Improvement of Scrap Request Process with Six Sigma Methodology

J. E. Ferreira, I. S. Lopes

***Abstract*—This paper depicts a project undertaken in a semi-conductor company. The aim of the project was to simplify the scrap request process of electronic controllers of wall hung gas boilers and to reduce its processing time. To achieve this purpose, the Six Sigma methodology was used.**

This project shows the application of the DMAIC methodology in a non-manufacturing process and assesses its applicability. Through the elimination of problems identified and resolved using Six Sigma methodology, the processing time of scrap request was substantially reduced allowing high costs saving.

***Index Terms*—DMAIC, Six Sigma, Scrap Process**

I. Introduction

As a problem solving methodology or process improvement framework, Six Sigma makes use of a series of well-defined steps. This includes definition of the problem (D), measurement (M) of the problem, data analysis (A) to discover the root causes of the problem, improvement (I) of processes to remove the root causes of defects and controlling (C) or monitoring processes to prevent the problem [1]. DMAIC methodology defines lines of strategy and orientation in Six Sigma projects [2]. The DMAIC methodology is a disciplined approach and well-structured, that provides a lot of advantages, which includes the study and analysis of the problem, and the search for the solution [3].

The Six Sigma methodology was initially implemented in manufacturing industry and in manufacturing processes. The use of the methodology has been extended to non-manufacturing processes and services such as financial services, health, education, logistic, human resources, security, customer's relationship and innovation [4]. For both processes, manufacturing and non-manufacturing, the Six Sigma plays a role in seeking continuous improvement and decreasing the number of defects.

To [5], the reasons that lead any kind of organization to the use of this methodology are:

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- Improved efficiency of organization;
- Increase in profit;
- Reduce waste;
- Improved customer service;
- Gain competitive advantage.

A major problem on the Six Sigma application is due to the fact that companies do not understand the methodology and transmit in the wrong way the concepts involved, damaging thus the organization. Companies that use Six Sigma methodology, collect benefits, but this action brings some problems such as the large number of projects performed simultaneously, the high amount of costs spent on training and the strength of its employees to cultural change.

Six Sigma methodology is suitable for manufacturing but is also applicable to organizational processes with some modifications, as in the areas of training, measurement and statistical tools [6].

In the service industry, the difficulty of the Six Sigma applications appears in the data collection, monitoring and measurement and in the existence of several sub-processes [7].

Despite many companies oriented to the service keep on with the notion that Six Sigma refers only to manufacturing companies, raises the interesting question on the applicability of this methodology in service organizations. In response to justify this application, three principles have to be considered [8]:

• All work occurs in a system of interconnected processes;
• All processes exhibit variation, and;
• All processes create data that explain this variation and our responsibility is to understand it and develops strategies to reduce or eliminate it.

In the service industry, Six Sigma offers several benefits such as the increase in the understanding of the needs and expectation of the customer and the achievement of the satisfaction of company's employees. There is a need to demystify the belief that Six Sigma should only be applied to solve problems that arise in production companies, since this tool is revealing highly effective when used in a service organizations.

In the present work, the Six Sigma methodology was used to increase performance of the scrap request process, through this methodology which allows efficiency improvement and reduction of costs [9]. The company where this work has been realized uses Six Sigma methodology and the associated DMAIC process in many quality improvement programs and some employees was already familiar with the methodology

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and some of them are Six Sigma champions, Green Belt or Black Belt. However, the methodology was only implemented in non-manufacturing processes. Therefore, this paper intends to assess the applicability and difficulties in the implementation of the methodology in a non-manufacturing process.

II. The Six Sigma Project

For the achievement of the project, the first step was the creation of a Six Sigma team. Table I indicates employees involved in the Six Sigma team.

Table I – Project Team Charter

Project Team Charter
A Black Belt.
Three Green Belt Candidate
Person responsible for establishing the agreement with the customer.
Person responsible for the access and movements on the company software.
Person responsible for all scrap processes in the company.

Then the different steps of the DMAIC methodology have been followed by the team.

A. *Define Phase*

This phase is important to define the problem of the current process and the objectives to be achieved. The flowchart tool has been used to describe the actual scrap process (Fig. 1) of thermotechnik products (TT).

