Applying Bayesian Network Techniques to Prioritize Lean Six Sigma Efforts

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ABSTRACT

In order to retain competitive advantages, many manufacturing organizations have applied Lean Six Sigma techniques to improve production processes. The general approach for implementing Lean Six Sigma is to perform various projects to tackle specific problems or areas. However, with the manufacturing system and its external environment becoming more and more complex, it is simply not possible to solve all the problems given the limited resources. The purpose of this study is to develop a model that provides a systematic evaluation for potential opportunities to enhance the effectiveness of Lean Six Sigma. Deriving from the Bayesian Network methodology, the proposed model combines a graphical approach to represent cause-and-effect relationships between events of interests and probabilistic inference to estimate their likelihoods in the area of process improvement. The developed model can be used for assessing the problems associated with Lean Six Sigma initiatives and prioritizing efforts to solve these problems.

INTRODUCTION

Manufacturers are under tremendous pressure to improve their performance in order to stay competitive in the rapidly expanding global economy. Externally, they face the challenge of satisfying increasingly sophisticated customer demand while trying to remain profitable while competing against international companies. In order to meet the unprecedented developments taking place in the new era, a majority of manufacturers are investing enormous resources for operational and cultural transformation.

Over the past few decades, there has been a significant shift toward Lean Six Sigma initiatives that promote the philosophy of continuously identifying opportunities to improve performance. The main benefit of this strategy is that the manufacturing processes are constantly being monitored and improved with a focus on maximizing the ability to create value for
the customer, which includes design, quality, function, cost, delivery, and any other aspects of the product. Lean is used to eliminate the wastes or non-value added activities while Six Sigma is used to reduce the variation and make the system more consistent.

During the implementation of Lean Six Sigma, a series of initiatives are planned and executed to achieve the designed goals. The sequence of these tasks is normally determined in a subjective manner, including personal experience, management guidelines, or simply arbitrary decisions. The existence of such practices is due to the fact that there is no easy way to rank the initiatives based on their impact on the entire system. What a practitioner normally sees is that most of the events are interrelated with each other to some extent and it is extremely difficult to clearly identify the most critical factor.

The purpose of this paper is to provide a Bayesian Network model to aid in quantifying and prioritizing the improvement efforts of Lean Six Sigma. The rest of this paper is organized as follows. The next section discusses the literature associated with Lean Six Sigma and Bayesian Networks, then a section follows that discusses the methodology, followed by a presentation of a case study, and the last section provides concluding remarks.

LITERATURE REVIEW

Lean Six Sigma

The term “Lean Production” was coined by Womack, Jones, and Roos in their book, *The Machine That Changed the World* (Womack et al., 1990), based on a five-year study of automobile industry. In summary, Lean promotes a constant identification and elimination of any activities that add no value and cause extra costs within the manufacturing system. Lean is a methodology to help identify and reduce non-value added activities based on the definition of value to customer. According to Lean manufacturing, value is the change for which a customer is willing to pay. These include the function of actual product and any additional delighters such as fast delivery and satisfactory customer service, but not the time spend on transportation, motion, storage, excessive inventory, and any defects and rework. There are a variety of tools utilized in the Lean Production system which attempt to address the concern of manufacturing firms that are under pressure to emphasize the improvement on delivery, quality, and cost reduction. The framework of Lean philosophy was summarized by Womack and Jones (1996) and more recent work includes Pettersen (2009), Nicholas (1998), Lamming (1996), Sawhney and Chason (2005), and Ellis et al. (2010). Lean techniques can also contribute to the performance improvements of other industries such as service sector (Arbós, 2002; Ali et al., 2012), healthcare (Chalice, 2007; Jenab & Staub, 2012; Huang et al., 2012), petroleum (Al-Husain et al., 2008), and construction (Alarcón, 1997).

Six Sigma is a collection of technical and managerial tools originally developed by Motorola to reduce variation and eliminate defects in electronic manufacturing processes. This philosophy then received huge successes at industry-leading companies such as General Electric (GE) and Allied Signal. Recent Six Sigma material includes Tennant (2001) and Thomas et al. (2009). The cornerstone of Six Sigma techniques is the application of scientific principles to manage business processes. Examples of the most widely used methods are Statistical Quality Control (SQC), and Design of Experiments (DOE).

Lean and Six Sigma are two major principles that address the efficiency and quality respectively and together they serve as fundamentals of the process improvement strategies. However, these two methodologies cannot be taken out of two packages and simply thrown into a single toolbox. Recent work has been
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