

## **Critical Success Factors for Six Sigma Deployment in Manufacturing Companies in Malaysia**

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### **Abstract**

*Since it was invented in Motorola in mid 1980s, many companies have adopted Six Sigma methodology as a means of quality and productivity improvement activities. However, not every company which deployed Six Sigma achieved desirable results. In this study, a survey was carried out at Malaysian companies which deploy Six Sigma to find out what are the critical success factors to Six Sigma implementation, and how the factors being practiced in the companies. A total of 42 survey questionnaires were sent out either by hand or email to Malaysian companies which are practicing Six Sigma. Thirty questionnaires was completed and returned. Survey results showed there are 12 critical success factors that deemed to be important for the success of Six Sigma deployment program in Malaysian manufacturing companies. They are: Management involvement and commitment, Deployment infrastructure, Training program, Linking Six Sigma to business strategy, Linking Six Sigma to human resources, Dedicated resources, Involving finance in Six Sigma, Reward and recognition program, Cultural change to data driven and learning organization, Linking Six Sigma to customer, Project selection and goal setting, and Linking Six Sigma to suppliers. However, only three out of the 12 critical success factors were found to be not significantly different in their Perception of Importance level and Actual Practice level. They are: Dedicate Resources, Deployment Infrastructure and Involving Finance in Six Sigma. Survey results also revealed that companies which deployed Six Sigma have shown significant improvement in key performance areas such as: Transformation of the company culture, Improvement on customer satisfaction level, Improvement on financial performance, Improvement on operational performance, Improvement on overall performance.*

**Keywords :** *Six Sigma, Critical Success Factors, Perception of Importance level, Actual Practice level*

### **1. Introduction**

Since its inception in mid 1980s, Six Sigma has taken the world industrial sector by storm. Six Sigma is known as a framework for quality and process improvement. However, Six Sigma is different from other quality and process improvement methodologies because it is regarded as a 'metric' that measure an organization's performance, a 'methodology' in driving rapid and sustainable improvement using Define, Measure, Analyze, Improve and Control (DMAIC) approaches, and a 'management system' for executing business strategy.

Many companies are keen to deploy Six Sigma initiative, but are unsure on how to proceed. Most of them have doubt on Six Sigma understanding, company readiness, financial commitment, resources involved and employee's acceptance, are preventing potential companies in taking a step further to embrace Six Sigma initiative [1]. There are also companies, which already deployed Six Sigma initiative, but they found lower than expected return on investment (ROI). Some companies even have to call-off their Six Sigma program after they encountered total failure or below expectation results in their Six Sigma implementation. This study

intends to identify the critical success factors in Six Sigma deployment in order to maximize the benefits and minimize the chance of failure when implementing Six Sigma initiative.

## 2. Literature Review

Harry and Schroeder [2] defined Six Sigma as “a business process that allows companies to drastically improve their bottom line results by designing and monitoring everyday business activities in ways that minimize waste and resources while increasing customer satisfaction.” Unlike other quality improvement program that focused on detecting and correcting defects, Six Sigma emphasized on providing specific methods to redefine the process to prevent defects and errors from occurring [2]. Pande et al. [3] summarized the definition of Six Sigma as ‘a comprehensive and flexible system for achieving, sustaining and optimizing business success.’ Even though it has been published that some Six Sigma companies have successfully reaping in million dollars of savings and substantial improvement in bottom line performance through Six Sigma initiatives, however not all companies can claim to enjoy the same returns from Six Sigma initiative. A survey by ISixSigma Magazine [4] reveals only fewer than 10% of the companies that deploy Six Sigma claimed to gain significant returns. Therefore, to implement it one must understand the critical success factors which, determines the success of Six Sigma deployment in a company. In the context of Six Sigma implementation, critical success factors represent the essential ingredients without which a program stand little chance of success [5]. Critical success factors can serve as very useful reference, both to companies that are considering Six Sigma deployment, and those that had deployed Six Sigma initiative but losing the initial momentum. Understanding what Critical Success Factors will definitely help in developing an appropriate deployment plan [2,3,6]. There are 12 critical success factors that frequently mentioned in the literature. These critical success factors are briefly described as follows:

### 2.1 Management Involvement and Commitment

Almost all Six Sigma experts agreed that top management’s involvement and commitment is crucial to the success of Six Sigma implementation [2,3,5,6,7]. A research carried out by ISixSigma Magazine [4] to identify the elements which

contribute to Six Sigma success revealed that "tangible commitment from organization’s executives" was the most important criterion for a successful Six Sigma program. Byrne [8] pointed out that ‘one of the main reasons Six Sigma initiative failed is the organizations that do not provide strong and visionary leadership commitment’. For Pande et al. [3], without top management commitment and support, the true importance of the initiative will be in doubt and weaken the energy that driving it. Management must also be willing to invest in time and resources to make it happen. Top leaders must be held responsible and accountable for the success of Six Sigma program. For Hariharan [9], the indication of top management seriousness is realignment of the performance appraisal system.

### 2.2 Dedicated Resources

The most important resource in Six Sigma implementation is human resources. In order to make Six Sigma work; management must provide dedicated full time personnel to lead projects and mentor others who are working to make process improvements [2,6,7]. Six Sigma initiatives will be short-lived if an employee is expected to do an operational job and act as a Black Belt at the same time [10]. Employees with such a dual assignment will normally focus on day-to-day activities rather than process improvement projects. Other than full time Black Belts on projects, other resources such as proper office space, computers and necessary statistical software also are required for smooth project execution and tracking of progress.

### 2.3 Deployment Infrastructure

In order to sustain Six Sigma program successfully in the long run, a robust deployment infrastructure that takes care of administration, training, project selection and execution is essential to support Six Sigma initiative [11]. Key personnel of the infrastructure include a Champion who oversees the Six Sigma implementation plan. Black Belts (BB) are trained in statistical tools in DMAIC approach, and work fulltime on Six Sigma breakthrough projects. Black Belts also mentor Green Belts on their projects. Green Belts (GB) are trained by Black Belts and work part time on projects. Depending on the size of the infrastructure; Master Black Belts (MBB) is recruited to support Black Belts on statistical and technical matter. MBBs work with the owners of the process to ensure that quality objectives and targets

are set, plans are determined, progress is tracked, and education is provided [11]. The deployment infrastructure also functioned as a communication channel to cultivate Six Sigma awareness among employees. According to Pande et al. [3], communication is important to the success of Six Sigma initiative in two aspects: to communicate the vision and strategy, and the success story of Six Sigma projects during the implementation stage.

#### **2.4 Cultural Change to Data Driven and Learning Organization**

To achieve breakthrough improvement through Six Sigma, a company needs to cultivate a culture of continuous renewal in order to transform the company into a 'Six Sigma Organization' [3]. Six Sigma stressed on the collection and analysis of data and the use of numerous statistical tools for correcting defect. For Six Sigma to be implemented successfully, people need to adopt a 'data driven' approach to in their daily job [2]. Companies wanting to improve their processes cannot depend on past experience, observation, or general consensus. Six sigma methodologies require companies to look for answer within data. To promote the culture change from experience-based decision-making culture to fact-based decision-making culture, the best way is through increased and sustained communication, motivation and education [12]. With lesson learned from doing Six Sigma projects, organizations are able to create new knowledge, thus generate more innovative solutions [13].

