Using Six Sigma to Improve Complaints Handling

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***Abstract*— Currently, companies are in increasingly competitive environment in which customers' satisfaction and loyalty are vital factors in the success of any organisation. This requires the use of continuous improvement methodologies, such as Six Sigma, which enable companies to improve customer satisfaction and meet their expectations. This paper describes a case study carried out in a company from the automotive industry that has selected a Six Sigma project to respond to a decrease in customer satisfaction regarding the response time of the complaints. The objective of the project was to improve the process of analysis of defective products through the identification of the variables that influence the process and proposes improvements to reduce the time of analysis to defective products. Results are positive and can encourage managers from other industry sectors or even services to improve their customer complaints handling process using Six Sigma.**

***Index Terms*— Six Sigma, Quality tools, Quality improvement, customer complaints**

I. Introduction

Over recent decades, the quality of services has become an area that is relevant to managers and researchers due to its strong impact on customer satisfaction and loyalty and company performance and profits [1]. The quality of service can be defined as the result of the comparison between the customers' expectations and his perception of the manner in which service was provided [2].

The competitive advantages and improvements of services can be obtained through the application of Quality Management techniques and, particularly, through Six Sigma [3].

Six Sigma is an organised and systematic methodology used to improve processes or products' performance with impact on customers, and is based on scientific and statistical methods [4]. This methodology is applied to repetitive, systematic and well known processes [5].

The use of methodologies for quality improvement fits in the competitive environment where companies operate. The selected company for the case study is a multinational from the automotive sector that uses six sigma projects to improve quality. This project is not a typical Six Sigma project, since the customer complaints handling process is not a core production process highly stable and repetitive. Nevertheless, the DMAIC methodology was chosen because it guarantees the commitment of the company's board of directors and the project team. This type of projects uses formal mechanisms to assess and control project execution.

A. Review Stage

Quality Management has been defined as an important strategy to achieve competitive advantages and improvements. Traditional Concepts such as Statistical Process Control, Zero Defects and Total Quality Management have been used much over the years, while Six Sigma is a most recent initiative but that has been gaining popularity and acceptance in many industries around the world [6]. Six Sigma methodology is used to improve the performance of the processes/products and the quality of service through the reduction of variation, based on statistical and scientific methods [4].

Six-Sigma was introduced in 1986 at Motorola in response to the problems associated with the many complaints from customers during products warranty period. The success of the implementation at Motorola was not only at the level of the defects reduction rate but also in increasing productivity, increasing service quality and customer satisfaction and reducing costs associated with operation and low quality [7] [8] [9]. Initially, the Six Sigma was only used in industry, because it was dealing with repetitive and well known processes. Due to the benefits of its implementation Six Sigma has been extended to the area of services, aiming to reduce the variability and process defects [5] [8]. The implementation of this methodology has brought significant benefits to businesses.

B. DMAIC

A typical Six Sigma project for quality improvement follows a structured methodology for the resolution of problems. The DMAIC methodology consists of, succinctly, in defining (D) and measure (M) the problem, analyse (A) data to discover the root causes, improve (I) the process to remove the root causes and control (C) or monitor the process to prevent the reappearance of defects [7] [10] [11] [12].

In each phase a set of quality tools and techniques are used with the purpose of making the whole process

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objective and measurable, allowing to analyse the current system performance, to propose and implement improvements and to keep the system under control [10] [12]. The transition from one stage to the next involves the fulfilment of a checkpoint that allows confirming if the goals of each phase have been completed [11].

The success of the use of DMAIC methodology can be explained by its structured approach and by the logic that connects the different phases. For the majority of projects, it is very risky to skip any step of the DMAIC since it can interfere with the successful of problems resolution. However, if the solution is obvious and the risk is minimal, some steps can be skipped, but before taking that decision the following questions must be answered.

- What data exist to demonstrate that the proposed improvement is the best solution possible?
- How can we ensure that the solution will actually solve the problem?
- What are the drawbacks of the proposed improvement?

If there is no data to answer these questions, although the solutions are obvious, it is necessary to follow a complete DMAIC project with all stages [10].

C. Six Sigma applied to services

A service can be defined as something that is not directly involved in designing or produce tangible product, such as sales, finance, marketing, customer support, logistics or human resources of any organisation from a manufacturing company to a bank or to a store [13].

Six Sigma is a methodology based on quality tools and techniques. Some of them require a high level of training, compared, for example with basic quality tools or with soft techniques that do not require exact calculations. However, when applied to services, most problems can be solved using the Six Sigma basic tools of problems solving, such as the Process Map, Cause-Effect Diagram, Statistical Process Control, Pareto analysis, histograms, among others [14].

