June 22, 2011 (Wednesday) 55th EOQ Congress

CONCURRENT SESSIONS **Wednesday 8:30 – 12:30**
KEMPINSKI HOTEL CORVINUS **Erzsébet tér 7-8, Budapest V.**

REGINA BALLROOM I. **Wednesday 11:00 – 12:30**

18.1. SIX SIGMA AND LEAN MANAGEMENT

Session Chair: ***Charles Aubrey****, Anderson Pharmaceutical Packaging an AmeriSource Bergen Company, USA*

12.00 Key Success Factors for Six Sigma Implementation – Green Belt Perspectives
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KEY SUCCESS FACTORS FOR SIX SIGMA IMPLEMENTATION – GREEN BELT PERSPECTIVES

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ABSTRACT

Six Sigma methodology is a well-known management tool to improve process variation and quality of outputs by using statistical methods. Although it has become a widespread application in many sectors of industry, it is not without controversy. Many initiatives fail during deployment with varied causes, such as; lack of commitment from project leaders, misalignment of the project to business goals, teamwork and commitment and so on and so forth. The most frequent questions being asked by potential Six Sigma followers are "What makes Six Sigma work?", "What are the factors contributing to its successes?", and "What makes a successful Six Sigma program?". Finding the critical success factors is an important part of six sigma project implementation. For this study, an electronic manufacturing company was chosen as a case study on the Key Success Factors for Six Sigma project implementation from Green Belts perspectives. A possible Key Success Factors selected from literatures are used as initial input to the questionnaires design. The questionnaires are sent to 133 Green Belts in the company and the results were analyzed using Logistic Regression Analysis. The result has confirmed 5 Key Success Factors that perceived to have the most effect on the completion of Six Sigma projects as follows; 1) Project prioritization and selection, 2) The use of data analysis with data that is easily obtainable, 3) Top Management involvement and commitment, 4) Training, and 5) Organization infrastructure.

Key words: Six Sigma, Key Success Factors, Greenbelts Implementation.

1. INTRODUCTION

Six Sigma is a management approach aimed at achieving significant improvements in business performance and popularized by the success stories of Motorola, GE, and Allied Signals and many global organizations. Motorola, where Six Sigma was developed in the 1980s, claims to have made amazing results. From 1987 to 1997, Motorola achieved a fivefold growth in sales with profits climbing nearly 20 percent per year, cumulative savings at $US14 billion and stock price gains compounded to an annual rate of 21.3 percent. Motorola was also cited as the first winner of America's Malcolm Baldrige National Quality Award in 1988(Klefsjo 2001). Similarly, GE and Allied Signals achieved savings of US$2 illion and US$1 billion in five and three years, respectively. Looking at the exemplary achievements of these companies, many other leading organizations have embarked upon the implementation of Six Sigma. However, not all companies can claim to have had the same benefits. A study by Deloitte indicates that fewer than 10 per cent of the companies are implementing Six Sigma to the point where it is significantly affecting the balance sheet and the share price in any meaningful period of time.

With such mix results, there had been many investigations into the critical success factors which contribute to the successful implementation of the Six Sigma program. Most of these research studies are based on the opinion of qualified Black Belts and top management. Very few had been conducted from the view point of the Green Belt team who carried out the projects.

This study is an in-depth analysis of the critical success factors involving the implementation of a manufacturing company. An electronic manufacturing company in Thailand was selected as a case study to investigate the factors which influence the implementation of Six-Sigma project in a manufacturing environment.

2. BACKGROUND AND SIGNIFICANT OF THE PROBLEM

Founded in October 1999, the Company specializes in the engineering and manufacture of complex optical, mechanical, and electronic components, modules, and subassemblies for a wide range of industries including communications, automotive & aeronautics, consumer electronics, and industrial sensing. The Company began to introduce Six Sigma as a strategic management tool for process improvement in 2001. The "Belt" system was established early as part of Six Sigma structure in the company. At the early stage, the results were amazingly good in pilot run projects with Black Belt team. However the Six Sigma initiative could not maintain the momentum over the following years and number of Six Sigma projects remained staggering for many successive years. Up to 2006, number of Six Sigma projects was around 6 and 8 per year only. In 2007, the Company's management decided to include Six Sigma Activity as a part of corporate goals, that's when the number of Six Sigma projects was ramped up to 40 and 81 projects respectively.

