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Critical Success Factors of Six Sigma Implementation in Malaysian Manufacturing Industry

Md Fauzi Ahmad, Wong Jing Ping, Nor Aziati Abdul Hamid, Shiau Wei Chan
Production and Operation Department
Universiti Tun Hussein Onn Malaysia *(UTHM)*
Batu Pahat, Johor, Malaysia
mohdfauzi@uthm.edu.my

Josu Takala
Department of Engineering Science and Industrial Management,
University of Vaasa,
Wolffintie 34, 65200 Finland
Email: josu.takala@uwasa.fi

***Abstract*— Six Sigma (SS) has grown quickly throughout the world, for improving performance such as quality, cost reduction and customer satisfaction. Six Sigma has been proven to be an effective approach for performance improvement in a variety of industries for many years. Six Sigma is a business strategy which is applicable in all industries. SS is set up for identifying and eliminating defects in any process such as products or services. However, many companies had implemented Six Sigma but not successful due to many reasons such as low return on investment, poor leadership and lack of commitment from senior management. Some of the barriers are due to lack of knowledge, insufficient exposure and wrong understanding of the Six Sigma practices. In order to improve business performance, implementation of Six Sigma is very important. The focus of this study is to determine the level of six-sigma implementation and the relationships between Six Sigma factors and their performance in Malaysian Manufacturing. The study is based on quantitative approach using a questionnaire survey in Malaysia manufacturing industry. Random sampling was used in this study and questionnaire had been distributed to 200 companies in Malaysia. Finally, 35 respondents have been received or equal to 17.5% response rate. The results shows that top management involvement and commitment, teamwork and organizational infrastructure factors show high level while training and education and cultural change show moderate level. This study also reveals that there is a significant impact of critical success factors (CSFs) on Six Sigma performance with r=0.41 with p<0.05. This study established a clear guideline on CSFs necessary to adopt in order to ensure the correct implementation of Six Sigma in organizations.**

Keywords—Six Sigma, performance, correlation

I. INTRODUCTION

Six Sigma is a major practices for quality and process improvement in many industries. Many companies are trying to deploy Six Sigma practices, but many of them are in dilemma whether to proceed or not. Six Sigma is an overall business improvement such as quality, productivity and cost [1]. Six Sigma uses data obtained from production and service processes in order to improve organizational performance. The world-class companies such as General Electric (GE), Johnson & Johnson, Honeywell and Motorola have adopted Six Sigma and proved the results to the world [1]. In addition, Six Sigma has been recognized as a management concept and systematic approach which are continues improvement, strengthen leadership, and enhance customer satisfaction. The implementation of Six Sigma can improve manufacturing processes in order to increase their profits and business competitiveness. However, there is a little research conducted on adoption of Six Sigma [2] [3]. Some companies that have implemented Six Sigma were not successful due to low return on investment [4]. Since Six Sigma requires top management involvement, the top management needs to understand the changes required and show their own commitment through support, allocate sufficient budget and resources [5]. Top management is constantly searching for the best practices around the world. There is an increasing need for companies to improve their productivity and eliminate waste in processes by applying Six Sigma tools [6].

In a large company, the Six Sigma project requires a lot of company resources such as financial resources, human resources, and time. Six Sigma implements is required a huge investment amount and hard work and labor [7]. An organization requires competent and trained manpower to be successful in their work. For a high level of manager, the cost of training is also high. The real improvement need is to analyze the sources of errors, and to plan and control the activities. Some of the improvement needs a minor change in the designs of the products or manufacturing process [1]. Most of business improvement

has failed during or after early phase of implementation [6]. The role of top management should support, encourage and provide resources that enable organization to achieve the objectives of business process [1].

The objectives of this study are:

1. To identify the level of Six Sigma implementation in Malaysia.
2. To determine the relationship between factors of Six Sigma and Six Sigma performance.