Traditionally, Six Sigma is associated with the reduction of defects and costs in the industry, however there are many studies about the implementation in services such as health centres, banks, call centres, logistics and financial services. The application of Six Sigma introduces significant benefits including the reduction of costs, reduction of errors/defects, reduction of complaints and increase in customer satisfaction, improvement of service delivery, increase of process capability and reduction of process variability [4] [7] [15].

Several authors report studies on the implementation of Six Sigma in banking institutions. For example, Rucker [16] applied the methodology in Citibank and obtained as main results the reduction of external calls back in 80% and internal ones in 85%, the reduction of credit decision cycle time in 67% (reduction from 3 to only 1 day) and the shortening of the processing cycle of claims from 28 to 15 days. The application of Six Sigma has enabled JP Morgan Chase (Global Investment Banking) to reduce failures in the process related to the client, such as opening accounts and ordering check books. These implemented measures have led to an increase in customer satisfaction and improvement of efficiency and in process cycle time in 30% [17]. In a financial services company and banking, the benefits were the reduction of transfer processing time in more than 40%, increase in customer satisfaction and annual savings of $ 74,000 and $ 700,000 by reducing administrative costs and expenses due to unnecessary processes [18].

The use of Six Sigma in the medical care industry led to improvement in the radiological process by 33% and decrease of radiological procedure costs in 21.5% which resulted in savings of $ 1.2 million [19] and a reduction in laboratory errors and drugs delivery and consequently an increase in the safety of patients [20].

At British Telecom Wholesale, the method implementation led to a significant increase in the level of customer satisfaction, the establishment of more robust and effective processes, the development of a common language for managing continuous improvement and savings of $ 77 million due to improvements in repairs management process, and the reduction of costs and unnecessary processes. In logistics companies, the benefits resulted in annual savings of $ 1.7 million due to the improvement of service delivery and a decrease of 50% in the number of complaints [18].

Table I shows the differences of the characteristics of Six Sigma projects in industry and in services [21].

The implementation of Six Sigma in services, compared with the industry, has some limitations [4]:

TABLE I
CHARACTERISTICS OF SIX SIGMA PROJECTS IN INDUSTRY AND IN SERVICES

	Industry	Services
Customers' requirements	Refer to product characteristics.	May refer to the outputs of the service or the process itself.
Performance Measurement	Data collection is performed automatically; The measurement systems are stabilised; Data relating to performance indicators of the production system are easily recovered.	Data must be collected manually; Measurement systems are not very stable because processes are characterized by human intervention; The performance of the process may vary with human interaction.
Defects	Defects can be easily quantified and refer to the characteristics of the product	Errors or defects are usually caused by human (employees).
Improvements impacts	Improvements are associated with financial	Improvements are associated with non-monetary benefits such

- The measurement of customer satisfaction is more subjective;
- Difficulty in data collection, because most data are collected manually, while industry generally uses automatic collection methods;
- Limitation on application of statistical techniques such as Design of Experiments;
- Higher resistance to change;
- Most decisions are based on human judgment and processes standards are less accurate;
- The services are subject to more noise and uncontrollable factors (psychological, social and personal);
- Greater difficulty in changing processes in services than in industry. Changing the parameters of a machine is different to train staff or adjust work procedures or tasks.

Despite these limitations, applying Six Sigma in services brings improvements in performance, and this methodology

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can be applied even in processes with low performance, such as the process of managing customer complaints [22] which will be presented in the next section.

II. Case study

A. Define

The company where the case study took place seeks high standards of quality, and is a reference company in the electronic industry. Increase in competitiveness and quality is achieved in several ways, with emphases on the use of Six Sigma projects.

Due to frequent complaints from customers motivated by the deadline infringement in the process of defective products (or devices) analysis and the high volume of product waiting to be analysed, the company selected a Six Sigma project to address this issue. Although the project selected is not a typical Six Sigma project, i.e., a systematic and repeatable process, Six Sigma was used, once it is a structured and organised improvement methodology that uses statistical tools and techniques to reduce variability and processes wastes [23].

In the laboratory where customer returned products are analysed, defective devices are divided into two types with respect to the origin of complaints: 0km complaints or field failure. 0km complaints are failures detected in customers' plants and field failures are detected by the end costumer after the car sale and throughout the warranty period.

Defect was defined as the non fulfilment of the deadline for device analysis. Devices that originated from a 0km complaint should be analysed in less than 2 days and devices originated from field failure have a maximum of 15 days, otherwise the analysis process is considered defective.

