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An empirical study of key success factors for Six Sigma Green Belt projects at an Asian MRO company

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ABSTRACT

This study determines critical factors for aircraft maintenance, repair, and overhaul companies during the initial incorporation stage of Six Sigma programs. This is achieved by examining 14 key success factors. Employees of an Asian maintenance, repair, and overhaul company are surveyed. Factor analysis is used to identify five key factors that are pertinent to successful completion of Green Belt improvement projects.

1. Introduction

Asia's commercial aviation service companies (MROs) face serious challenges, including the determination of how to reduce costs while maintaining quality and profitability (Mathews, 2006). Here we analyze an MRO company in Asia (Company A) that has used Six Sigma for over 6 years to complete a pioneering modification project that transformed a Boeing 747 passenger plane into a large freight aircraft (Harbison, 2006). Since 1999, Company A has worked with General Electric (GE) to implement the Six Sigma methodology and has decreased the B747-400 engine overhaul turn around time (TAT) from 92 days to 45 days. We identify the key success factors that enabled its Green Belts to complete their initial projects and obtain certification.

Six Sigma in statistical terms means 3.4 defects per million opportunities. Early in its development, a team at Motorola developed a four-phase process for improving the quality of its products looking at "Definition," "Analysis," "Optimization," and "Control" (Harry and Lawson, 1992). Based on this four-phase process, two additional major processes were developed: the "Define, Measure, Analysis, Improve, and Control" (DMAIC) and the "Design for Six Sigma" (DFSS) processes (Harry and Schroeder, 2000)—also known as the "Define, Measure, Analysis, Design, and Verify" (DMADV) process (Keller, 2001). The DMAIC process was developed to eliminate defects in production or service processes. The DFSS process was developed to enable companies to design new or redesign processes that were not able to achieve targets, even after they had been improved.

2. Six Sigma personnel and organizational structure

Personnel involved in implementing Six Sigma in a company are termed Champions, Master Black Belts, Black Belts, and Green Belts—the last three terms being borrowed by the Unisys Corporation from the sport of karate. The role of a Champion is to direct the entire Six Sigma program in a company, a Master Black Belt is responsible for managing a Six Sigma team and reporting to the Champion, Black Belts carry out major Six Sigma projects, report to Master Black Belts, and coach Green Belts, who are responsible for carrying out smaller Six Sigma projects.

Table 1 lists the original four roles as well as additional roles that were developed later. Fig. 1 shows the overall organizational structure of a Six Sigma program. The methodology and organizational structure are aimed at enabling the value stream of a company, indicated by the arrow at the bottom of the figure, to increase efficiency and effectiveness as a result of successful Six Sigma projects.

Within aviation, the AlliedSignal Corporation began using Six Sigma in 1994. A year later, GE adopted Six Sigma methodology and in 1998 introduced "At the customer, for the customer" plan to airlines who purchased aircraft engines from the company. As a result, Six Sigma quickly spread throughout the commercial aeronautical industry.

3. Six Sigma success factors

Several Six Sigma success factors have been investigated in previous research (Table 2) and to these we add an additional factor.

1. *Top management's commitment and participation.* Harry and Schroeder (2000) stated that managers should make a serious

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Table 1
The various roles in the Six Sigma system

	Study			
	Harry and Schroeder (2000)	Eckes (2001)	Brue (2002)	Pande et al. (2000)
Personal roles	–	–	Executive Leaders	Leadership Group or Council
	Champions	Team Sponsor or Champion	Champions	Project Sponsors and Champions
	–	–	–	Implementation Leader
	Master Black Belt	Team Consultant–Master Black Belt	Master Black Belt	Six Sigma Coach/Master Black Belt
	Black Belt	Team Leader–Black Belt	Black Belt	Team Leader/Project Leader/Black Belt
	Green Belts	Team Leader–Green Belt	Green Belts	Team Members (including Green Belts)
	–	Team Members	–	–
	–	–	–	Process Owner

