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ScienceDirect

Expert Systems with Applications 34 (2008) 2693–2703

Expert Systems with Applications

www.elsevier.com/locate/eswa

A systematic methodology for the creation of Six Sigma projects: A case study of semiconductor foundry

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Abstract

Nowadays, Six Sigma has been widely adopted in a variety of industries in the world and it has become one of the most important subjects of debate in quality management. Six Sigma is a well-structured methodology that can help a company achieve expected goal through continuous project improvement. Some challenges, however, have emerged with the execution of the Six Sigma. For examples, how are feasible projects generated? How are critical Six Sigma projects selected given the finite resources of the organization? This study aims to develop a novel approach to create critical Six Sigma projects and identify the priority of these projects. Firstly, the projects are created from two aspects, namely, organization's business strategic policies and voice of customer. Secondly, an analytic hierarchy process (AHP) model is implemented to evaluate the benefits of each project and; a hierarchical failure mode effects analysis (FMEA) is also developed to evaluate the risk of each project; and from which the priority of Six Sigma projects can be determined. Finally, based on the project benefits and risk, projects can be defined as Green Belt, Black Belt, or others types of projects. An empirical case study of semiconductor foundry will be utilized to explore the effectiveness of our proposed approach.

Keywords: Six Sigma; Project selection; Six sigma projects; FMEA; AHP

1. Introduction

Over the past few decades, Six Sigma has been espoused by many world-class companies and has also a lot of successful cases. The main benefit of a Six Sigma program is the elimination of subjectivity in decision-making, by creating a system where everyone in the organization collects, analyzes, and displays data in a consistent way (Maleyeff & Kaminsky, 2002). Six Sigma is regarded as a well-structured methodology for improving the quality of processes and products. It helps achieve the company's strategic goal through the effective use of project-driven approach. Six Sigma projects must be linked with business strategy and should meet the requirements of the customer. As Six Sigma is a project-driven methodology, it is essential to prioritize projects which provide maximum financial benefits to the organization (Coronado & Antony, 2002). Generating and prioritizing the critical Six Sigma projects, however, are real challenges in practice. To our knowledge, Six Sigma initiatives are not driven based on business strategy and thereby the Six Sigma projects neither achieve the expected benefits nor satisfy the requirements of customer due to the incorrect direction.

Pande, Neuman, and Cavanagh (2000) have indicated that there should not be too many factors in project selection; instead, choosing the five to eight that are the most relevant criteria for the organization would be sufficient. In Six Sigma initiative, although there are many criteria on which to judge the performance of Six Sigma projects, for instance, net cost savings, cost of poor quality, capacity, and customer satisfaction (Harry & Schroeder, 2000), it still lacks to have an standard and unanimous rule for selecting or prioritizing of those projects. Traditionally, Six Sigma initiative uses impact and effort on both dimensions to find out desirable Six Sigma project (Pande et al.,

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doi:10.1016/j.eswa.2007.05.014

2000; Pyzdek, 2003). The effort of each project, however, is difficult to evaluate. Impact and effort dimensions are also hard to quantify. To resolve these problems, the facile quantification dimensions should be further developed.

Projects may differ in size, duration, objectives, uncertainty, complexity, pace, and some other dimensions. It does not matter how different or unique a project is; there is no doubt that every project contains some degree of uncertainty and there is no risk-free project (Tüysüz & Kahraman, 2006). The project manager should pay more effort to accomplish the project goal if the project involves with the high risks (Elkington & Smallman, 2002). In addition, the widespread applications of Six Sigma are possible because to the organization are able to articulate the benefits as reflected in financial returns (Goh, 2002; Kwak & Anbari, 2006). Therefore, the risk and benefits can be considered the dimensions to be used for selecting and prioritizing Six Sigma projects.