With the realisation of the six sigma project, benefits were expected namely the improvement of customer service, increase in laboratory productivity, the improvement in quality indicators related to 0km and field devices, standardization of the laboratory analysis' process and reduction in the amount of equipment waiting to be analysed.

A project charter was built (see Fig. 1) to define the project, and it was complemented with other tools such as a flowchart and turtle diagram to represent the process, its inputs and outputs.

B. Measure

For a better perception of the current state of the process, data were collected about the analysis of customer complaints deadline compliance and customer satisfaction. It was found that the process was in a critical state, most devices were analysed belatedly, i.e., the analysis processes were considered defective (Table II). Two types of devices are analysed in the laboratory car-radios (CR) and navigation systems (DI).

In the case of 0km complaints, the devices analysis deadline was 2 days, but in practice the analysis time was 7 days for CR and 10 days for DI. In the case of field complaints, the agreed deadline was 15 days, but the analysis time is of 21 and 22 days for the CR and DI, respectively. Through the collected data, it was found that the analysis average time was high in comparison with deadlines agreed with costumers and there is large variability in the analysis time. The sigma level was calculated for the four situation depicted in Table II. Overall, the sigma level was only 1.08, quite distant from other typical stabilized and repetitive company processes.

TABLE II
PERCENTAGE OF DEFECTIVE PRODUCTS

Product type	Origin	% Defectives
CR	0km	75,0%
	Field	55,6%
DI	0km	79,3%
	Field	52,3%

Case study	**Declaration of Opportunity**
In recent years the company has seen a decrease in customer satisfaction in relation to complaints response time and thus selected a Six Sigma project to improve the process of analysis of defective products. Defect Definition: Failure to comply with the time of analysis (2 days for 0km claims and 15 days for field claims).	Reduction of the defects analysis time and variability.
Objective	**Project Scope:**
Identify the variables that influence the process of analysis; propose improvements to reduce the analysis time and the related variability in order to meet the deadline of delivery. Benefits: Increase the laboratory productivity, improve customer service; improve 0km and field quality indicators; standardize the process of analysis and reduce the number of products without analysis.	Start Date: April 1, 2011 End date: October 14, 2011 Scope: Analysis of 0km and field defects Outside of the scope: Analysis of defects FOR

Project Plan:			**Team:**		
phase	**start**	**end**	**name**	**role**	**commitment**
Define	April	May	Patrícia Abreu	Leader	high
Measure	May	June	Natália Semanas	Black Belt	medium
Analyse	June	July	João Roque	Black Belt	medium
Improve	July	September	Miguel Soares	Sponsor	low
Control	August	October	Fernando Barbosa	Project Team	low
			Nuno Iglésias		low
			Tec. QMM1 Lab		low

