement methodologies to increase organizational performance by reducing process variations. Although within the Lean Six Sigma methodology production is the first target, the entire organization is involved in serving the value-creating chain because production needs support processes that do not add value, but are necessary. Market requirements are not only related to the company's ability to deliver products on time: the important component of the product is its quality, the response to the functional role.

The organization, the improvement of the productivity and the competitiveness, have integrated the production systems and the concern for the quality, leading to the success: the market can now be gained by making the requisite products available in the quantities desired by customers. Companies that aim to be competitive on the long term must implement a system that presents flexible, fast adaptability to the general market requirements, in a period when production is not absorbed entirely. The rapid capital circuit is no longer an actual reality, stocks are not tolerated anymore, waiting becomes another frustration and non-quality is simply a luxury that the company can no longer afford.

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