II. LITERATURE REVIEW

A. Definition of Six Sigma (SS)

According to Jirasukprasert *et al*., (2014) [8], Six Sigma is a problem-solving and improvement methodology that is applied to every type of process in order to eliminate defects. It is a management philosophy and strategy that help organizations to achieve lower costs. Six Sigma is defined as a disciplined, project-oriented, statistically based approach for reducing variability, removing defects and eliminating waste from products and processes. Anthony & Banuelas (2001) [9] stated that in business terms, Six Sigma is defined as a business improvement strategy used to improve business profitability, to eliminate waste, to reduce costs of poor quality and to improve effectiveness and efficiency of all operations in order to meet or exceed customers' need and expectations. However, there is lack of study in terms of relationship between Six sigma and its performance in previous work especially in Malaysia.

B. Critical Success Factors (CSFs)

Numerous researchers have identified a various of factors that can be considered critically to the success of Six Sigma implementation as shown in Table 1. Ma *et al*., (2008) [10] have summarized in literature and Six Sigma practice in China, point out critical success factors for the successful implementation of Six Sigma included Six Sigma leadership and strategy, organization infrastructure, focus on market and customer, select, manage and implement Six Sigma project, evaluation and motivation, and business results. Moreover, Alhuraish (2014) [11] are explained that key success factors of implementing Six Sigma and Lean in SME in France. There are 19 success factors for Lean and Six Sigma: top management involvement and commitment; linking method to suppliers; cultural change; organizational infrastructure; leadership; linking method to business strategy; project prioritization and selection; reviews and tracking; linking method to customers; linking method to human resources; understanding tools and techniques within method; project management skills; education and training; reward system; kaizen team; communication; consultant participation; skill and expertise; and monitoring and evaluation of performance. In addition, Baba *et al.*, (2011) [4] proposed 12 CSFs: (1) management involvement and commitment; (2) dedicated resources; (3) deployment infrastructure; (4) cultural change to data driven and learning organization; (5) training program; (6) linking Six Sigma to suppliers; (7) linking Six Sigma to business strategy; (8) linking Six Sigma to customer; (9) project selection and goal setting; (10) linking Six Sigma to human resources; (11) reward and recognition; and (12) involving finance in Six Sigma. But, out of twelve only six were found have been practiced by companies. They are comprised of deployment infrastructure, linking Six Sigma to business strategy, linking Six Sigma to human resources, dedicated resources, involving finance in Six Sigma, and training program. In Malaysia, Leong & Teh, (2012) [5] had proposed a model which includes five CSF's as follow: (1) top management involvement and commitment; (2) training and education; (3) teamwork; (4) cultural change; and (5) organizational infrastructure. While according to Laureani & Anthony (2012) identified the most important factors of CSFs of SS quality program such as management commitment, cultural change, linking Lean Six Sigma to business strategy and leadership styles. They also identify the least important of CSFs of SS quality program such as linking Six Sigma to HR rewards and extending Lean Six Sigma to supply chain. Although there are some published journal on CSFs, but, it found that there is scarcity of literature on CSFs of Six Sigma implementation.

Table 1: CRITICAL SUCCESS FACTOR

	Sivakumar, & Muthusamy, (2011)	Desai, *et al.* (2012)	Leong & Teh (2012)	Tlapa,. *et al.* (2014)	Anand, (2015)	Frequency
Top management Involvement and commitment	×	×	×	×	×	5
Training and education		×	×	×	×	4
Cultural change		×	×	×	×	4
Organizational Infrastructure	×		×	×		3
Teamwork			×			1

1) Top Management Involvement and Commitment

Six Sigma is a top-down approach that responsible for planning and implementation in an organization. Management commitment is the most important CSF [12]. The top-down strategy is more effective which leads to greater immediate success and contributes to company performance [13]. The role of leadership is critical in enabling the successful deployment of tools and techniques [8]. While implementing Six Sigma, it is necessary for the organization to create new policies, absorb knowledge towards new practices [14]. Top leaders have responsible and accountable for the success of Six Sigma program. Top management should check and evaluate work system, identify obstacles in customer satisfaction and implements effective plan. Leadership commitment will enable the organization to maintain the focus on operational efficiency and enhance productivity in business. Top management support is a fundamental for effective implementation of Six Sigma project [14]. The involvement of top management includes director and chief executive officer of the organization. It is important that top management provides full support toward Six Sigma implementation. They also need to provide adequate resources to facilitate Six Sigma efforts. The resources include allocation of time, talent, equipment, training, and skill workers. Therefore, top management has clearly set up organization objectives for Six Sigma project.