Fig. 1. Project Charter

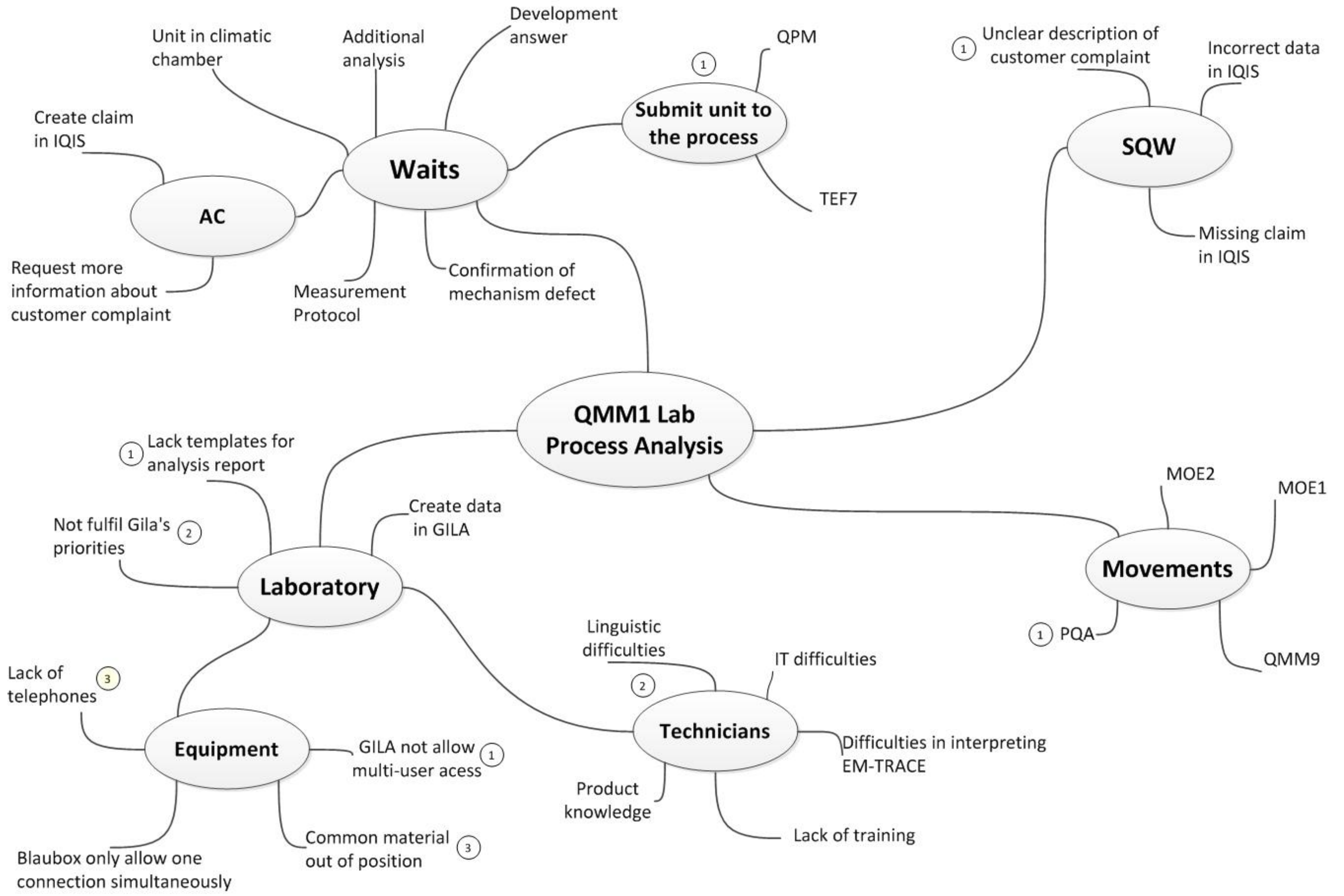

Fig. 2. Mind Map

The company's perception about overall opinion of their customers is done through surveys, conducted every two years.

In 2010 the company had aimed a level of customer satisfaction of 3.15 on a scale of 0 to 4, where "0" means total dissatisfaction and "4" total satisfaction.

With the analysis of last year, it was found that all clients had a satisfaction level in relation to response time of complaints, much less than the expected company goal.

C. Analyze

A Brainstorming was performed with the participation of the people involved in the project (sponsor, project team and coordinator of the laboratory) to generate ideas about possible causes that affect the long time of devices' analysis. At the end, the generated causes were added to the causes previously identified during data collection, either by observation or by the researcher's interviews of technicians or by facts observation. A Mind Map was developed (Fig. 2) in order to group the causes into four groups: delays, resident engineer, travel and laboratory (equipment and technicians). In this diagram the problem is presented in the centre and is linked to the four groups of causes. Priorities for actions were also set according to a colour code (red circle with the number 1 means high priority, the blue circle with the number 2 represents a medium priority and the circle yellow with the number 3 indicates a low priority issue).

Due to project constraints, only the identified causes about which there was more knowledge and a recognised improvement opportunity were considered as priorities.

D. Improve

After the identification of problem causes, improvements to enhance the performance of the analysis process have been proposed, these proposals are summarized in Table III.

TABLE III
PROBLEMS AND ACTIONS TO BE IMPLEMENTED

Prio-rity	Type	Problem	Action
1	Movements	Movements to the department of defective product analysis (PQA).	Creating a milk run between QMM1 Lab and PQA.
1	Resident Engineer (SQW)	Unclear description of the defect.	Training for SWQ, mandatory checklist.
1	Waiting	Submission of devices to the process.	Only devices of corporate responsibility will be submitted.
1		Lack of template for the analysis report	Creating a template.
1		SAP does not allow multi-user access.	
2		Lack of launch of the device in SAP.	Change in SAP operation
2		Infringement of priorities in SAP.	
2	Laboratory	Technicians	Training in foreign languages, information technology, new equipment and software.
3		Commonly used materials outside the place	Creating areas for placement of commonly used materials.
3		Lack of telephones	Placing a phone on each bench

At this stage it was intended to provide improvement solutions for the root causes of the problem. The proposed improvements were the creation of a milk run to eliminate trips to the PQA, development of a checklist to be used by SQW to improve and standardize the defect description and only submit the devices of responsibility B to the production process. At the laboratory level, where the analyses are performed have been proposed several improvements, involving the equipment and the technicians. Some other improvement actions are not yet implemented. For example, some of the improvements require changes to the company's information system that need further time to be implemented.

