



Impacts of Lean Six Sigma over organizational sustainability: A survey study



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ABSTRACT

The purpose of this paper was to verify how Lean Six Sigma (LSS) could influence the organizational sustainability through their projects, given that there are few scientific studies that seek to evaluate the relationship that current exist between this tree streams: Lean, Six Sigma and Sustainability. The metodologie used on this study has qualitative point of view, based on experts' perception and collected by survey. The authors structured a questionnaire with 13 impacts of LSS, which was subsequently applied over 106 international LSS experts, with Green Belt, Black Belt, Master Black Belt or Champions certification. The survey investigate the expert perception of LSS influence over the three pillars of the Triple Bottom Line (TBL). There were identified in this study the correlation between LSS and organizational sustainability, principally due to impacts that significantly influence over Financial pillar of TBL. The authors also identified the 5 more influential impacts over organizational were identified and the importance of cost dimension for sustainability in organizations. This study assists in expansion of knowledge about the use of LSS by evaluating the influence of the metodologie over organizational sustainability and providing a deeper understanding of the relationship existing between them. Because of its feature, this study also raises the awareness among governments and companies regarding the weaknesses identified between TBL pillars. The survey application model through the LinkedIn platform presented in this study also shows itself as a possible source of inspiration for future studies. Even with the large volume of articles published about the Green Lean Six Sigma (GLSS) theme, it was not possible to identify papers that aim to verify the impacts of LSS methodology over the organization with a holistic and sustainable point of view. Within this scenario, the present study seeks to fill the verified gap.

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1. Introduction

Lean thinking emerged initially with the development of the Toyota Production System, which Taiichi Ohno and associates structured to help Toyota company survival in a scenario of capital and resources constraints during the post-war recovery (Kurdve et al., 2014). A team of engineers of Motorola, led by Bill Smith in the mid-80s, developed the Six Sigma methodology with the goal to improve the performance of the production process, but the methodology was widely disseminated by GE CEO Jack Welch (Shah et al., 2008).

Many authors have sought to integrate these two methodologies in the last few years in order to compose a single implementation model denominated by Sheridan (2000) as Lean Six Sigma (LSS).

Pepper and Spedding (2010) define the LSS as a structured and systematic approach for results improvement that perform statistical analyzes in order to reduce the incidence of defects in the final product at 3.4 defects per million and eliminate waste around all the production process. Originally developed in order to increase productivity on the shop floor, the LSS methodology stands as an effective track for improving organizational performance, mainly due to its feature to seek the improvement of processes with the purpose of achieving superior results in cost, productivity and quality (Salah et al., 2010).

The LSS methodology continues to evolve in terms of the application of LSS methodology in other areas of an organization (Antony et al., 2012; Fischman, 2010; Hsieh et al., 2012), beyond the production environment itself, the expansion of the tools used (Kornfeld and Kara, 2013; Lertwattanapongchai and William Swierczek, 2014; Meza and Jeong, 2013) and the development of multiple deployment models (Arnheiter and Maleyeff, 2005; Campos, 2013; Salah et al., 2010).

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The integration between Lean, Six Sigma and Sustainability comes to stand out in the latter year as an innovative field of study, mainly due to the alignment of the logic and systematic approach of the LSS methodology and the need for a more practical model for managing and controlling sustainability in organizations. According to Cherrafi et al. (2016a) the LSS methodology has a high potential to be the sustainability challenge answer for those organizations that use it as a management system.

Although the integration between these three methodologies presents itself as a study trend, the existing bibliographic base is still incipient with few studies focused on this field. Through a systematized review of the literature, Cherrafi et al. (2016a) identified only 118 scientific studies in this field of research, of which only 5.6% sought to integrate the three pillars simultaneously: Lean, Six Sigma and Sustainability.

The few studies identified in this area of knowledge focus on creating a conceptual basis for the field (Cherrafi et al., 2016a), on the identification of a conceptual model for the integration (Cherrafi et al., 2016b; Fatemi and Franchetti, 2016; Ho, 2010) or on the definition of similarities and differences between methodologies (Cherrafi et al., 2016a; Garza-Reyes, 2015a). None of the identified studies sought to diagnose the integration between the methodologies as it is to verify the impacts generated by the LSS on the development of a more sustainable management before the integration.

As predicted by the LSS methodology, it is necessary to look first at the current situation experienced (AS IS) before initiating any type of improvement and innovation (TO BE). So the authors identified a gap on the literature regarding the impacts currently generated by the LSS methodology on the three pillars of the organizational sustainability: ecological prevention, financial efficiency and social equity.