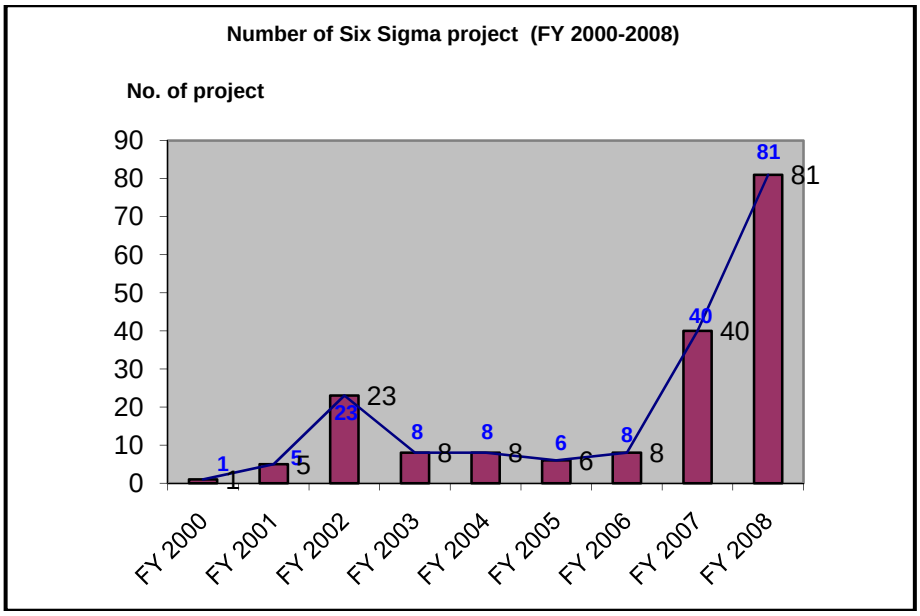

Figure 1-1: Number of Six Sigma Projects during FY 2000 – 2008.

Conceptually, it is important to sustain the growth in this phase as long as possible either via strategic goals or incentive system. However not knowing what contributes to the successful implementation of the projects can cause an abrupt failure in this growth phase and curtail the gain from the projects.

Critical Success Factors have been used significantly to present or identify a few key factors that organizations should focus on to be successful. Identifying Critical Success

Factors allows firms to target their efforts on building their capabilities, or decide if they have the capability to build the requirements necessary to meet Critical Success Factors.

However only a few Black Belts exist in the Company and most of the projects in Six Sigma have been concentrated at the level of Green Belts. All Green Belts are trained in the methodology of Six Sigma, those who can complete successfully at least one project will be called "Certified Green Belts". The company had trained around 190 Green Belts, with mere 102 Certified Green Belts. Could the perspective of Green Belts to Six Sigma implementation be totally different to those of Black Belts? To what extent, are individual characteristics such as learning style and employment years impact the project implementation of Green Belts? Answers to these questions can lead to the successful implementation of Six Sigma in the Company.

3. SURVEY METHODOLOGY

Using a selected number of empirical studies on Key Success Factors for Six Sigma Implementation sighted from various journals as a starting point, a list of common key success factors was drafted. These were reviewed and discussed with Black Belt leader team in the organization and sorted out accordingly. Finally Key Success Factors were categorized into 9 groups as the most appropriate (see Table 1).

Table 1: Common Key Success Factors.

No.	Key Success Factors	Sujar Y., Balachandran P. and Ramasamy N. (2008)	Anbari and Kwak. (2004)	Antony (2004)	Chakrabarty and Tan (2007)	Antony and Banuelas (2002)	Ying-Chin Ho, et, al (2008)
1	Top Management involvement and commitment	X	X	X	X	X	X
2	Linking Six Sigma to business strategy			X		X	X
3	Linking Six Sigma to customer	X	X		X	X	
4	Organization infrastructure	X		X		X	
5	Training	X	X	X	X	X	X
6	Communication	X	X		X	X	X
7	Project prioritization and selection	X	X	X		X	
8	Incentive/ reward system			X			X
9	The use of data analysis with data that is easily obtainable						X

Further investigation also reveals that within each of these Critical Success Factors, there are sub-factors to further define the actions, responsibilities and behaviours that demonstrate to assure success and get significant results. For simplification, the list of sub-

factors in each factor is limited to 5 (Table 2). A questionnaire was drafted for information gathering.