#### **2.5 Training Program**

A systematic training program for Green Belts (GB), Black Belts (BB), Master Black Belt (MBB) and Champion levels is essential for the success of Six Sigma as the methodologies comprise of statistical methods, analytical techniques and various measurement tools [2,5,7,14]. Training is also one of the most important factors that contribute to modify and shape a Six Sigma culture [11]. To be effective, Six Sigma training should emphasize on 'hands-on' learning and provided with relevant practical examples. At the same time, training curriculum should be customized for a variety of businesses, while building core knowledge on Six Sigma [3]. To sustain Six Sigma activity for long term, training should be made as an ongoing effort. Six Sigma Awareness and Champion Training can be used as a

way to gain buy-in from middle management level [13]. According to Harry and Schroeder [2]; to maximize the gain of the training, competent Six Sigma consulting firm must be engaged. Ideally, a competent Six Sigma consulting firm should be highly experienced at conducting a corporate wide Six Sigma deployment and training to Black Belts, and also should have in-depth understanding about Six Sigma philosophy [2]. However, due to flourishing of Six Sigma initiative, many Six Sigma consulting firms spawned in the market offering consultation services on Six Sigma deployment and training, which might lead to huge variation in the quality of service of those Six Sigma consultants, thus resulting in the diminishing effect on Six Sigma [15].

#### **2.6 Linking Six Sigma to Supplier**

To sustain Six Sigma performance, it is important to select suppliers which have Six Sigma capability. One of the main reason companies involve its suppliers in their Six Sigma initiatives is due to the fact that supplier as an input that influenced the organization's quality performance level [16]. It is important to consider when and how to involve their suppliers in Six Sigma. Companies that haven't applied Breakthrough Strategy to their own processes, products and services can't expect suppliers to improve theirs without being given more accurate data and information. This will result in clearer supplier requirement. However, since Six Sigma required considerable effort and resources, companies must involve the key suppliers whereby their products or services are critical [2].

#### **2.7 Linking Six Sigma to Business Strategy**

A study by Anthony [17] had shown that linking of Six Sigma to business strategy is the most critical success factor. This is aligned with the definition of Six Sigma as a 'breakthrough improvement business strategy'. According to Harry and Schroeder [2], Six Sigma projects should be tied to the overall strategic goals and direction of the organization and involving the plant leadership. It should focus on process and product improvements that have a direct impact on both financial and operational goals. The link between Six Sigma project and business strategy should be identified, and the benefits it bring in achieving business strategy should be reflected in financial performance of the company. With clearly

defined business strategy, Six Sigma projects can be generated with the focus on improvement of the key strategic or operational weaknesses or opportunities [3].

### **2.8 Linking Six Sigma to Customer**

Customer satisfaction is one of the most important Key Performance Index (KPI) in any company. The heart of Six Sigma lies in improving products and services that will benefit the customer [2]. In fact, ISixSigma Magazine [4] survey showed that 39% of respondents who said the initial motivation that led their organization to deploy Six Sigma was to improve the quality of existing products/services. Improve customer satisfaction by capturing the 'voice of customer' (VOC) and closing the gap between customer expectation and actual performance became the main core of Six Sigma projects [3]. Core elements of Six Sigma methodologies which emphasize on root causes identification through statistical analysis and sustainable solutions are very much handy for customer satisfaction improvement projects [3].

### **2.9 Project Selection and Goal Setting**

As Six Sigma is project driven approach, it is essential to prioritize projects that provide optimum impact to bottom line and business benefits to the company [2]. Many feel that it is the most challenging aspect of their early stage of Six Sigma deployment [4]. Well-selected and defined improvement projects yield better and faster results [3]. Pande et al. [3] suggested the project selected should be 'meaningful' and have significant impact to the bottom line of the company. In addition, it needs to be manageable and the project scope should be within the capability of the company. According to Harry and Schroeder [2], breakthrough projects should be selected based on the potential dollar amount they can return to the company, the amount and types of resources they will require, and the length of time it will take to complete the project.

