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# Critical success factors for Six Sigma projects ☆

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**Abstract**

The goal of this article is to identify and understand the relationship between critical success factors for Six Sigma programs and its projects performance, considering Six Sigma projects. This article explores those relationships through PLS (Partial Least Squares) method, using a sample of 149 respondents in Brazil and Argentina. The variables were collected initially by a survey conducted with Black Belts, Green Belts, program managers and company executives and goes further on projects documental analysis. The results show that not all the claimed critical success factors are relevant for program or project performance, what could direct the effort of companies into working harder in the relevant ones. This study has a noteworthy contribution to Six Sigma literature presenting a structural model that shows the significant impact of Six Sigma Method, Project Management and the Project Manager competencies on project performance.


*Keywords:* Project management; Six sigma; Project manager; Project success; Competence

## 1. Introduction

Many companies have sought to adopt the Six Sigma program, as a way to improve their results. This search is motivated by the results obtained by companies such as Motorola, AlliedSignal, 3M, and GE, who were the pioneers in the adoption of the program (Pande et al., 2000; Snee and Hoerl, 2003). Despite these organizations reporting hundreds of millions of dollars as a result of the adoption of Six Sigma since the 90s (Pande et al., 2000; Seri, 2002), definitions of the scholarly literature on what is Six Sigma are much more recent and the empirical evidence of the impact on results are restricted to few studies.

Despite the success claimed by practitioners with the adoption of Six Sigma, in academia, the first discussions on the subject were related to the discussion on the Six Sigma which can be regarded as a new form of different quality management TQM (Kaynack, 2003; Kwak and Anbari, 2006; Schroeder et al., 2008; Yeung et al., 2006; Zu et al., 2008).

Although Kaynack (2003) argue that the Six Sigma can be considered "TQM on steroids", Schroeder et al. (2008) and Zu et al. (2008) indicate that the Six Sigma uses a common platform of knowledge, practices, and quality resources, complementing them with some features and specific resources in order to increase its effectiveness.

Evaluating the recurring themes in research on Six Sigma, plus getting a coherent definition and presentation of cases of application of the program in various industries, a recurring theme that arises frequently in the research is the analysis of critical success factors of Six Sigma programs, as shown by Marzagão et al. (2014). The interest in the discussion of this issue has grown in the number of citations, although still incipient in the number of published articles.

Considering studies on the topic, Goh (2010) reviews the practices over the 25 years of implementation of Six Sigma, suggesting opportunities for improvement in the aspects of evolution of the structured method of troubleshooting, issues related to the conflict between applications of sophisticated

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techniques and practical outcomes perceived, which suggests that a critical success factor quite cited in literature, which is the application of statistical and quality tools (Antony and Bañuelas, 2002; Antony and Desai, 2009; Bhote, 2002; Brady and Allen, 2006; Brun, 2011; Dedeke, 2002; Firka, 2010; Hahn, 2005; Henderson and Evans, 2000; Keller, 2001; Kim, 2010; Kumar and Antony, 2008; Kumar et al., 2009; Martens, 2001; Pande et al., 2000; Pfeifer et al., 2004; Pyzdek, 2003; Smith et al., 2002; Snee and Hoerl, 2003; Timans et al., 2011) should be viewed with caution because a full application of all the tools could not always predict the success of the program. The relation between Six Sigma and project has been explored in Project Management literature, aligned with the theoretical proposition that the successes of operational excellence concepts, such as Six Sigma, "leads to project excellence" (Basu, 2014, p. 180), and the idea that successful implementation of major managerial innovations as six sigma are "critical to the survival of organizations, while relying on project management and change management" (Hornstein, 2015, p. 294). Moreover, Nair et al. (2011) study the relationship between the Six Sigma project context, its elements and the success of the initiative, suggesting deeper study from the link between the themes of project, its complexity and context and the performance of such projects, suggesting that project performance can be affected not only by directly Six Sigma program variables but also the way Six Sigma program is inserted in company, which refers to the need to assess the outcome of the program and projects moderated by those aspects. Parast (2011) also proposes eight propositions relating the effect of Six Sigma projects on innovation and firm performance. Both Shafer and Moeller (2012) and Swink and Jacobs (2012) demonstrate quantitatively the effect of the Six Sigma program in the performance of companies that adopted Six Sigma, finding significant positive effects. Both studies suggest investigating in future research how aspects of form and intensity of adoption of Six Sigma practices correlate with benefits earned by companies adopting Six Sigma.

In addition, to these studies, the validation of critical success factors in each country has been a recurring theme. The works of Sharma and Chetiya (2010) and Desai et al. (2012) discuss and validate critical success factors in enterprises in India, Brun (2011) discusses the critical success factors in Italy and Zailani and Sasthriyar (2011) also discuss those critical success factors in Malaysia.

In this context, this study aims to contribute to fulfilling the discussed research gap by proposing and validating a research model on critical success factors (CSFs) for Six Sigma programs. Moreover, it aims to relate those CSFs and project success. The methodological approach is a survey-based research, using structural equation modeling to validate the research model.

This paper is structured in 6 sections. In the next section, we provide a theoretical overview that addresses the literature on six sigma and project success. The methodological approach of the research is detailed in Section 3, followed by the results in Section 4. Section 5 presents the discussion and our conclusions are in Section 6.

## 2. Literature review

Analyzing in more detail these references, it is possible to identify common elements in these definitions, but with different settings for each key element that makes up the Six Sigma.

In the literature of the practitioners, the definitions of Six Sigma are wider. To Pande et al. (2000, p. 3), Six Sigma can be defined as "a flexible system for improved performance and leadership". To Rotondaro (2002, p. 18), "Six Sigma is a working philosophy to achieve, maximize and maintain the commercial success, through the understanding of customer needs". For Harry and Schroeder (2000), Six Sigma is a strategy that relies on its ability to fulfill its goals. Harry and Schroeder (2000) also mention that the Six Sigma is a strategic initiative and can be considered by itself as a vehicle for other strategic initiatives.

For Linderman et al. (2006), Six Sigma is an organized and systematic method for improvement of processes and the development of new products and services, based on statistics and scientific techniques, with the purpose of reducing defects defined by customers. On Linderman et al. (2006, p. 780), the authors emphasize that "nothing is radically new in Six Sigma but Six Sigma does place a strong emphasis on challenging specific goals".

Schroeder et al. (2008, p. 540) define Six Sigma as "parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives." They also suggest that Six Sigma is seen as a process of organizational change.

Zu et al. (2008, p. 633) divides his definition of Six Sigma roles and structure practices between keys. According to the authors, "Six Sigma role structure is considered as an infrastructure practice in that it is part of human resource infrastructure to assist the deployment of Six Sigma". Core practices already are described as "Six Sigma structured improvement procedure and Six Sigma focus on metrics", which emphasizes "the use of scientific methods, statistics, and quantitative metrics tools".

Krueger et al. (2014) concluded, in its research based on grounded theory, that the Six Sigma program has a number of key aspects, and that success cannot be achieved focusing on only a few of them. In their study, they found differences between critical aspects correctly addressed companies studied, such as leadership, which may be related to the formation of parallel-meso structure and the roles to be played by the direction of the company, training, which is related to the technical qualifications of "Belts", affecting the knowledge of Six Sigma of members of parallel-meso structure and rigor in execution, which is linked to the application of structured method DMAIC and its tools. In this study, however, there were still unresolved points found in the practical approach as to project selection and alignment with other initiatives of the company, suggesting that these aspects should be studied in greater depth, which shows that there is, even among practitioners, a gap related to the corporate understanding of the benefits to be obtained from the projects, in which the Six