Table 2: Questions in questionnaire

Variable	Key Success Factors
X1	**1. Top Management involvement and commitment**
K1	1. Conducting and attending regular reviews to assure and verify progress
K2	2. Top Management expresses a clear vision and aim of six sigma
K3	3. Top Management participates in special Six Sigma activity to make quality awareness.
K4	4. Top Management was present at the start of training to address the class participants.
K5	5. Top Management was active listeners in the review and asks questions.
X2	**2. Linking Six Sigma to business strategy**
K6	1. There is a clear linkage of Six Sigma to corporate /business strategy
K7	2. Linkage of department's Six Sigma quality objective to corporate/business goal
K8	3. There is regularly review of Six Sigma Quality Objective in your department
K9	4. Your project directly impacts on both financial and operation goal
K10	5. Benefit of Six sigma project was presented and calculated in the term of financial benefit
X3	**3. Linking Six Sigma to customer**
K11	1. Define the project scope and goal based on customer feedback and their needs.
K12	2. Your department's key processes directly impact customers' needs and satisfaction.
K13	3. Key customers' focus processes are clear to you.
K14	4. Customer requirements are identified at the beginning of Six Sigma program
K15	5. Communicate the result of Six Sigma project to customer
X4	**4. Organization infrastructure**
K16	1. Black belts display ability in advisory and assist your project completed.
K17	2. Organization provides adequate training and budget for supporting Six Sigma project
K18	3. Organization provides adequate numbers of black belt team for supporting Six Sigma project
K19	4. Cooperation among peers in the project life
K20	5. Manager adjusts workload to ensure that Green belt have sufficient time to complete Six Sigma project
X5	**5. Training**
K21	1. Formal training is part of development plan of various belt level experts
K22	2. Understanding of Black Belt Instructor's explanation during the training class
K23	3. There is a continuous training of talents
K24	4. You (Green belt) have good understanding on statistical tools and techniques trained
K25	5. Training material help you find solution you want.
X6	**6. Communication**
K26	1. There is a clear communication on Creation plan to support Six Sigma roles.
K27	2. Regular communications on Six Sigma news and successes encourage you to your project progress
K28	3. The good methodology of Six Sigma project was public in an organization.
K29	4. Financial benefit from Six Sigma project was public in an organization
K30	5. Communicating pertinent facts about Six Sigma in every company meeting
X7	**7. Project prioritization and selection**
K31	1. Assistance on selection of project is available
K32	2. Scope of project is challenging and feasible
K33	3. Project duration complies to time and resources available
K34	4. What achievement level of your first project
K35	5. Management identifies potential improvement areas and establishes a process to generate, capture, and prioritize project ideas.
X8	**8. Incentive/reward system**
K36	1. Rewards structure and system is clearly linking to project outcome.
K37	2. Attractive tangible rewards is a success factor in six sigma projects
K38	3. Project completion itself is a self-rewarding to Green Belt
K39	4. The reward leads you to make more effort to do Green belt project intently.
K40	5. Company's clear announcement to put extra score in performance review/ annual raise for completion of Green Belt Project
X9	**9. The use of data analysis with data that is easily obtainable**
K41	1. The data needed for the analysis of Green Belt project are easy to obtain
K42	2. Most of data you want is available to begin Six Sigma project
K43	3. When data is needed but not available, you can ask the IT department or members of the Green Belt project for assistance
K44	4. Available data is current and up-to-date
K45	5. Systematical information storage and processing

The questionnaire is divided into 2 main parts.