### **2.10 Linking Six Sigma to Human Resource**

Right people are the driving force behind a successful Six Sigma program in a company. One of the most challenging and critical aspects of Six Sigma deployment is selecting the competent candidates within the company to be full-time Black Belts. Harry and Schroeder [2] believed as project

leader, Black Belts should possess hard (analytical/statistical) and soft (leadership/people) skills. Harry and Schroeder's view is in line with the outcome of a survey conducted by Oriel Incorporated [18], which show that the top three qualities for Black Belt candidates in order of importance are leadership skills, teamwork (good with people), besides technical and analytical skills. Typically, in selection process of Black Belts, a company should start by looking for persons with a well-balanced set of leadership, analytical and ability to lead a project [17]. He or she should possess sound project management skills so that the project can be completed within the time frame and budget, and achieving the targeted results. Typically, a Black Belt is required to complete one project per quarter [2]. Survey conducted by Oriel Inc. [18] on Black Belt recruitment and retention reveal that 75% of the Black Belts were internal candidates. Internal candidate identification skills processes include high potential and leadership processes, job postings, internal referrals and self-nominations. Either internal or external recruitment, most importantly Black Belts or Green Belts candidates should demonstrate strong determination to overcome barriers, and willingness to learn and apply new tools, especially statistical tools [1].

### **2.11 Reward and Recognition Program**

High turnover of competent Black Belts and Green Belts is becoming roadblock in the deployment of Six Sigma activities. Reward and recognition program for trained Six Sigma personnel are very important component of the process in sustaining the momentum of Six Sigma activities [2]. Companies that do not have a compensation program in place, will not only facing the risk of losing them, but also will not be able to see Six Sigma reaching its full potential [19]. Findings from a survey by a popular Six Sigma website ISixSigma Magazine [4] show a strong relationship (61%) between successful Six Sigma program in a company and tying compensation to Six Sigma results.

### **2.12 Involving Finance in Six Sigma**

It is important that Six Sigma projects had to be reviewed by finance on the calculation of potential saving during define phase of the project and tracking of the actual saved amount after project completion [6]. Without third party or Finance verification, the integrity of the saving amount will

be questionable [20]. Harry and Schroeder [2] stressed on financial evaluation as part of a business decision on project prioritization. Through financial verification, only bottleneck projects that have significant impact to bottom line results be carried out. This will focus the Six Sigma resources to the right area to maximize the return.

### 3. Research Methodology

To gather information on the subject of study, a survey was carried out. The main survey objective is to identify critical success factors in a successful Six Sigma deployment program. Target population of the study consists of Six Sigma practitioners such as Black Belts, Master Black Belts, Deployment Champions, and managerial staff who are familiar with Six Sigma activities in the company. In this survey, the questionnaire consists of three sections; an Introduction which explain the purpose of the survey, Part A which focus on the survey of Critical Success Factors in Six Sigma program, and Part B

which is about the survey on the improvement areas due to Six Sigma program. Questions in Part A are about Critical Success Factors. A total of 12 Critical Success Factors are short-listed from literature review and shown in Table 1. Respondents are required to rank these critical success factors according to the level of importance based on their individual perception in the ‘Importance’ column, and the level of how the factor being practiced in the company in the ‘Actual Practiced’ column follow Likert scale ranking as shown in Table 2. Part B is regarding evaluation on the impact of critical success factors with respect to the results of the Six Sigma deployment in the company. Respondents are requested to evaluate how successful their company had performed in terms of cultural change, financial performance, operational performance, improvement in customer satisfaction, bringing in new business and overall performance. The Likert scale ranking according to the degrees of agreement are shown in Table 2.

**Table 1:** Twelve critical success factors

Critical Success Factors			
F1	Management involvement and commitment	F7	Linking Six Sigma to business strategy
F2	Dedicated resources	F8	Linking Six Sigma to customer
F3	Deployment Infrastructure	F9	Project selection and goal setting
F4	Cultural Change to data driven and learning org.	F10	Linking Six Sigma to Human Resources
F5	Training Program	F11	Reward and Recognition
F6	Linking Six Sigma to suppliers	F12	Involving Finance in Six Sigma

**Table 2:** Likert scale ranking used in the questionnaire

Survey question		Likert scale ranking
Part A	Importance level	1 = Not relevant; 2 = Not important; 3 = Neutral; 4 = Important; 5 = Very Important.
	Actual Practice	1 = Not practiced; 2 = Low; 3 = Moderate; 4 = High; 5 = Very high.
Part B	Critical success factor impact	1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree.