Semiconductor industries all over the world have had significant growth over the last decade in the world and also make up for the bulk of economic benefits (Arita & McCann, 2002). Semiconductor foundries are major suppliers of global semiconductor products. Owing to the market's competitiveness, a foundry usually employs a systematic and disciplined approach to move towards the world-class quality level. Nowadays, many foundries are interested in implementing Six Sigma to improve the quality of their products. Indeed, the implementation of Six Sigma methodology into a semiconductor foundry has become globally popular.

Semiconductor foundry requires a large volume of human resources, capital, and complex technology; therefore its organization structure has a complicated hierarchy and is usually divided into many different departments. Due to the organization structure is huge, when a semiconductor foundry wants to execute Six Sigma methodology some problems may arise. Some of these problems include the ways on how to link the projects with the business strategy, while the responsibility over the projects is scattered in different departments. Another concern is how to select the critical Six Sigma projects under the finite organization's resources? In a semiconductor foundry, projects are usually separated into several subsystems where a different department manages each subsystem. In this way, it is difficult to evaluate the priority of those projects. As a result, a systematic methodology is desired to solve these problems. This study aims to help a semiconductor foundry determine the Six Sigma projects and decide the project benefits and risk of those projects. Based on the benefits and risk priority, the projects can be defined as Green Belt, Black Belt or other projects.

This paper is organized as follows. Section 2 reviews the relevant literature used in this study. Section 3 presents a systematic methodology to generate Six Sigma projects and decide the project benefits and risks of those projects. In Section 4, a real case is studied to demonstrate the feasibility of the proposed methodology. Finally, the conclusion will be drawn in Section 5.

2. Relevant research

2.1. Six Sigma

Six Sigma was first espoused by Motorola in 1987 and was taken up by Allied Signal in 1991. In 1995, Jack Welch, the CEO of General Electric successfully established and published Six Sigma. He implemented Six Sigma in many processes and documented significant gains in process and financial results (Coronado & Antony, 2002; Pfeifer, Reissiger, & Canales, 2004). The simplest definition for Six Sigma is to eliminate waste and to mistake proof the processes that create value for customer. The elimination of waste led to yield improvement and production quality; higher yield increased customer satisfaction. Naumann and Hoisington (2001) have indicated that the concept of Six Sigma is the development of a uniform way to measure and monitor performance and set extremely high expectations and improvement goals. Treichler, Carmichael, Kusmanoff, Lewis, and Berthiez (2002) have concluded that Six Sigma is a highly disciplined process that helps an organization to focus on developing and delivering near-perfect products and services. The Six Sigma methodology of measuring and monitoring performance issue deals with a variety of statistical applications. The objective of Six Sigma is to enhance the sigma level of performance measures that reflects the needs of the customer. In addition, the Six Sigma level of performance means a product defect rate of 3.4 per million opportunities for error.

In order to achieve company goals, the critical-to-quality (CTQ) representatives of the product or service are identified. As the average CTQ capability increases, the capability of the corresponding process increases, make it further achieve strategic business goals. In an organization, Six Sigma is a top-down initiative led by the company CEO, and the hierarchy of trained personnel designated as Champion, Master Black Belt (MBB), Black Belt (BB), and Green Belt (GB) usually constitutes the infrastructure of a Six Sigma project. Current applications of the Six Sigma methodology emphasize the phases that are integrated in conducting a project, which include define-measure-analyze-improve-control (also known as the DMAIC cycle). The DMAIC cycle comes into play to meet the customer needs consistently and perfectly (Kuei & Madu, 2003). Su, Chiang, and Chiao (2005) have summarized the unique features of the Six Sigma approach include (1) sequences and links improvement tools into an overall approach (known as DMAIC); (2) integration of the human and process elements for improvement using a belt based organization (Champion, Master Black Belt, Black Belt and Green Belt), and (3) attention to bottom-line results and the sustaining of gains over time.

With Six Sigma methodology, the benefits of an organization include not only higher levels of quality but also lower levels of costs, higher customer loyalty, better financial performance and profitability of business. More related applications about Six Sigma methodology could be found