Part1. Personal information. This section aims at finding out the extent to which individual characteristics have on the success of Six Sigma project implementation at Green Belt level. However after reviewing with experts and seniors in the organization, in order to avoid sensitive questions and discrimination, this part is reduced to only 4 necessary questions;

- Years of employment at the company
- Number of Six Sigma projects completed
- Certified in Green Belt
- Experience with the first project

Part2. Perceived level of Key Success Factors. This part is designed from the major aspects of key success factors from sighted literature. It includes 45 questions in 9 aspects (Key Success Factors) and each aspect had 5 corresponding questions. Each question is a statement followed by a five-point Likert scale ranging from "Least important" to "Very important"; 1= Least important, 2= Less important, 3= Moderately important, 4= Important and 5= Very important.

The questionnaire was tested for reliability with a small sample group of 30 Green Belts using Cronbach's alpha coefficient across 45 variables. The reliability of questionnaire is considered to be fairly high as the result is 0.724. The study is in a good extend which minimize the risk for misinterpretation.

Questionnaires were sent to all trained Green Belts listed (a total of 190), the study is divided into two groups, namely certified (successful completion of Six Sigma project) and non-certified(unsuccessful completion of Six Sigma Project). The survey conducted on site by email and followed by face-to-face interview as well as telephone to target group during November-December, 2009. Responses were 133 returned questionnaires.

Table 3: Six Sigma training Performance in April -2009.

Group	***Number of staff***	***Percent***
Certified Green Belts	102	54%
Not certified Green Belts	78	41%
On program	10	5%
Total staff trained	**190**	

Data obtained was analyzed with SPSS version 16.0. Logistic Regression Analysis was performed using Forward Stepwise Method. Logistic Regression is used to predict a categorical (usually dichotomous) variable from a set of predictor variables. Logistic regression is a useful way of describing the relationship between one or more independent variables (e.g., age, sex, etc.) and a binary response variable, expressed as a probability, that has only two possible values, such as death ("dead" or "not dead"). For this study, there are two possible values of the completion of Six Sigma project (Y), "Fail" or "Succeed".

For this study, the completion of Six Sigma project exhibits itself as categorical variables (Y) which is dependently from a set of scoring Key Success Factors (X1 – X9) and Years of service in company (X10). Hence the assigned variables are as follows;

Y = Completion of Six Sigma project; the result with 0 = Fail (Non- certified Greenbelts), the result with 1 = Succeed (Certified Greenbelts).

X1 = $\sum_{i=1}^{5} K_i$ (Score of Top Management involvement and commitment)

X2 = $\sum_{i=6}^{10} K_i$ (Score of Linking Six Sigma to business strategy)

X3 = $\sum_{i=11}^{15} K_i$ (Score of Linking Six Sigma to customer)

X4 = $\sum_{i=16}^{20} K_i$ (Score of Organization infrastructure)

X5 = $\sum_{i=21}^{25} K_i$ (Score of Training)

X6 = $\sum_{i=26}^{30} K_i$ (Score of Communication)

X7 = $\sum_{i=31}^{35} K_i$ (Score of Project prioritization and selection)

X8 = $\sum_{i=36}^{40} K_i$ (Score of Incentive/reward system)

X9 = $\sum_{i=41}^{45} K_i$ (Score of The use of data analysis with data that is easily obtainable)

X10 = Years of service in company

4. SURVEY RESULT AND ANALYSIS

From 133 respondents, 38% are non-certified Green Belts, as they were unable to complete the project; and 62% are certified Green Belts. Survey findings in Table 4 show response from different groups classified by their service years as; less than 2 years, between 2-4 years, and more than 4 years. Although the group of "less than 2 years" is the smallest group when comparing with others but has the highest success rate of project completion (73%), whereas for the group of "2-4 years" and "> 4 years" are 63.8% and 51.0% respectively.

Table 4: Years of service versus Project completion rates

			Project completion		
			Fail	Succeed	**Total**
Years of service	<2 years	Count	10	27	37
		% within Years of service	27.0%	73.0%	27.8%
	2-4 years	Count	17	30	47
		% within Years of service	36.2%	63.8%	35.4%
	> 4 years	Count	24	25	49
		% within Years of service	49.0%	51.0%	36.8%
Total		Count	51	82	133
		% within Years of service	38.3%	61.7%	100.0%

Among the success group, mostly had experience with only one Six Sigma project (79 respondents from 82 succeed), only 3 cases who have experience in more than 2 projects.