H1: Top management involvement and commitment will have a positive relationship with the Six Sigma implementation.

2) Training and Education

Training is one of the essential items based on the goals of an organization. Quality improvement requires changes, and the changes must be started with people. People must understand the function to execute Six Sigma. The execution of Six Sigma will allow the organization to set new goals, ask employee to manage with the change by thinking and acting differently. Involvement of top management in the process of training and understanding Six Sigma is vital [15]. Provision of training and education is important to success in the implementation of Six Sigma. It is necessary to design and plan for Six Sigma project development, training, and resource by using Six Sigma technique [16][17][18]. Before the execution of Six Sigma, managers must provide employees to engage in training and education. Skills and knowledge are important to daily operation and problem solving in the organization. To sustain Six Sigma activity for long-term, training should be made as an ongoing effort. It also can enhance employee's positive attitude.

H2: Training and education will have a positive relationship with the Six Sigma implementation.

3) Teamwork

Effective teamwork is the main component for the success of Six Sigma program [19][20][21]. Teamwork is defined as a group of individuals that work together to achieve a common goal. Teamwork applies to all organizational members. Team members can use methods and tools to solve practice problem effectively. Organizations cannot success without teamwork [22][23][24]. Each team should set up a clear mission, vision and objectives. According to Pande *et. Al*., (2000) suggested that a good team members for a project is between five to eight people. The most important is all the members must involve in their contributions and work toward a common goal. It requires involvement of managers, from senior executive to downwards. Each person contributes their different skills and coordinates his or her individual interests and opinion.

H3: Teamwork will have a positive relationship with the Six Sigma implementation.

4) Cultural Change

Many scholars studied that acceptance of cultural change is a major role in implementing Six Sigma [14]. Every country, city and even organization has their own unique in setting of philosophy and beliefs. The success of quality improvement strategy is based on different organization. "Doing things right at the first time" should be practiced by all the employees' attitude. The need for Six Sigma in terms of benefits is demonstrating to the employees. The meetings are held regularly by functional team to discuss Six Sigma projects. Six Sigma should be reviewed periodically. It also can allow organizations to choose the right project, and evaluate the project progress. The quality improvement strategy in an organization is accomplished successful when the constant support delivered by each employee [14][25][17]. In order to promote the culture change from experience, the best way is to increase and sustain communication, motivation and education to achieve better performance[14]. In organizational culture, Six Sigma acts as transforming management strategy. From doing Six Sigma projects, organization is able to create new knowledge and generate innovation solution.

H4: Cultural change will have a positive relationship with the Six Sigma implementation

5) Organizational Infrastructure

In order to implement Six Sigma within an organization, some organizational characteristics have already in place [26]. Organization infrastructure involves training of employees for achieving effective work. Companies that deploy Six Sigma should train their staff into four classifications; champion, master black belt, black belt and green belt, because the belt system is required in an organization to achieve success.

H5: Organizational infrastructure will have a positive relationship with the Six Sigma implementation.

C. Six Sigma Implementation

There is no one right way to implement Six Sigma in an organization successfully. According to Tasmin (2013) [22], Six Sigma is implemented in a traditional departmental paradigm without much dependence on business process thinking. There are some Six Sigma practitioners complain of the difficulty in identifying the best opportunities to apply Six Sigma techniques. There are also some serious issue and failure of integrating business process thinking with Six Sigma methods.

III. METHODOLOGY

Random sampling method is chosen for this research. The respondents for this research were companies which are familiar with Six Sigma activity in manufacturing industry. Based on FMM Directory, 200 companies have been selected. Finally, 35 respondents gave feedback or 17.5% return rate. Survey questionnaires were distributed via mail to respective persons. These seven sections are demographic information of company and respondents, top management involvement and commitment with five items, training and education with five items, teamwork with five items, cultural change with five items, organizational infrastructure with five items and Six Sigma implementation with five items. The measurement of these items is using a seven-point likert scale.

IV. RESULT

A. Reliabilty Test

According to Table 2, Cronbach's Alpha value has been used for evaluating reliability. The result shows that good reliability in all factors which are top management involvement and commitment (0.769), training and education (0.710), teamwork (0.717), cultural change (0.790) and organizational infrastructure (0.769).