The set of studies initiated by Freitas and Costa (2017) seeks to develop a model to select and evaluate LSS projects in order to achieve a more sustainable management for the organizations, bringing a vision of cause and consequence between the two themes. In this second stage of the study, the authors seek to identify through the perception of experts: How LSS are capable to influence the three pillars of sustainability management through their projects?

In this context, this research seeks to map the influence of LSS impacts over organizational sustainability, according to LSS experts perception, verify the impacts that experts indicate as having more influence over organizational sustainability, identify the most impact pillar and identify the dimensions of the LSS that have the greatest influence over organizational sustainability.

The authors conducted this work as follows: Section 2, present a critical review of the existing literature related to the integration of Lean, Six Sigma and Sustainability. On section 3, we exposed the research methodology, with a more detailed presentation of the impacts selected, instrument for data collection and details of the collection of data. On section 4, a presentation about the results achieved and its discussion was developed. section 5 includes the conclusions reached by this work. On section 4, the authors presented these research limitations, implications and suggestions for future works.

2. Lean Six Sigma and organizational sustainability

Organizational sustainability has become, in recent decades, a highly relevant issue for organizations, mainly due to the pressures generated by stakeholders and the change of thinking experienced by society. Because of this scenario, sustainability is no longer an interesting thing to achieve in order to become a market imperative and a relevant competitive advantage (Garza-Reyes, 2015a; Wong

and Wong, 2014).

One of the main barriers to better performance in the social and environmental pillars on organizations comes from the idea that economic performance could be affected by the implementation of these improvements (Florida, 1996; Found, 2009). It is possible to perceive in the literature that the impacts on costs and on clients and employees satisfaction mitigate this risk (Cherrafi et al., 2016a).

Creating reports for disseminate the company's results based on TBL had its structured concept initially in 1997 by John Elkington and was designed with the main objective to incorporate metrics related to impacts generated on society, environment and organization's economic performance, creating a continuous process of management, measurement and accountability of results achieved (Chapman and Milne, 2003; Tyrrell et al., 2013; Wood and Garnett, 2010).

In their study, Singh et al. (2009) identify the existence of 41 different indices, organized in 12 categories, to measure sustainability. Despite the high number of indexes available, the authors highlight the need for a more rational and easy-to-apply model for assessing sustainability in the activities currently performed by organizations. According to Bebbington et al. (2007) "There is a widely recognized need for individuals, organizations and societies to find models, metrics and tools for articulating the extend to which, and the ways in which, current activities are sustainable".

In this context, multiple authors present the LSS as a management system capable of achieving measurable results for the sustainability of organizations through a structured and continuous method of continuous improvement. Cherrafi et al. (2016a) points out in his work that the integration between Lean, Six Sigma and Sustainability presents potential to generate a system for continuous improvement more effective and well organized, especially in organizations that already apply these strategies.

Initially, the integration between Lean and Sustainability was the most studied, since the focus on waste elimination is common between the two strategies and elevates the potential of its integration (Cherrafi et al., 2016b; Garza-Reyes, 2015a). In this union, the Lean provides tools and courses of action that enable the elimination of waste and sustainability provides a visualization of the impacts generated by environmental, social and financial perspectives (Garza-Reyes, 2015b). Subsequently, researchers have highlighted the need to include of Six Sigma in this formula, bearing in mind the latent need for a rational, disciplined, quantitative and structured model to solve problems and achieve real results (Banawi and Bilec, 2014; Cherrafi et al., 2016a; Furukawa, et al., 2016; Sagnak and Kazancoglu, 2016).

The guide developed by the U.S. Environmental Protection Agency (EPA) present several business cases (3M, General Electric, General Motors, etc.) of interaction between the Lean and the environment to prove the benefits generated through their integration. According to the guide, the improvement actions generated by this integration help to incorporate a philosophy of continuous improvement help eliminate waste and increase team engagement.

Cherrafi et al. (2016a) notes that the integration between Lean, Six Sigma and Sustainability has the strategic goal of improving the organization performance, regarding its performance in the environmental, social and economic pillars, with the help of LSS tools and standards. The authors still flag the need for new techniques and tools that will support this integration.

According to Kumar et al. (2016), six sigma, lean, agil, resilient, green and world-class standard strategies are widely used by business organizations to achieve sustainability criteria, demonstrating a trend in the market, especially for manufacturing companies.

Cherrafi et al. (2016b) identifies in their work evidences that the

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