Although the company had completed more than 100 Six Sigma projects since 2000, there was no information available on the attempt of the first Six Sigma projects. The survey found that 44% (58 respondents) failed at this stage. Other 23% could achieve within 6 months and 33% completed Six Sigma project after 6 months (see Table 6).

Table 5: Experience in Six Sigma Projects

Category	N= 133	
	Frequency	Percent
Project not realized	51	38%
1 project	79	59%
2-3 projects	1	1%
More than 3 projects	2	2%

Table 6 : Time to complete Six Sigma Projects

Category	N= 133	
	Frequency	Percent
1st project not realized	58	44%
3-6 months	31	23%
More than 6 months	44	33%

Data from questionnaires were tabulated into two groups; fail and succeed, representing project successful completion (non-certified and certified). Mean value and standard deviation are calculated for all response variables(x) tabulated into Fail, Succeed and Total (Table 7). The top nine factors which are regarded as important and very important by both groups are;

- Top Management participation in Six Sigma activity
- Customer focus processes
- Financial benefit of Six sigma project was presented and calculated
- Linkage to corporate/business strategy
- Availability of current data
- Department's Six Sigma quality objective
- Regular reviews
- Direct linkage of department process to customers' needs and satisfaction
- Regular communication and encouragement

Further investigation found that there is a marked difference in the perception between the two groups. This is expressed in the difference in mean value. The difference in mean can be implied that the Green Belt's perceived level of each group was so different and may affect to completion of Six Sigma project. However these shall be confirmed with Logistic Regression Analysis later. The differences in mean are both positive and negative which means that there are factors which either group rated of higher importance over the other group. The major differences are factors rated strongly by the "Succeed" group. These factors are;

- Top Management express a clear vision and aim of six sigma
- Black Belts display ability in advisory and help with project completion
- Understanding in Black Belt instructor's explanation during the training class
- Project duration complies to time and resources available
- Achievement level of the first project
- Management identify potential improvement areas and establish a process to generate, capture, and prioritize project

- The data needed for the analysis are easy to obtain
- Data availability for Six Sigma Project start up
- Assistance for needed data from the IT department or group members

It is also found that some factors are considered to be more important to the "Fail" group, although not very significant but worth taken note for, they are;

- Cooperation among peers throughout the project life
- Systematic information storage and processing
- Financial benefit was calculated and presented in Six Sigma project
- Adjustment of workload and time for project
- Training
- Extra score for performance review is tied to project completion.