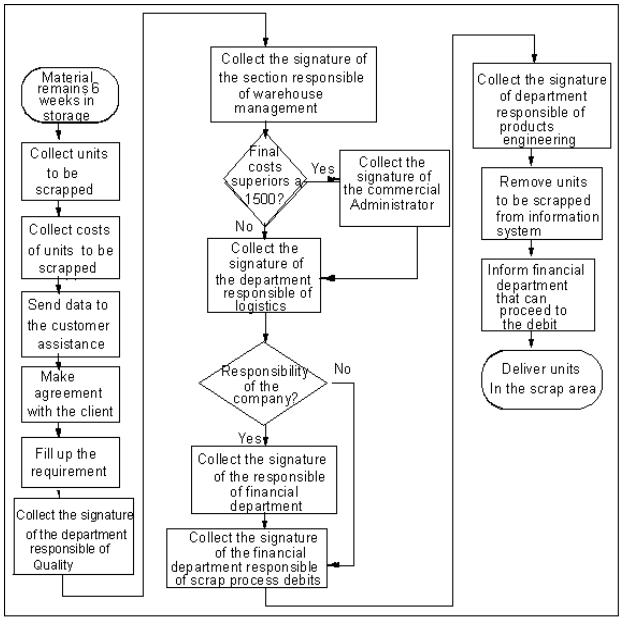

Figure 1 – Flowchart of Scrap Request Process

The company receives defective products from costumers, which are analyzed in the company laboratory to identify the origin of the defect. Then, considering internal policy of the company, the product remains six weeks in store to allow the costumer to claim the analysis result. After six weeks, the products can be scrapped independently of the decision taken.

The scrap request process involves several steps and depends of decisions that need to be taken by several departments in the company. At least after six weeks, the units to be scrapped are identified and the respective cost is obtained from the accounting department. Then, a requirement of material elimination is filled in. The requirement goes through several departments to get the agreement of department responsible, through his signature. After gathering the signatures of the departments involved, the units are removed from the system software, the accounting department is informed to proceed to the debit of the units to be scrapped and, then the units are delivered in the scrap area for the slaughter of physical pieces. This process involves many people and was time-consuming due to many problems encountered in different steps. The lack of efficiency of this process originated the accumulation of pallets of products and also forced the company to rent an external warehouse. Besides the space occupied by the products, which implies costs for the company, a great amount of capital is immobilized. Through this project, the company intends to implement a simple process, easily understanding for the people involved, in order to reduce the stocks of these unused products.

Table II uses a Sipoc Diagram, which is a tool frequently used in Six Sigma project to describe all relevant elements of the process to be improved.

Table II – SIPOC Diagram

SIPOC Diagram

Supplier	Inputs	Process	Outputs	Customers
Customers	Products remains six Weeks in storage	Request of scrap processes	Units to scrap with the respective cost	Quality department
Electronic technicians	Information of the units to scrap		Agreement with customer	Finance department
Quality department	Information of the costs of the units to scrap		Desciption and quantities to scrap are written on the requeriment	Company software
Finance department	Customer assistante makes agreement with customer		Signatures obtained	
Purchasing department	Document of the signatures of all departments to approve the process		Scrap units removed from information software	
Logistic department			Customer assitance with data of costs and quantities of the units to scrap	
Company software			Debit done	
			Units delivered on scrap area	

B. *Measure Phase*

At this stage, it is necessary to find a unit that enables a proper analysis of the reality involved, which sets out a proper evaluation of process performance. Therefore, based on the advice of experts directly involved in the process, it was determined that:

- Each scrap request process is a unit;
- By convention, the request process is defective if the total time is more than three weeks.

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The specification for the duration of the request scrap process, that takes initially 13.5 weeks in average, was agreed with the project team and people with knowledge of the issue. After specified the defective process, the actual Six Sigma level was determined for the project. it has been noticed that in six request process, five of them was defective. Therefore, the actual Six Sigma level is 0.53. It was agreed that the Six Sigma level should be in the future of 2.88, which mean a reduction of 90% for the time to process a request.

