

Critical Success Factors of Lean Six Sigma and Its Relation on Operational Performance of SMEs Manufacturing Companies: A survey Result

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Abstract— Many companies implement lean six sigma (LSS) approach aiming to improve business performance. However, not many companies can be benefited from this program as the implementation is not easy to be executed effectively. Thus, the objective of this study is to identify the important factors in LSS implementation and its relation on operational performance (OP) of the business. This study employed quantitative survey with structured questionnaire. Random sampling was used and the sample of this study was SME manufacturing companies which has implemented LSS approach. A set of questionnaires were sent out to 200 companies through email and targeted to LSS practitioners such as managing director, quality manager and production manager. Finally, 63 response have been received with 32% response rate. Statistical Package for the Social Science (SPSS) 22.0 version software was used to evaluate descriptive and the relationship between variables. This research studies the role of three factors in LSS implementation, which are management engagement and leadership, lean six sigma competency, and effective training and education. The findings revealed that there is a significant relationship between LSS factors with OP. Management engagement and leadership was the most perceived

important factor in LSS implementation. This research model serve as a practical guide which can assist the company to achieve better operational business performance.

Keywords— Total Quality Management, SMEs, Lean six sigma, operational performance

1. Introduction

Small Medium Enterprises (SMEs) company have played significant role in manufacturing sector all over the world. The SMEs sector in Malaysia has plays a significant role in the national economy [1]. As the pillar for the nation, the important role of SMEs in national development has been highlighted in many development policies in Malaysia [2][3]. The sector's contribution to the nation's economy can be seen from various aspects such as in business units, employment opportunities, as well as economic output.

According to Eikebrokk & Olsen [4], SMEs are a major part of the industrial economies. SMEs have increasingly involved in the global competitive market [5]. Many SMEs became suppliers for large company and have been seen severely pressure to improve the productivity and services. In today's competitive market, organizations such as SMEs must have capability to revolutionize in order to

survive in the market. The need for development, improvement, high level of performance and quality are always demanding for change in SMEs.

The role of continuous quality initiative within organisation has improved and matured. A number of different methods focused on the continuous improvement of production processes have emerged aiming on the growth of productivity and cost saving [6][7]. These approaches were used by the businesses to stay competitive, by eliminate waste and reduce variability in the production. Lean manufacturing and Six Sigma are the two familiar representatives of those approaches [7], [8]. This two concept are even more common with large companies due to their encouraging influence on the productivity, quality and financial results [1]. As a result of the advancement of these two concept, the hybrid of Lean and Six Sigma (LSS) was formed to act more fully on the whole organization of the company [1]. Because of its advantages in improving the smoothness of business operation and organisation performance, many companies have decided to move from the current quality practices to the LSS approach [9][10][11].

Nowadays, organizations in various sectors, regardless of the sizes, are constantly being faced with a growing competitive environment and the need to face the pressure from customers who want better quality value in both products and services offered. Corresponding with these revolution, many businesses have turned to a new business approach, the practice of LSS, as a key for continuous improvement [12][13]. Some world class leading company that has been well adopted LSS are Ford, Du Pont, 3M, Dow Chemicals, and Honeywell [14]. These companies implement LSS program aiming towards a better business performance.

Lean Six Sigma (LSS) has been defined, for instance [15] as “a business improvement methodology that aims to maximize shareholders’ value by improving quality, speed, customer satisfaction, and costs: it achieve this by merging tools and principles from both Lean and Six Sigma.” According to Gremyr & Fouquet (2012), LSS model is more well-organized to reduce waste and improve the quality of an organisation than single Lean and Six Sigma deployments. In addition, LSS has assisted businesses to gain better continuous improvement activity and better saving in terms of quality and operation cost [17][18][19]. These benefits are also

being extended to manufacturing SMEs, where the application of LSS appears to be increasingly in common [20][21][19].

J Jayaraman, Ali, & Choong [17] in their study on CSFs of LSS such as management commitment, training, resource allocation, maturity of LSS deployment, and awareness of important of LSS have significant impact on operational performance. Recently, Belekoukias, Garza-Reyes, & Kumar [18] found that lean practices (JIT and automation) are significantly with operational performance. In addition, several empirical studies [17][18][19] have been marked as a catalyst and a starting point in the study of the relationship between LSS and the OP in the manufacturing industry. However, variables of these studies do not portray the formation of LSS as a complete set of initiatives in influencing the increase in OP. The lack of empirical evidence about the impact of LSS on the OP may be one of the main reasons of why the application of LSS in the manufacturing industry is still a subject of heated debate ever since.

The hypothesis is set to test the relationship between LSS practices and operational performance. The research hypotheses are formulated by:

H1: There is significant relationship between LSS practices and operational performance.

The Objectives of this study are:

- i. What is the extent level of LSS?
- ii. What is the relationship between LSS and operational performance?

2. Methodology

In this section, descriptive analysis and Spearman correlation analysis are used to analyse the data for the purpose of understanding the extent level of LSS enablers and correlation among variables. In order to facilitate the data analysis process and prepare the data for analysis, the data was screen and out of the 200 questionnaires distributed, only 83 were retrieved, and out the 83 that were retrieved, 20 of them were incomplete and damaged, thus making the total useable questionnaires for analysis purposes to become 63. It represented 32.0% of response rate. Statistical Package for Science Social (SPSS) was used to analyse the data being collected. Descriptive and correlation test have been carried out to answer the research questions. Spearman test have been used for correlation test.

3. Result

Demographic analysis section explains the demographic background of the companies and respondents. Table 1 shows that the demographic analysis which consists of seven aspects; operation years, company award and department. A total of 63 questionnaires have received. The results obtained were analyzed as shown in Table 1.