Table 7: Descriptive Statistics of the perceived level of each question

Factor	Variable/ Question	Fail			Succeed			Diff. mean	Total		
		Mean	N	Std.	Mean	N	Std.		Mean	N	Std.
X1	K1	4.12	51	0.77	4.23	82	0.69	0.11	4.19	133	0.72
	K2	3.10	51	0.30	3.89	82	0.69	**0.79**	3.59	133	0.69
	K3	4.73	51	0.45	4.67	82	0.47	-0.06	4.69	133	0.46
	K4	1.27	51	0.45	1.33	82	0.82	0.06	1.31	133	0.70
	K5	1.45	51	0.50	1.40	82	0.49	-0.05	1.42	133	0.50
X2	K6	4.33	51	0.48	4.49	82	0.50	0.16	4.43	133	0.50
	K7	4.31	51	0.47	4.40	82	0.49	0.09	4.37	133	0.48
	K8	3.08	51	0.48	3.27	82	0.52	0.19	3.20	133	0.51
	K9	2.35	51	0.48	2.28	82	0.53	-0.07	2.31	133	0.51
	K10	4.55	51	0.50	4.39	82	0.58	-0.16	4.45	133	0.56
X3	K11	3.31	51	0.47	3.33	82	0.52	0.02	3.32	133	0.50
	K12	4.12	51	0.59	4.20	82	0.62	0.08	4.17	133	0.61
	K13	4.61	51	0.49	4.60	82	0.49	-0.01	4.60	133	0.49
	K14	3.98	51	0.62	3.91	82	0.55	-0.07	3.94	133	0.57
	K15	1.22	51	0.42	1.60	82	0.87	0.38	1.45	133	0.75
X4	K16	1.98	51	0.58	3.07	82	0.56	**1.09**	2.65	133	0.78
	K17	2.92	51	0.52	2.80	82	0.53	-0.12	2.85	133	0.53
	K18	1.82	51	0.39	1.84	82	0.51	0.02	1.83	133	0.46
	K19	3.08	51	0.52	2.89	82	0.50	-0.19	2.96	133	0.51
	K20	2.02	51	0.79	1.88	82	0.81	-0.14	1.93	133	0.80
X5	K21	3.35	51	0.48	3.22	82	0.47	-0.13	3.27	133	0.48
	K22	1.98	51	0.58	3.02	82	0.57	**1.04**	2.62	133	0.76
	K23	3.51	51	0.50	3.62	82	0.49	0.11	3.58	133	0.50
	K24	1.96	51	0.49	2.28	82	0.45	0.32	2.16	133	0.49
	K25	2.76	51	0.55	2.93	82	0.60	0.17	2.86	133	0.59
X6	K26	1.63	51	0.49	1.91	82	0.59	0.28	1.80	133	0.57
	K27	4.18	51	0.39	4.16	82	0.43	-0.02	4.17*	133	0.41
	K28	1.27	51	0.45	1.28	82	0.45	0.01	1.28	133	0.45
	K29	1.16	51	0.37	1.23	82	0.42	0.07	1.20	133	0.40
	K30	2.92	51	0.48	2.89	82	0.44	-0.03	2.90	133	0.46
X7	K31	2.90	51	0.30	2.83	82	0.38	-0.07	2.86	133	0.35
	K32	3.84	51	0.50	3.83	82	0.41	-0.01	3.83	133	0.45
	K33	1.25	51	0.44	2.99	82	0.71	**1.74**	2.32	133	1.05
	K34	1.35	51	0.56	3.43	82	0.57	**2.08**	2.63	133	1.16
	K35	1.63	51	0.63	3.22	82	0.57	**1.59**	2.61	133	0.98
X8	K36	1.20	51	0.40	1.15	82	0.36	-0.05	1.17	133	0.37
	K37	2.06	51	0.61	2.10	82	0.54	0.04	2.08	133	0.56
	K38	3.24	51	0.47	3.21	82	0.46	-0.03	3.22	133	0.47
	K39	2.06	51	0.61	2.20	82	0.53	0.14	2.14	133	0.57
	K40	1.31	51	0.47	1.20	82	0.40	-0.11	1.24	133	0.43
X9	K41	1.61	51	0.67	3.18	82	0.61	**1.57**	2.58	133	0.99
	K42	1.51	51	0.54	3.02	82	0.47	**1.51**	2.44	133	0.89
	K43	1.76	51	0.65	2.91	82	0.48	**1.15**	2.47	133	0.78
	K44	4.25	51	0.72	4.52	82	0.63	0.27	4.42*	133	0.68
	K45	3.20	51	1.02	3.02	82	0.90	-0.18	3.09	133	0.95

When sum the scores of all sub-factors within the main key factors(Table 8), there are two factors which have major mean difference between the two groups; factor X7 (Project prioritization and selection) and X9 (The use of data analysis with data that is easily obtainable). Factor X2 - Linking Six Sigma to business strategy remains the most important key success factor for both groups. The difference in means for each factor shall be confirmed with Logistic Regression Analysis whether they are related to the completion of Six Sigma project.

Table 8: Total score of the perceived level of Six Sigma Key success factors

Variable	Fail			Succeed			Diff. mean	Total		
	Mean	N	Std.	Mean	N	Std.		Mean	N	Std.
X1	14.67	51	1.31	15.52	82	1.57	0.85	15.20	133	1.52
X2	18.63	51	1.70	18.83	82	1.40	0.2	18.75	133	1.52
X3	17.24	51	1.14	17.63	82	1.68	0.39	17.48	133	1.51
X4	11.82	51	1.51	12.49	82	1.49	0.67	12.23	133	1.53
X5	13.57	51	1.30	15.07	82	1.30	1.5	14.50	133	1.49
X6	11.16	51	1.08	11.48	82	1.30	0.32	11.35	133	1.23
X7	10.98	51	1.24	16.29	82	1.42	**5.31**	14.26	133	2.92
X8	9.86	51	1.36	9.84	82	1.15	-0.02	9.85	133	1.23
X9	12.33	51	1.96	16.67	82	1.59	**4.34**	15.01	133	2.73