TABLE 2 RELIABILITY ANALYSIS

Factors	**No. of Items**	**Cronbach's Alpha (α)**
Top Management Involvement and Commitment	5	0.769
Training and Education	5	0.710
Teamwork	5	0.717
Cultural Change	5	0.790
Organizational Infrastructure	5	0.823
Six Sigma Implementation	5	0.703

B. Descriptive Analysis for factors of Six Sigma

Based on Table 3, top management involvement and commitment shows the highest mean with 5.17 followed by organizational infrastructure factors with mean 5.13. Next, the mean for teamwork, cultural change and training are 5.11, 4.96 and 4.46 respectively. The mean for teamwork, cultural change and training are 5.11, 4.96 and 4.46 respectively.

TABLE 3 RANKING FOR CSF FOR SIX-SIGMA

Factors	Mean score	Result	Rank
Top Management Involvement and Commitment	5.1714	High	1
Training and Education	4.4571	Moderate	5
Teamwork	5.1143	High	3
Cultural Change	4.9571	Moderate	4
Organizational Infrastructure	5.1286	High	2
Total	4.3657	Moderate	

C. Test of Normality

Since p-value of normality test for Six Sigma factors and six sigma implementation show respectively 0.063 and 0.143 means that the distribution is normal distribution. Therefore, parametric test can be used.

TABLE 4 NORMALITY TEST

	Shapiro- Wilk		
	Statistic	df	Sig
Factors of Six Sigma	0.953	35	0.143
Six Sigma Implementation	0.942	35	0.063

D. Regression and Correlation Result

Pearson Regression Method was used in analysing the data from the respondents in stating whether there is significant correlation between factors of Six Sigma and Six Sigma implementation. The regression result shows that there are significant impact of Six sigma factors towards Six Sigma implementation ($r=0.412$, $p<0.05$) as shown in Table 5. From the result in Table 6, there is positive correlation between dominant factors of Six Sigma and Six Sigma implementation. The correlation value which is (r) between top management involvement and commitment and Six Sigma implementation is 0.441, training ($r=0.538$), teamwork ($r=0.193$), cultural change ($r=0.136$) and organizational infrastructure ($r=0.432$). Hence, all of the correlation values are more than 0.01 indicates there is a positive correlation between factors of Six Sigma and Six Sigma implementation. For factors such as top management involvement and commitment, training and education and organizational infrastructure are shows significant positive correlation towards Six Sigma implementation. Meanwhile, teamwork and cultural change are shows insignificant positive correlation towards Six Sigma implementation.

TABLE 5 REGRESSION RESULT

		Six Sigma Implementation	Result
Factors	Pearson correlation	0.412*	Positive
	Sig. (2-tailed)	0.014	Significant

TABLE 6 CORRELATION RESULT

		Six Sigma Implementation	Result
Top Management Involvement and Commitment	Pearson correlation	0.441**	Positive
	Sig. (2- tailed)	0.008	Significant
Training and Education	Pearson correlation	0.538**	Positive
	Sig. (2- tailed)	0.001	Significant
Teamwork	Pearson correlation	0.193	Positive
	Sig. (2- tailed)	0.267	Not significant
Cultural Change	Pearson correlation	0.136	Positive
	Sig. (2- tailed)	0.436	Not significant
Organizational Infrastructure	Pearson correlation	0.432**	Positive
	Sig. (2- tailed)	0.010	Significant

V. DISCUSSION

A. Discussion on level of Six Sigma Implementation

Based on the descriptive analysis, top management involvement and commitment, teamwork and organizational infrastructure shows high level in mean score. This includes top management such as directors and chief executive officer of the organization. Management must invest time and resources to implement six sigma. Top leaders had responsible and accountable for the Six Sigma program to be successful. Moreover, effective teamwork plays an important component for the success of Six Sigma program [19]. Teamwork applies to all organizational members [22]. However, training and education

and cultural change shows moderate level in mean score. The best way to achieve good result in training and education is involvement of top management in the training process and understanding Six Sigma [15]. Organizations require change in organizational culture. In order to promote the culture change, the best way is increased and sustained communication, motivation and education [4].