Sample of questionnaire was pre-tested among fellow colleagues who are qualified Black Belts to determine if there are any perceived bias, inconsistency, ambiguity in the questionnaire. In this analysis, a hypothesis test statement was developed as shown below:

**“Is the survey response median value of Perception of Importance level and Actual Practice level for each CSF are significantly different?”**

Two possible outcomes of hypothesis test are written as below:

Null hypothesis;

$H_0: \eta_1 \neq \eta_2$ , and

Alternative hypothesis;

$H_a: \eta_1 = \eta_2$ , where  $\eta$  is the survey response median.

Since the survey data are ordinal discrete data, in most cases its distribution does not follow Normal

Distribution curve. To analyze ordinal discrete data that does not fall under a normal distribution curve, Non-parametric statistical tools such as one Sample. Sign test, Mann- Whitney test and Kruskal Wallis test are used. Using appropriate tools available in Minitab software, p-value can be determined and decision can be made whether to accept or reject Null hypothesis

**4. Results and Discussion**

Survey questionnaires were distributed via email to Six Sigma companies through business contacts and colleagues. Some of the questionnaires were hand over to targeted respondents and were answered on the spot. A total of 42 questionnaires were distributed either via email or by hand to Six Sigma practitioners such as Black Belts, Master Black Belts, Deployment Champions and managerial staffs who are familiar with Six Sigma activities in the company. From the

42 questionnaires distributed, 30 or 71.4% responded within three weeks after the start of distribution of questionnaires. Out of 42 questionnaires, 29 are distributed via email, while 13 questionnaires are delivered by hand. The respond rates for both methods are 72.4% and 84.6% respectively. No reasons were given by those not responding to the questionnaires distributed via email. Compared to responses received via email, the questionnaires distributed by hand directly to the respondent gets higher respond rate. Only two out of 13 questionnaires distributed by hand did not respond. Reason given by both was ‘incompetent to answer the questions on behalf of the company’. Therefore, only 17 out of 30 (or 57%) responded questionnaires gave complete answer. The summary of company background survey is compiled in Table 3.

**Table 3:** Summary of company background

Company background	Category	n	%
Type of company	Local	1	5.9
	Multinational (MNC)	15	88.2
	Government-link (GLC)	1	5.9
Country of origin of Six Sigma MNC	America	9	53.3
	Germany	2	13.3
	France	1	6.7
	Japan	3	17.6
	South Korea	2	13.3
Size of employment	<150	0	0.0
	150 – 1000	2	11.8
	1001 – 3000	7	41.2
	> 3000	8	47.1
Annual sales revenue (in mil. RM)	< 25	0	0.0
	25 – 500	1	5.9
	501-1000	6	35.3
Nature of business	>1000	10	58.8
	Manufacturing	15	88.2
	Service	1	5.9
	R&D	1	5.9
Quality certification/s obtained	Others	0	0.0
	QS 9000	17	100.0
	ISO 14000	15	88.2
	TS 16949	3	17.6
	Others	2	11.8
Year of experience in Six Sigma deployment	Less than 1 year	0	0.0
	1 to 3 years	7	41.2
	4 to 6 years	7	41.2
	More than 6 years	3	17.6