Logistic Regression Analysis was then employed to confirm which Key Success Factors affect the completion of Six Sigma project. Apart from 9 Key factors, years of service in the Company was also included as the 10^{th} factor. Table 9 shows that at 10% significant level**,** there are 5 factors with significance on the Six Sigma project completion. These are;

X1 (Top Management involvement and commitment),
X4 (Organization infrastructure),
X5 (Training),
X7 (Project prioritization and selection), and
X9 (Incentive/reward system).

As for Factor X10 (Years of service), it has no significant impact (p-value is 0.108). However this result is for combined data. Years of service may have significant impact (since the groups with years of service less than 4 have higher successful completion rate) when investigated in conjunction with other personal factors such as statistical analysis skill, assistance from project, etc..

Table 9: The result of Logistic Regression Analysis

			Score	df	Sig.
Step 0	Variables	X1	10.024	1	.002
		X2	.559	1	.455
		X3	2.224	1	.136
		X4	5.996	1	.014
		X5	32.282	1	.000
		X6	2.142	1	.143
		X7	104.690	1	.000
		X8	.010	1	.922
		X9	79.713	1	.000
		X10	4.443	2	.108
		X10(1)	2.778	1	.096
		X10(2)	.146	1	.703
	Overall Statistics		114.654	11	.000

The result from Logistic Regression Analysis has reflected previous explanation in Descriptive statistics (Table 7 and Table 8), all were observed and compared according to the project completion success. The results from the finding can be discussed and explained as follows;

1) **Top Management involvement and commitment**

This Key Success Factor continues to emerge as the most significant and highly rated in both groups. Although not all sub-factors are rated as important, at least three out of five are rated as moderate to high important among the two groups. They are; Top management's reviews, clear vision and aim in Six Sigma and participation in Six Sigma activities. All of these are attributes of top management personal involvement to the program. There was a gap in the perceived level between the two groups in factor of Top management express clear vision and aim of Six Sigma which was perceived as more important to the "Succeed" group. It can be interpreted to better understanding on the vision and aim of Six Sigma to the group. The recommendation for this part is the company should put forth the effort into the first step of Six Sigma via clear translation of vision and aim of Six Sigma. According to Richard Normann. Park (2003), he has recommended that Top-level management commitment is first and foremost factor to success of Six Sigma initiative. The CEO (Chief Executive Officer) of the corporation or business unit should genuinely accept Six Sigma as the management strategy as well as setting up long-term Six Sigma vision for the company.

2) **Organization infrastructure**

Although the average score in this Key Success Factor is rated relatively low, but there is a major gap in the mean difference in perceived level of Black Belts display ability in advisory and help project completed. The result show that the "Succeed" group rated higher perceived level on Black Belts ability (3.07) while the "Fail" group scored lower perceived level (1.98). Black Belts ability is a key factor required for Six Sigma program. Qualified Black Belt is important since they have to work closely with Green Belts. These individuals

are required as fulltime project leaders. Not having enough full time Black Belts in the departments could post a failure to the project implementation from the beginning. It is worth noting that in this Key Factor, there are three sub-factors which are considered to be of higher importance to "Fail" group. They are; cooperation among peers throughout project life, manager adjusts Green Belts workload to let Green Belts have sufficient time to complete the project and adequate training. These can be interpreted that the potential unsuccessful Green Belts need more assistance from the organization both in terms of peer assistance, time resources and training. If the company is able to identify early sign of this group, support and assistance should be provided early in the project to ensure success.

3) **Training**

The finding in this factor is the "Understanding in Black belt instructor's explanation during the training class". Looking at the mean score, the "Succeed" group rated this sub-factor as important to their success (3.02), while the "Fail" group failed to identify this as a major factor(1.98). Can this mean that due to lack of awareness of the importance in this factor, the potential failed group had ignored and not paid much attention to the instructor's explanation? Or could it mean that the "Fail' group did not understand the Black Belt instructor's explanation well enough to grasp the essence of the technical concept? In any case, both groups seem to give more importance to the formal training as a part of the development plan for various belt level experts (3.35 and 3.22 respectively).