In order to simplify the measurement of the total processing time, the process was divided into four parts:

- Time to collect data and send to the client (T1);
- Time spend by Customer Assistance department to establish an agreement with the client (T2);
- Time to obtain the approval of all sections (T3);
- Time to deliver the material in the scrap area (T4).

The time T2 was not studied in this project, since it depends on the response time of the client, which can be hardly controlled by the company. Therefore, the study focuses on times T1, T3 and T4 and corresponding activities.

Through the quality tool "Pareto chart" (Fig. 2), it was possible to establish a priority in order to resolve the problems faced in the request process. The Pareto chart shows that the time T3 is the longest time in the process (about 9.5 weeks) consisting in 69% of total time spent, followed by time T1 (about 2.5 weeks) and by the time T4 (about 1.5 weeks).

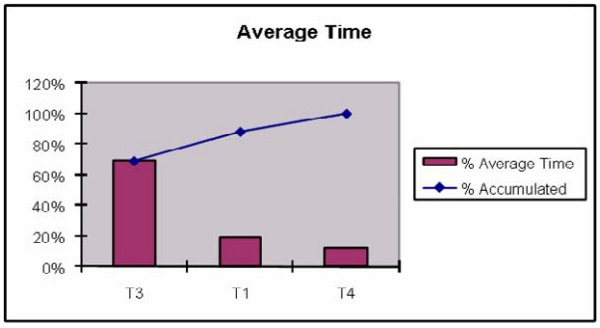

Figure 2 – Pareto Chart

C. *Analyze Phase*

To pursue the needs to find solutions to the problems associated with the scrap request process, full attention was devoted to the analysis of the process through the use of statistical tools. For this, the project team did a "brainstorming" of process issues, and elaborated a Cause and Effect diagram" (see Fig. 3).

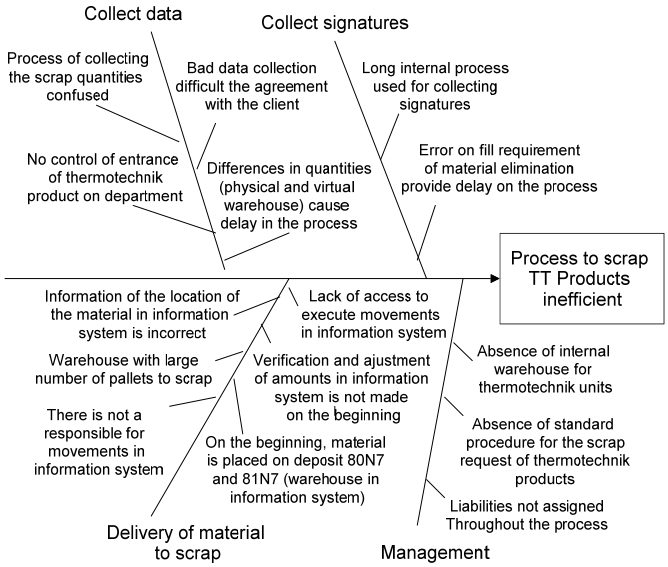

Figure 3 - Cause and Effect diagram

Through quality tool above, we find that there are more specific causes, which cause delay in the process which also involved the initial process of units' registration.

Then, the Six Sigma team elaborated a Cause and Effect matrix in order to prioritize the problems with a view of its proper solution. A scale was defined to assign a degree of importance to each output of the process, and to the relationship input/output of that process. In both cases, it was established a scale values from one to nine.

Each input corresponds to a particular problem detected in the process. The inputs identified in fig. 4 are staggered in descending order of their importance in the process.