From Table 3, the survey results show that 88.2% of companies that deploy Six Sigma are multinational companies. Of the 88.2%, majority (73.3%) is from Western countries especially United States of America (53.3%), Germany (13.3%) and France (6.7%), and another 26.7% are from Eastern countries such as Japan and South Korea. The results also revealed none of the Six Sigma companies employed less than 150 employees, nor has annual sales revenue below 25 million Ringgit Malaysia. This indicates that they do not belong to Small & Medium Industries (SMI) category [21]. Among them, 41.2% employed from 1000 to 3000 workers, while another 47.1% employed more than 3000 workers. About 94.1% of the Six Sigma companies generate sales revenue more than RM500 millions annually. Majority of the companies (58.8%) have sales revenue exceed one billion RM per year. On nature of company business, most of the companies (88.2%) are in manufacturing business. Non manufacturing companies only consist of 11.8% of all Six Sigma companies. All Six Sigma companies that responded have obtained at least one quality certification. Majority of them have QS 9000 and ISO 14000 certification. On the number of years experience in Six Sigma deployment, 82.4% of the companies deploy Six Sigma in the last 1 to 6 year, while the other 17.6% deployed more than 6 years ago. None of companies deployed Six Sigma in last 12 months.

#### 4.1 Importance Level of Each Critical Success Factors (CSF)

In order to determine whether the Perception of Importance level median value of each CSF is greater than target value of 3.0, the authors had selected 'one Sample Sign test' in Minitab software for calculating their p-value. One Sample Sign test is used when the author want to find out whether the median value of discrete sample group is equal to a target value. For the 1-Sample Sign test, the hypotheses are

$H_0$ : median = hypothesized median

$H_a$ : median > hypothesized median

In this study, it is decided that hypothesized median = 3.0.

In Figure 1, using 1 Sample Sign test, the Minitab output shows that p-value = 0.00 for all the CSF. Since p-value is < 0.05, this leads to rejection of Null hypothesis, which concluded that the median value of each CSF is significantly greater than 3.0. Practically, it means that all the CSFs are either 'important' or 'very important' to the success of Six Sigma program in the company. Table 4 shows the comparison of the survey findings with other findings by Anthony and Coronado [5] and Brun [22]. The findings by Anthony and Coronado [5] were based on importance level perception of Six Sigma judgement on UK's SMEs, whereas the results of Brun [22] was based on the study of Six Sigma in Italian SMEs. All findings agreed that "Management Involvement and Commitment" without doubt is the most critical factors in Six Sigma. However, F6 (Linking Six Sigma to Supplier) which was ranked the lowest in the survey, has scored higher in the other surveys findings. Both Brun [22], and Anthony and Coronado [5] ranked it as second critical factors.

#### 4.2 Actual Practice Level of Each Critical Success Factors

On the p-value calculated, six CSFs (F1, F4, F6, F8, F9 and F11) have their p-value more than 0.05. This suggests that there are insufficient evidences to proof that their median values are significantly greater than 3.0. In practical, it means only six CSFs (F3, F7, F10, F2, F12, F5) are highly practiced by Six Sigma companies. All CSFs are ranked according to the median value of their Actual Practice level score as shown in Figure 2. The most critical factors in Six Sigma implementation are F1 (Management involvement and commitment), F2 (Dedicated resources), F3 (Deployment infrastructure), F5 (Training program), F7 (Linking Six Sigma to business strategy) and F10 (Linking Six Sigma to human resources).

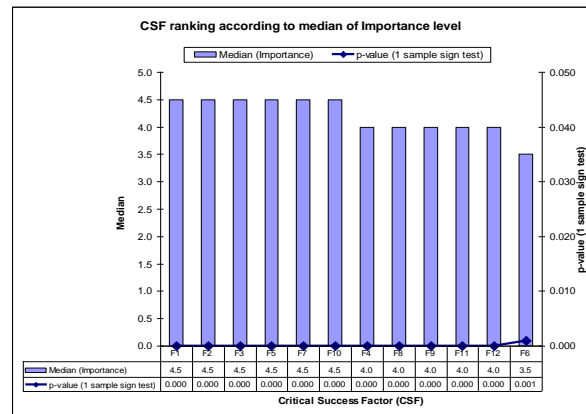
**Table 4:** Comparison of CSF survey findings