4) **Project prioritization and selection**

In this Key Success Factor, both groups scored the challenging and feasible project as important factor. There are gap in three sub- factors, "Project duration and resource available", "Achievement level of first project", and "Management identify potential improvement areas and establish a process to generate, capture, and prioritize project ideas". All these three sub- factors are rated as low to least important in the "Fail' group (mean score of 1.35, 1.25, and 1.63 respectively). While the "Succeed" group ranked all these factors as moderate to important (mean score of 2.99, 3.43 and 3.22 respectively). This is clear that for potential successful Green Belts, they will evaluate and give priority to the project feasibility both in terms of time and resource available. Hence they treasure the assistance of management in identifying potential improvement ideas as well as project prioritized areas. In choosing feasible project will ensure their success from the beginning and consequently, the achievement level of their first projects will enforce their learning cycle.

5) **The use of data analysis with data that is easily obtainable**

This Key Success Factor is ranked as moderate to high important in all of its 5 sub-factors in both groups. The availability of current and up-to-date is score as the highest importance. Major gap exists in three sub-factors; needed data for analysis is easy to obtain, available of most data at the beginning of the project, and IT and member assistance if data is not available on hand. The "Succeed" group ranked all these three factors much higher than the other group. Does this mean that eventhough both groups considered that data availability is a major Key Success Factor for project implementation, but how they tackle data and look for needed data in other places is a key to their success? While the "Fail" group stressed more importance to the information storage and data processing, the "Succeed" group paid more attention to the availability and obtainability of data needed.

5. CONCLUSION

The result in this study is unique due to the culture of the organization and its operational environment. Although Logistic Regression Analysis has confirmed that there are 5 Key Success Factors which are significant to the successful implementation of Six Sigma projects, all these factors are classified as organizational factors and no significance was found in the years of service which is regarding as personal factor. The 5 main Key Success Factors are;

1) Project prioritization and selection
2) The use of data analysis with data that is easily obtainable
3) Top Management involvement and commitment
4) Training
5) Organization infrastructure

"Top Management involvement and commitment" has not been identified as the most important factor as most of the cited literatures. However Top Management involvement and commitment remains as one of the top ranked Key Success Factors.

Many sub-factors point towards the importance of paying more attention to the start up phase of the project, such as;

- Top Management express a clear vision and aim of six sigma
- Management identifies potential improvement areas and establish a process to generate, capture, and prioritize project ideas
- Availability of data needed to start of Six Sigma project

Although personal factor did not appear to be significant in the analysis, the result deducted from the "Fail" group implies that they may need more assistance and clear understanding than the other group. These are presented in the following factors;

- Benefit of Six sigma project was presented and calculated in the term of financial benefit
- Organization provides adequate training and budget for supporting Six Sigma project
- Cooperation among peers throughout the project life
- Manager adjusts workload to ensure that Green Belts have sufficient time to complete Six Sigma projects
- Formal training is part of development plan of various belt level experts
- Clear company announcement to put extra score in performance review/ annual raise for completion of Green Belt Project
- Systematic information storage and processing

Financial reward and incentive system, which had been identified as one of the basic influential factors in many literatures, did not come up as such in this survey in either group. Both groups ranked "Self-rewarding of project completion" as more "important" factor.

Implication of the result also showed some inherent and hidden problems in the organization. There is clearly a marked difference in the perceived important factors in the

two groups. It is important for the management to identify signs of failure factors and put in place prevention mechanisms in the early stage of implementation.

Some recommendation for the Company in this study;

a. Translate vision and aim of Six Sigma clearly throughout the organization as well as establish short and long term vision for Six Sigma.
b. Provide adequate full time Black Belts to assist problem solving at front line.
c. Make available Master Black Belts during class discussions and exercises.
d. Encourage team cooperation and recognize the necessity of resource allocation and time for Six Sigma project
e. Management should identify potential improvement areas and establish a process to generate, capture, and prioritize project ideas.
f. Identify early at the start up what data, assistance and resources are needed. Provide close supervision to all "New" and "Fail" Green Belts.

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