B. Discussion on relationship between the factors towards the Six Sigma implementation

Firstly, top management involvement and commitment show positive significant relationship toward Six Sigma implementation. As literature study shown by Brady & Allen, (2006) [27], the first and the most important factor for Six Sigma success is top management commitment. According to Zu *et al*. (2008), top management decisions on the organization's strategic objectives will affect the metrics and goals set for the Six Sigma improvement projects. In the past researcher, Chakrabarty & Tan (2009) [2] had reported that top management involvement and commitment is positively related to the Six Sigma implementation. The top management support is needed in the implementation of Six Sigma [28]. Secondly, training and education show positive significant relationship toward Six Sigma implementation. According to Coronado & Anthony, 2002 [26], provision of training and education is vital towards the success of Six Sigma implementation. In order to implement Six Sigma techniques in company, it is necessary for design and plan in terms of training and resources [16]. For example, case study of Six Sigma implementation on Malaysian manufacturing companies had been demonstrated [5]. Based on the finding, the adequate training and education are necessary for Six Sigma know-how, resulting in Six Sigma implementation successfully. However, teamwork factors show positive insignificant relationship toward Six Sigma implementation. The top management is reluctant to spread the concept throughout the organization [29]. According to Leong and The (2012) [5], managers should improve the effectiveness of communication among colleagues, increase the levels of motivation and team-working spirit among the employees. Fourthly, cultural change show positive insignificant relationship toward Six Sigma implementation. By developing a group culture, organizations promote participation, trust, and concern for human development [8]. According to Anand, (2015) [14], the employees' attitude towards the task should be "Doing things right at the first time". But, the success of quality improvement strategy such as Six Sigma is possible only when the constant support delivered by each employee. Besides, employees do not properly know their important of quality in their work and product [29]. According to Tlapa (2014), cultural influence does not have significant impact to Six Sigma implementation. Lastly, organizational infrastructure show positive significant relationship toward Six Sigma implementation. According to Coronado & Anthony (2002) [26], the need of organizational infrastructure place prior to introducing Six Sigma program in an organization. For example, an organization should have enough resources and investment to engage in Six Sigma program [5]. Moreover, every worker in a Six Sigma- oriented organization shall have undertaken Six Sigma activities [30]. The introduction of Six Sigma within an organization requires a great deal of resources, commitment of leadership, time and investment.

VI. CONCLUSION

The involvement of Six Sigma in business strategy helps an organization improve on their performance. With Six Sigma, it acts as a powerful business strategy and provides business leaders and executives with the strategy, methods, tools and techniques in their organizations. The performance of the company is increased to a better level in terms of customer satisfaction, at delivery time, and reduce or eliminate errors. This development can become more efficient, capable, reliable and consistent manufacturing process and better overall performance.

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IX. BIOGRAPHY

Md Fauzi Ahmad is an academic staff at UTHM. His undergraduate studies was in Electrical & Electronic Engineering from Muroran Institute of Techonolgy (MIT), Japan and Post Graduate studies in Total Quality Management (TQM) from Universiti Teknologi Malaysia (UTM). His majoring research is in TQM of Japanese companies and actively publishing international and local journals. He embarked his career as Quality Engineer at Sharp Corporation in 1999 and has been assigned at various departments which include Product Quality Assurance (PQA), Quality Control (QC), Product Planning and Sales Department. He has working experience for 12 good years in quality and marketing management. He is a Certified Quality Engineer (CQE) from Federation Manufacturing Malaysia (FMM) and Sharp Corporation Japan. He also participated in On Job Training (OJT) for quality, reliability management and data analysis at Sharp Corporation, Japan under Association of Overseas Technical Scholarship (AOTS). He also contributed in establishing company strategy for improving customer satisfaction and other major improvement projects. He has working with Japanese companies for more than 12 years.

J. Takala is a Professor and Director (Dean) of International MSc and PhD Programme on Industrial Management and Management of Technology at University of Vaasa, Finland. His PhD in Dr Tech (El. Eng.) from Tampere University of

Technology, Finland. His majoring research is in TQM and technology management. He authored about 500 articles and working reports related to industrial engineering and management.