Critical success factors			Anthony & Coronado	Brun
F1	Management involvement and commitment	4.5	4.3	4.5
F2	Dedicated resources	4.5	3.6	4.0
F3	Deployment Infrastructure	4.5	N.A.	3.8
F4	Cultural Change to data driven and learning org.	4.0	3.9	3.4
F5	Training Program	4.5	3.4	3.6
F6	Linking Six Sigma to suppliers	3.5	4.2	4.0
F7	Linking Six Sigma to business strategy	4.5	4.1	3.8
F8	Linking Six Sigma to customer	4.0	3.1	3.4
F9	Project selection and goal setting	4.0	3.5	3.3
F10	Linking Six Sigma to Human Resources	4.5	4.2	3.7
F11	Reward and Recognition	4.0	3.6	3.7
F12	Involving Finance in Six Sigma	4.0	3.9	3.7

**4.3 Comparison between Perception of Importance Level and Actual Practice level of Each CSFs**

For comparison, the median score of perception of Importance level and Actual Practice level of each CSF are shown in Figure 3. P-value was calculated using Mann-Whitney test for each CSFs to find out whether significant difference exists between Medians of perception of Importance level and Actual Practice level of the same CSF. Mann-Whitney test is used when the data are independent random samples from two populations that have the same shape and whose variances are equal and a scale that is discrete ordinal (Minitab 2003). Result reveals that there are nine CSFs having p-value less than 0.05; F1 (Management involvement and commitment), F4 (Cultural Change to data driven and learning org.), F5 (Training Program), F6 (Linking Six Sigma to suppliers), F7 (Linking Six Sigma to business strategy), F8 (Linking Six Sigma to customer), F9 (Project selection and goal setting), F10 (Linking Six Sigma to Human Resources), and F11 (Reward and Recognition), which show there are significant differences in median value of perception of Importance level and Actual Practice level. Three CSFs with p-value > 0.05 are; F2 (Dedicated resources), F3 (Deployment Infrastructure) and F12 (Involving Finance in Six Sigma), which indicate there are no significant differences in median value between perception of Importance level and Actual

Practice level. This results support the finding by Kumar and Anthony [23]. According to them, even though the company has Six Sigma initiatives in place, there is still a huge gap in the level of importance and practice of CSFs, which may result in the poor organisational performance of the company.



**Figure 1:** Significant CSF ranking according to median of Perception of Importance level



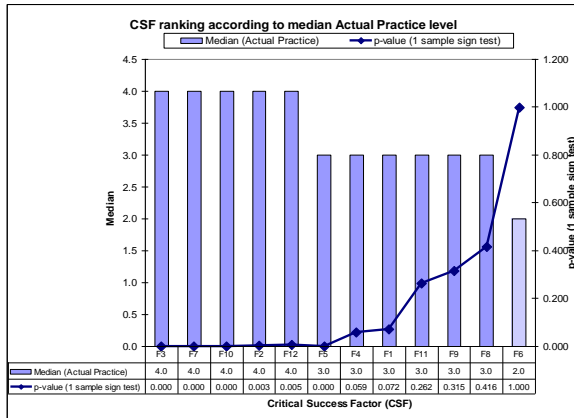


Figure 2: Significant CSF ranking according to median value of Actual Practice level

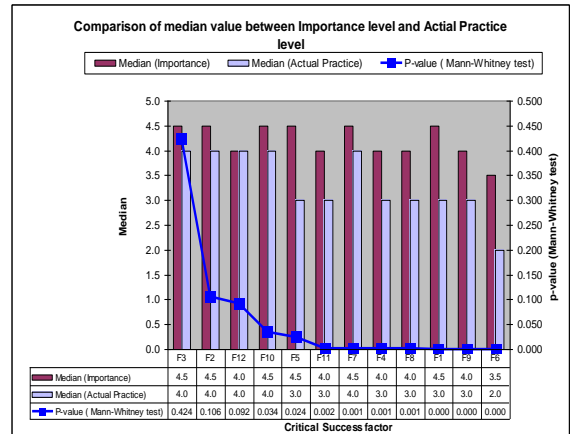


Figure 3: Comparison between median value of Perception of Importance and Actual Practice level