		Outputs Y1 ... Yn			
Priority of importance to the customer		Y1	Y2	Y3	TOTAL
Rating (1 to 9)		3	9	6	
Inputs X1 ... Xn		Time spent by those who process the application	Capital immobilized	Ocupation of space	
X12	There isn't a standard procedure for the scrap Thermotechnik process	9	6	6	117
X13	Liabilities not assigned in all process on the section of Quality	9	6	6	117
X4	Diference of quantities (physical and virtual warehouse in the information system) causes delay on the process	6	6	6	108
X14	Poor data collection dificult the agreement with the client	9	6	3	99
X3	There isn't a warehouse for Thermotechnik units	3	3	9	90
X1	There isn't registration and supervision of the entrance of products thermotechnik	6	6	3	90
X15	Flow of information and comunication complex	6	6	3	90
X2	The process of collect the scrap quantities confused	9	3	3	72
X6	Internal post method used collecting signatures slow	9	3	3	72
X9	Lack of acess to use information system	9	3	3	72
X10	Verification and adjustment of amounts in information system isn't made on the beginning of the process	9	3	3	72
X5	Poor fill of the requirement of material elimination causes delay on the process	6	3	3	63
X7	There isn't a responsible for the movements on information system	6	3	3	63
X8	Information of the location of the Thermotechnik material on information system is incorrect	3	3	3	54
X11	Material is placed on deposit 80N7 and 81N7 (logistics warehouse in information system) count to the materials planning	3	3	3	54

Figure 4 - Cause and Effect Matrix

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The realization of the Cause and Effect matrix allows, with appreciable degree of accuracy, providing solutions for the actions that are expected to have the greatest impact on improving the process.

One of the identified problem situations is the lack of a suitable storage place for thermotechnik units, since the section of quality method management has only one place to store the principal product of the company (radios for car). Pallets with thermotechnik products are placed in external warehouses and other locations not suitable for this purpose such as crossing points. The use of external stores leads to additional costs, with all the resulting disadvantages.

D. Improve Phase

Based on the previous phase of the DMAIC methodologies, two procedures have been defined to allow a more efficient and then quicker request process.

The processing time of the scrap request is greatly dependent of the previous activities such as the reception and the storage of the product. Then, it is considered essential the improvement of this phase to avoid subsequent problems and difficulties encountered in the scrap request. In a second Phase, the scrap request process is reorganized to allow a better efficiency.

Reception of the scrap material

When materials arrive to the section of quality method management (section responsible for the quality of the product), the logistics manager of the section shall register all the units through a portable bar code (see Fig. 5).

Figure 5 - Tag and Scan

However, because not all materials come already labeled, it is convenient to label the material when appropriate (see Fig. 6).

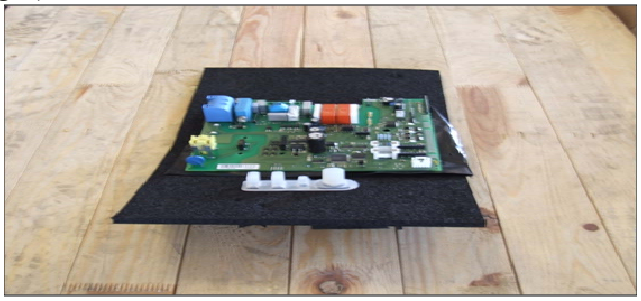

Figure 6- Material Heatronic not labeled

The registration of the material involved a large time of entrance, thus this method would reduce the time substantially. These allow the control of all units in the quality department and thereby reduce the difficulty to identify the units for which a scrapping request process can be made.

After the registration of all materials, they are instantly sent to the warehouse of the quality department suitably modified so as to provide the conditions for the receipt of products. Due to the lack of space in the laboratory of the quality department to store the products thermotechnik, there is a need to introduce some modifications in the layout.

The optimization of the new layout involves the change of the laboratory of equipment test to an empty space that existed beside the laboratory; this change enabled the construction of a warehouse for products thermotechnik. With the new configuration of space and the software for warehouse management (GILA software), that already exists, a particular product is easily find in the store. This software was applied to the scrap process to improve it.

This change brings a significant improvement in time. Before the introduction of this change, when the customer complained about a thermotechnik unit, the product should be discovered in several pallets without indication of its contain.

The new procedure for the reception of thermotechnik products is presented in Fig. 7.