E. Control

After implementing the improvements actions, the process performance was measured in order to assess the impact and verify the effectiveness of improvement actions (Fig. 3 and Fig. 4).

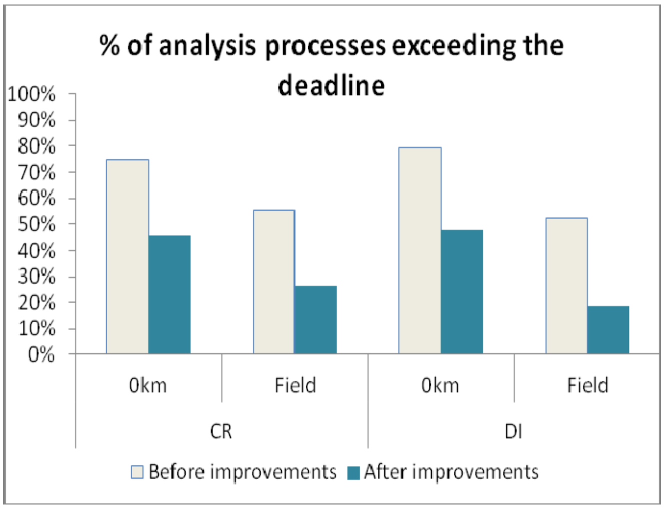

Fig. 3: Percentage of analysis processes exceeding the deadline

Comparing the initial data with the data gathered after the implementation of improvements, it is evident that the number of analysed devices beyond the deadline decreased considerably. Consequently, the analysis mean time was reduced (Fig. 4).

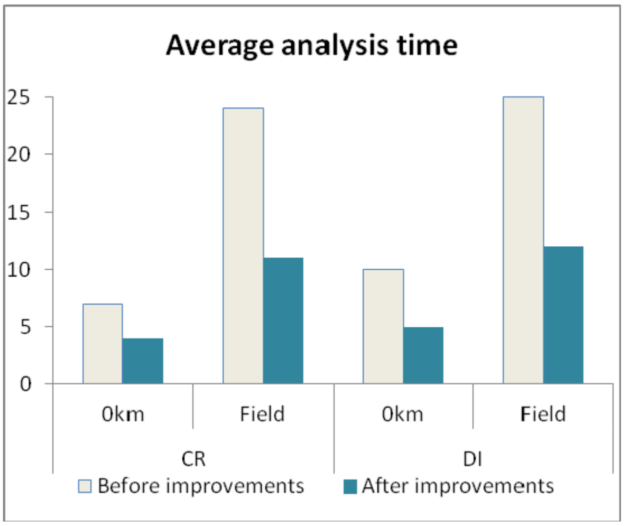

Fig. 4: Average analysis time

For 0km devices, the average analysis time changed from 7 to 4 days in the case of CR and changed from 10 to 5 days in the case of DI, whereas for field devices, there was a reduction in the analysis mean time from 24 days to 11 days concerning CR and from 25 to 12 days concerning DI.

The variability was also reduced. The standard deviation changed:

- For CR, from 9.41 to 2.72 for 0km devices and from 16.74 to 6.16 for field devices;
- For DI, from 10.79 to 3.36 for 0km devices and from 23.49 to 5.43 for filed devices.

Despite the significant reduction in the analysis mean time and variability, average time reduced 49.8% and standard deviation reduced 71.2%. For 0km devices the analysis mean time is still above the target, in two days, while for field devices the goal of 15 days was reached. Overall, the sigma level was improved from 1.08 to 1.92, and some of the improvement actions are not yet implemented.

The defects (not fulfilling deadlines) depend, not only, of reduction of analysis average and variability time, but also of customer requests and the number of technicians. The improvements achieved did not comprise the increase in the number of technicians and the variability reduction achieved will allow a better work planning. Thus if the number of requests increase over process capacity defects can be anticipated and, eventually, prevented.

III. Conclusions

This case study describes the implementation of Six Sigma for improvement of the analysis process of defective products in a company of the automotive industry.

Due to the frequent complaints received from costumers motivated by infringement of the deadlines and by the high amount of devices waiting to be analysed, the company carried out a Six Sigma project.

The root causes of low performance were identified and solutions for improvements were proposed. Due to project constraints, in this first stage of improvement, only some improvements were implemented, nevertheless the goals were achieved. The analysis mean time and the variability were reduced (49.8% average time of analysis and 71.2% its standard deviation) and for field devices the set analysis time of 15 days is not exceeded nowadays, while for 0km devices it is expected that the goal of two days will be achieved with the implementation of the second phase of improvements.

In addition to these benefits, the project implementation managed to increase productivity, allowed standardising the analysis process, improving customer service and quality indicators.

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