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Improve the extrusion process in tire production using Six Sigma methodology

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Abstract

Nowadays, market’s constant changes require continuous flexibility and adaptation in the supply provided by organizations. In this context, the automotive industry represents one of the most demanding sectors due to the high levels of competition it is exposed to. Therefore, and so that these organizations are able to survive, it is crucial to seek operational excellence. This is undertaken through the constant processes improvement and continuous reduction of costs. This study was developed at a tire manufacturing company with the purpose of improving the rubber extrusion process of two tire semi-products: the tread and the sidewall. By adopting Six Sigma methodology and using the DMAIC cycle (Define-Measure-Analyze-Improve-Control), one was able to implement some improvement procedures whose resulted in a decrease of 0,89% on the indicator of work-off generated by the production system. This approach resulted in a significant financial impact (savings of over 165 000€ per annum) on the company’s quality expenses.

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1. Introduction

The permanent pursuit of excellence, in the competitive context of the automotive industry, is based on the existence of organisations commitment to deliver products or services close to perfection, promoting the philosophy

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of zero defects and first-time-right production [1]. Over the last years, the Six Sigma program has become increasingly popular and of a widespread use both in various organisations across the world as well as in several types of industries [2]. This methodology was initially adopted at the end of the 80s at the Motorola company, which used the term Six Sigma as a form of describing the approach used to measure defects and improvements in quality [2, 3]. However, there were also companies such as AlliedSignal, 3M and GE, pioneers in the use of the Six Sigma program, which reported savings of millions of dollars from the 90s onwards as a result of this implementation [4]. Initially, the Six Sigma methodology only targeted production processes; nevertheless, other types of sectors such as marketing, purchasing and customer support centres, amongst other services and functions, also currently have this methodology implemented with the aim of continuously improving their processes and ensuring customer satisfaction [5]. This methodology is widely acknowledged as an application of tools and statistical or non-statistical techniques to maximise the returns on investment made by organisations [6]. This is achieved through the optimisation and control of the organisation's processes, aiding management in the maximum enhancement of the value produced by using as few resources as possible [7,8]. The improvement cycle - Define, Measure, Analyse, Improve and Control (DMAIC) - constitutes one of the keys to the success of the Six Sigma program [9]. Through this approach, the improvement obtained in products and processes converges, in the sense that they become more efficient and effective [8].

The present study was developed in an industrial environment at Continental Mabor, a tire manufacturing company located in Famalicão, Portugal. The study’s main objective was to improve the extrusion process, which is responsible for the production of two tire semi-products: the tread and the sidewall. One of the production system’s performance indicators (KPI) is designated as a work-off generation (non-conforming material), which was found to be above the required target. This constituted the main reason for this study, which focus was to enable its reduction. The structure of this article is divided into five sections: the first one presents the introduction; section 2 consists of a bibliographical review concerning the approaches to continuous improvement in Six Sigma processes; section 3 deals with the methodology used in the development of this study; section 4 describes the work developed at the Continental Mabor company through the implementation of the DMAIC cycle and, finally, section 5 presents the final conclusions.

2. Literature review

Over the last years, companies have been confronted with huge competition in global economics. Many of the companies which adopted the Six Sigma approach have achieved success in their activities [10]. Six Sigma constitutes an innovative approach to the constant improvement of processes and is a methodology of Total Quality Management [11]. The Six Sigma concept was introduced in the 80s by Motorola and constitutes an essential feature of its own quality improvement program [12]. The term Six Sigma refers to a statistical performance target of operating with only 3.4 defects for every million opportunities [13]. As a result of the investment of 170 million dollars in Six Sigma training provided to its workers, Motorola reported savings of 2.2 billion dollars in expenses relating to poor quality [14]. This management strategy has gained popularity since it was adopted and explored by various organisations worldwide; General Electric (GE), Boeing, Kodak and Sony, amongst others, reporting great improvements in performance and savings of millions of dollars [15].

In the context of organisations’ business dealings, Six Sigma is a strategy which is used both to improve profitability as well as ensure efficiency in all operations, with the purpose of meeting customers’ demands and expectations [16]. It consists of a strict, focused and extremely efficient application of practices and quality concepts, and tends towards an approach of error-free performance in organisations [8]. Unlike other movements aimed at improving quality, which primarily focuses on the product or service provided to the final customer, Six Sigma methodology places emphasis on the quality of the organisation’s global system [17]. Some of the benefits ensuing from the implementation of this system include cost reduction, improved productivity, growth in market share, customer loyalty, reduction in cycle times and defects, amongst others [13]. The strategy of this approach, as a problem-solving or process improvement methodology, resort to a series of well-defined steps, which constitute the DMAIC cycle and are one of the keys to success in the implementation of the Six Sigma program [9]. The operation of this cycle is similar to other problem-solving procedures used in production systems, such as Deming’s Plan-Do-Check-Act cycle and Juran and Gryna’s Seven Step procedure [18]. This cycle consists of five stages, beginning with the definition of the problem and of all aspects which are relevant to the project (Define). During the second stage, one carries out a measurement of the problem; namely, all defects which result in its occurrence (Measure) [19]. The
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