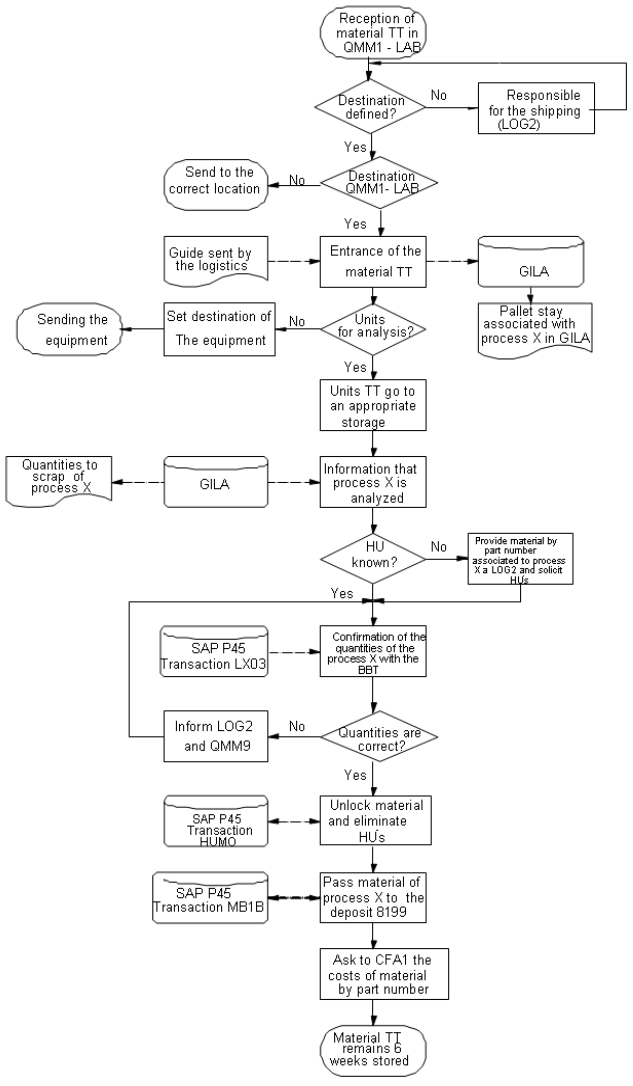

Figure 7 – Reception of TT products

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Process improvement of the scrap request

Six weeks after the storage of the products, the software GILA reports that the scrap request process of thermotechnik products (See Fig. 8) can begin and provides the quantities to scrap. Then, data will be sent to customer assistance in order to get agreement with the customer. The responsible for the scrap process has to fill a sheet and a requirement of scrap process, and then collects the necessary signatures for approval of the process. To conclude the scrap process he also has to remove the quantities from information system, inform financial department to carry out the debit, and finally deliver the material in a scrap area.

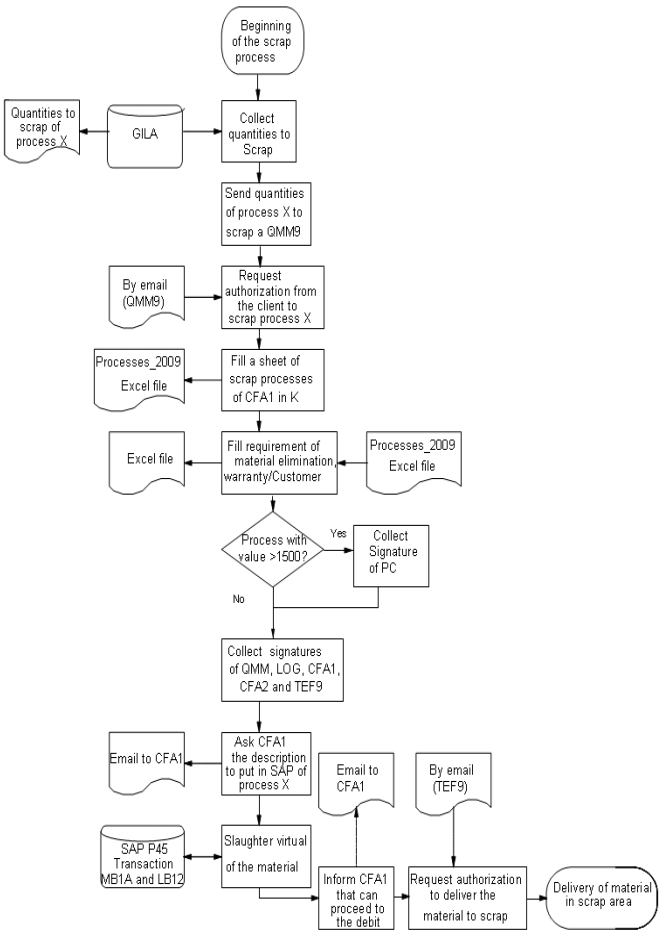

Figure 8 – Scrap process of TT products

The main changes introduced with this new process are:

- New storage for products thermotechnik;
- Registration of the entrance of the material in software used for this purpose;
- Control of all material, avoiding errors, and facilitating the agreement with the client;
- Access on the information system attributed;
- Creation of a procedure for the scrap process of products thermotechnik;
- Reduction of the total time of process, and consequently a faster debit in the customer account.

E. Control Phase

In order to ensure that the new scrap process of TT products is properly controlled, it is important that:

• All employees directly involved in process know the procedure created for the scrapping of thermotechnik products;

• The responsible for the scrap request process must register in a table already developed in this project, the state of each scrap request process.

III. Results

According to the improvements in the request process, visible results were obtained.

A. Impact on Customer

The section of quality method management showed great satisfaction with the positive performance of the process.

B. Impact Costs

The figures and table listed below (Fig. 9 and Fig. 10 and table III) allow assessing possible advantages associated with the implementation of the improvement identifies by Six sigma methodology. The cost of external storage will disappear and the cost of lost opportunity and costs of stock will be considerably reduced. The resulted gains largely justify the costs incurred in carrying out this project.

• Cost of lost opportunity

The long period of time that the company took to charge the client for high values of scrap materials, kept the company unprofitable by investing that amount, with considerable disadvantages for the economic situation of the company, see Fig. 9 and Fig. 10, respectively.

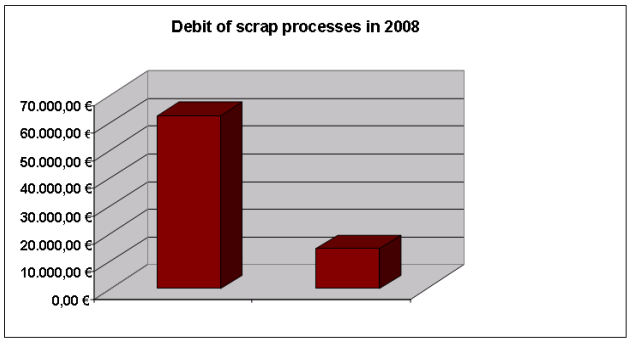

Figure 9 - Values of scrap debited in 2008

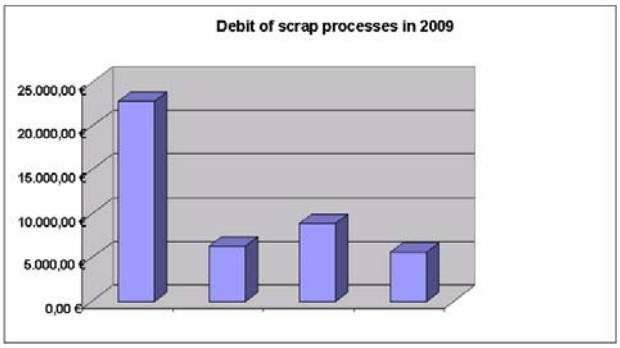

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Figure 10 - Values of scrap debited in 2009

In the set of six cases for which the measurement was developed, only the second process (see Fig. 9) was carried out in due time (three weeks).

Fig. 9 and Fig. 10 present data from 2008 and 2009, respectively. The bars in both graphics represent the amount to debit the customer account.

• Costs of external Warehouse

Hiring a storage space outside the company involves costs which, although reduced, are always invariably an obstacle to quality section (see Table III).