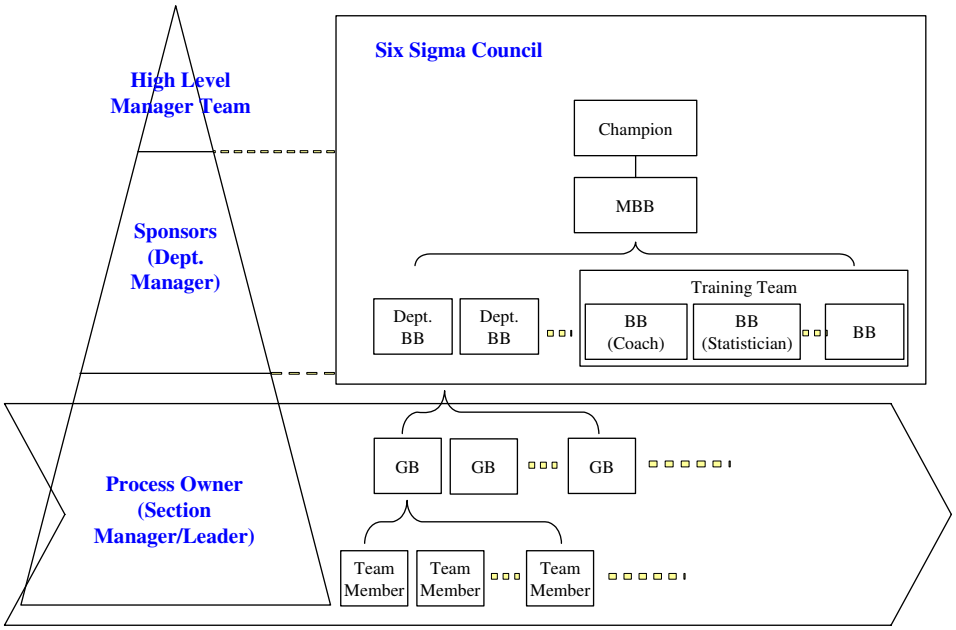

Fig. 1. The organizational structure of a Six Sigma program.

commitment when the Six Sigma system is initially introduced. Henderson and Evans (2000) found that at GE, top management support and participation is a significant factor determining success with Six Sigma.

2. *Business strategy based on customer demands*. Pande et al. (2000), looking at 16 English companies concluded that for a Six Sigma program to be successful, a company must connect it to both its business strategy and its customers. Harry and Schroeder discuss the importance of conducting benchmarking to ensure that an organization understands what its customers need while Dedeke (2002) suggests that an audit process should be set up to ensure that projects satisfy their customers.
3. *Establishment of the Six Sigma framework*. Henderson and Evans (2000) also discussed the Six Sigma framework. They emphasized the importance of "speaking the same language" within the organization. Dedeke states that leaders should form teams of champions. Jiju and Banuelas (2002) note that "an effective organizational infrastructure should be in place to support Six Sigma."
4. *Project execution and follow-up of the results*. Harry and Schroeder propose a system for tracking progress in Six Sigma projects. Henderson and Evans, Pande et al., Martens (2001), Jiju and Banuelas, and Snee and Hoerl (2003) all also emphasize that a measurement system should be used to track progress in Six Sigma projects. Dedeke emphasizes the importance of integrating financial evaluation systems.
5. *Investment of essential resources*. Pande et al. show that companies must invest resources in Six Sigma programs. Keller (2001) emphasized the importance of allocating resources effectively. Research by Brue (2002), Jiju and Banuelas, and Smith et al. (2002) also showed the need for companies to provide sufficient resources to their Six Sigma teams.
6. *Investment and training framework for trainers and mentors (such as Black Belts)*. The research done by Henderson and Evans focused on the importance of training. Harry and Schroeder emphasized the need for companies to provide necessary education, training, guidance, and assistance to Champions and Black Belts.
7. *Incentive/reward system*. Henderson and Evans state that Six Sigma projects should be supported by human resource programs, such as promotions and rewards. Brue (2002) stated that celebrating every success is important to keep everyone involved in a Six Sigma project enthusiastic. Dedeke found that compensation policies can encourage employees to focus more attention on Six Sigma programs. Henderson and