4.4 Improvement in Company Performance as a Result of Six Sigma Deployment

Table 5 is a statistical summary derived from the 1 Sample Sign test results. P-value is calculated using 1 Sample Sign test method, with test median set at 3.0. Using this method, p-value < 0.05 means the median value of the key performance area is significantly greater than 3.0. Practically it means significant improvement has taken place in these key performance areas. The results show that p-value for each performance area is below 0.05 except the area of ‘Bring-in new businesses. Practically, p-value < 0.05 means significant improvement on the key performance areas such as transform the company culture, improve customer satisfaction level, improve financial performance, improve operational performance and improve overall performance, as a result of Six Sigma program implementation. However for area of ‘Bring in new businesses’, which p-value = 0.1, it means there are insufficient evidence to proof that significant improvement has taken place.

Table 5: Performance improvement as a consequence to Six Sigma program

Performance improvement	Median	p-value
Transform the culture of the company	4.00	0.000
Improve customer satisfaction level	3.50	0.002
Improve financial performance	4.00	0.000
Improve operational performance	4.00	0.000
Bring in new business	3.50	0.099
Improve overall performance	4.00	0.000

5. Conclusions

The main objective in this study is to find out the critical success factors that determine the success of Six Sigma initiative in manufacturing and service companies that practice Six Sigma in Malaysia. At the same time, this study also tries to find out the actual level these critical success factors actually being practiced in Six Sigma companies. Out of the 12 critical success factors that are deemed important, only six were found being practiced significantly by companies that practice Six Sigma. They 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. However, only three critical success factors are actually practiced at a level that matches with their perception of importance level. They are Deployment Infrastructure, Dedicated resources, and Involving Finance in Six Sigma. The other nine critical success

factors show lower actual practice level compared to their perception of importance level, indicating stronger effort by the companies is required. They are Management Involvement and Commitment, Linking Six Sigma to Supplier, Project Selection and Goal Setting, Linking Six Sigma to customer, Reward and Recognition, Cultural Change to data driven and learning organization, Linking Six Sigma to business strategy, Training Program, and Linking Six Sigma to Human Resources. Successful Six Sigma initiatives brought improvement in five key performance areas such as: Transformation of the company culture, Improvement on customer satisfaction level, Improvement on financial performance, Improvement on operational performance, and Improvement on overall performance. Further research will concentrate on longitudinal study on Six Sigma implementation of manufacturing firms. The study could uncover the actual practices of the manufacturing firms in terms of the process how they implement and adopt the Six Sigma at their respective companies. In addition, further studies in these companies will provide greater insight into the Six Sigma implementation process. Several limitations exist in this study. The most obvious is the unavailability of database in the population of Six Sigma companies in Malaysia. Information on companies that practices Six Sigma was gathered through peers, business contacts and sources on internet. Limited information resulted in disproportion of survey company distribution. As in this survey, 87% of the respondent companies are from manufacturing sectors. The authors are unable to ascertain whether this ratio reflected the actual distribution of companies that practiced Six Sigma according to their business nature. As a result, the authors cannot confidently claim that the survey results truly reflect overall situation of all companies that practice Six Sigma in Malaysia. The survey is more relevant to manufacturing companies because large majority of the respondents are from manufacturing sectors. This finding has implication for the companies as it provide a mean to help them to identify the critical factors in the implementation of Six Sigma in Malaysian context. The management should understand and emphasis the importance to overcome the problems and resistance for the successful deployment of Six Sigma in their companies.

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