Table III – Values of external Warehouse July/2008 to July/2009

Values of the external warehouse							
Section	Year	Month	Quantity/ Pallet	Maintenance	Transport	Storage	Total *Value*
QMM1	2008	July	32	32,96	72,52	31,68	137,16
		August	32	-	-	158,72	158,72
		September	20	12,36	36,26	128,64	177,26
		October	17	3,09	36,26	91,04	130,39
		November	17	-	-	81,6	81,6
		December	7	10,3	36,26	58,72	105,28
	2009	January	0	16,48		54,24	70,72
		June	16	49,44	145,04	70,72	265,2
		July	16	-	-	79,36	79,36

C. *Impact on Time*

In the opinion of professionals, the implementation of the improvements made in the process allows to fulfill the deadline previously established of three weeks which contrasts with the previously assumed duration of several months.

D. *Impact on efficiency*

The efficiency of the process was optimized by using various resources and with the allocation of responsibilities throughout the process. The activities that did not add any value was eliminated.

IV. Conclusion

In resume, it can be stated that the objectives that led to the realization of this project have been achieved. An efficient procedure to be followed in the scrap request process of thermotechnik products has been defined and implemented. This action allowed the assignment of a new space for storage of the thermotechnik that release the need to rent an external warehouse, providing a cost reduction.

At the same time, the thermotechnik products have gained a greater projection in the context of section of quality, to the extent that the whole process is methodically structured, since it is controlled from the outset with records of entry, storage, analysis and their effective scrap.

In order to continue the project, a table for registering cases of scrap was implemented, which lets you know which processes are taking place and the phases in which they are. For the same purpose, all requirements that correspond to each process will be archived.

Following this work in future, the performance of the process will be measured to confirm the improvement achieved with the implementation of the proposal. The possibility of using e-mail will also be examined in order to speed up the process of collecting signatures in the application for the disposal of materials. Currently, this method cannot be followed by limitations associated with the regulation of the company.

The project team did not feel difficulty in defining the unit of measure, since this process created data and variations that could be improved or eliminated in order to optimize the process.

The company invests in Six Sigma training of employees and several projects are performed simultaneously, as they bring several economic benefits. The company uses this methodology for all business processes, with large or small economic impact to improve quality or reduce time.

The project presented in this paper justifies widely the costs involved. However, It could also be achieved through other quality methodology, but six sigma clearly proved to be a tool well-structured, that use statistical tools to validate improvements and that is well-known and accepted by the company.

References

[1] J. Antony and R. Bañuelas, "Key ingredients for the effective implementation of six sigma program," *Measuring Business Excellence*, Nº 6, 2002, pp. 20-27.

[2] J. P .C. Tong, F. Tsung and B.P.C. Yen, "A DMAIC approach to printed circuit board quality improvement," *The International Journal of Advanced Manufacturing Technology*, vol. 23 Nº 7-8, 2004, pp. 523-531.

[3] P. Pande, R. Neuman and R. Cavanagh, *The Six Sigma Way: How GE, Motorola, and other top companies are honing their performance*. Macgraw Hill: New York, 2000, pp. 137-234.

[4] B. Nakhai and J. S. Neves, "The challenges of six sigma in improving service quality," *International Journal of Quality and Reliability Management*, vol. 26 Nº7, 2009, pp. 663-684.

[5] T. N. Desai and Dr. R. L. Shrivastava, "Six Sigma – A New Direction to Quality and Productivity Management," *Proceedings of the World Congress on Engineering and Computer Science*, 2008.

[6] R. Shah, A. Chandrasekaran, K. Linderman, "In pursuit of implementation patterns: the context of lean and Six Sigma," *International Journal of Production Research*, vol. 46 Nº 23, 2008, pp. 6679-6699.

[7] M. Kumar, J. Antony, F. J. Antony, C. N. Madu, "Wining customer loyalty in an automotive company through Six Sigma," *Quality and Reliability Engineering International*, vol. 23 Nº 7, 2006, pp. 849-866.

[8] S. Ruthes, P. S. Ceretta, I. B. Sonza, "Seis Sigma: Melhoria da Qualidade Através da Redução de variabilidade," *Revista Gestão Industrial*, vol. 2 Nº 2, 2006, pp. 181-199.

[9] J. van Iwaarden, T. van der Wiele, B. Dale, R. Williams, B. Bertsch, "The Six Sigma improvement approach: a transnational comparison," *International Journal of Production Research*, vol. 46 Nº 43, 2008, pp. 6739-6758.

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