Table 1. Summary Results of Demographic Analysis

	Frequency	Percentage (%)
Operation Years		
5 years below	22	36.6
5-10 years	22	36.6
10-15 years	10	16.0
15 and above	9	10.0
Total	63	100.0
Company Award		
Industrial Excellent Award	17	28.3
State Award	16	26.6
National Award	14	23.3
International Award	4	6.6
None	12	15.0
Total	63	100.0
Department		
Prod Department	17	28.3
QA Department	40	66.6
Others	6	5.0
Total	63	100.0

Descriptive analysis is a technique which is used in describing the extent of business enablers' practices. The data is computed into means and standard deviation. Mean value obtained provides the average of respondents answered based on questionnaire [26][27]. While standard deviation is used to measure the dispersion of the data in which how close the entire set of data is to the average value. The lower the value of standard deviation, the closer is the data to the average value. Table 2 shows the level of mean measurement which is ranked by the central tendency level.

Table 2. Level of Mean Measurement

Mean Range	Central Tendency Level
High	5.00-7.00
Moderate	3.00-4.99
Low	1.00-3.00

A. Descriptive analysis

Table 3 shows the summary of mean and standard deviation for each variable based on importance. Based on the table below it can be seen that all variables were recorded mean score at high level. This is between 5.18 to 5.51. Meanwhile, the standard deviation value is in range of 1.241 to 1.405. This shows the data point are closely grouping around the mean. The highest value of mean score, 5.51, is from management engagement and leadership, which make it ranked as first priority. Second is lean six sigma competency with a total of 5.42 mean score, and lastly is effective training and education, with a mean score of 5.18.

Table 3: Summary descriptive analysis based on importance

	Average μ	Std.	Level	Ranking
Management Engagement and Leadership	5.51	1.351	High	1
Lean Six Sigma Competency	5.42	1.241	High	2
Effective Training and Education	5.18	1.405	High	3

Table 4 shows the summary of mean and standard deviation for each variable based on practices. Based on the table below it can be seen that all variables were recorded mean score at moderate level. This is between 4.18 to 4.74.

Table 4: Summary descriptive analysis based on practices

	Average μ	Std.	Level	Ranking
Management Engagement and Leadership	4.74	1.700	Moderate	1
Lean Six Sigma Competency	4.67	1.416	Moderate	2
Effective Training and Education	4.18	1.566	Moderate	3

A. Type of analysis: Correlation

Table 5 shows the correlation between critical success factors of LSS practices with operational performance. The result indicated that the correlation of all independent variables are significant at $p < 0.05$ (2-tailed). This shows that they are correlated and have relationship to each other. The result also shows that all variables have a positive relation with the operational performance. The strongest correlation with the operational performance is effective training and education with $r(63) = 0.745$. Lean six sigma competency has a positive correlation with $r(63) = 0.701$, while the lowest correlation is management engagement and leadership with $r(63) = 0.535$. This can be concluded that, based on practices, providing effective training and education was the most important factor in lean six sigma implementation to improve operational performance of the businesses.

Table 5: Correlation analysis based on practices

		ME AL	LS SC	ET AE	O P	Res ult	Ra nk
ME AL	Correlation Coefficient	1.000	.868**	.684**	.535**	Positive	3
	Sig. (2-tailed)		.000	.000	.000	Sig.	
	N	63	63	63	63		
LS SC	Correlation Coefficient	.868**	1.000	.814**	.701**	Positive	2
	Sig. (2-tailed)	.000		.000	.000	Sig.	
	N	63	63	63	63		
ET AE	Correlation Coefficient	.684**	.814**	1.000	.745**	Positive	1
	Sig. (2-tailed)	.000	.000		.000	Sig.	
	N	63	63	63	63		

MEAL-Management Engagement and Leadership
 LSSC-Lean Six Sigma Competency
 ETAE-Effective Training and Education
 OP-Operation Performance

4. Discussion

Objective 1: To determine the extent level of critical attributes of LSS implementation

The first objective of this study is to examine the extent level of critical attributes of LSS implementation. All factors based on importance

were in high level, while factors based on practices were in moderate level.

Management engagement and leadership recorded the highest average mean for both importance and practices, which make it ranked first among the other variable. This indicated that the respondents perceived it as the most important factor in lean six sigma implementation. This result parallel with the past research done by Habidin & Yusof [17]. The study found that leadership for quality improvement program is perceived by respondents as one of the most important foundation LSS practices.

Hence, successful LSS implementation requires leader to change the continuous improvement culture. This is because without management engagement, this change and improvement activity may face problem and obstacles during their implementation and unclear link between strategy and LSS project because the project is not tied to business goal and financial result [26][27].

Objective 2: To identify the relationship of critical attributes of LSS implementation toward the operational performance

Effective training and education is found to be significantly correlated with the operational performance. This is found contradicting with the study [18], whose have failed to find the impact of training on the organisational performance, but aligned with the study by [18][19]. Training has been viewed as key inputs to enhance the knowledge, understanding and skillset of employees. However, if the training are not fully utilised and awareness in people is low, then it is difficult to attain the desirable organisational performance. According to Manville et al. [20], Manville et al. [20] the purpose of training is to enhance skill sets of employees in applying the LSS tools and techniques in DMAIC methodology. Lack of knowledge about LSS methodologies could be one of main impeding factors in implementation of LSS and it is therefore one of the critical success factors [18][19].

5. Conclusion

This study revealed that there is a significant relationship between LSS factors with OP. Management engagement and leadership was the most perceived important factor in LSS implementation. Authors suggest to examine mediators and moderator effects between LSS factors and OP such as tools and techniques in future research.

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