Measuring Lean Six Sigma and quality performance for healthcare organizations

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Abstract

Purpose – This study aims to investigate applications of Lean Six Sigma approaches and quality performance in Malaysian hospitals. It identifies five dimensions of Lean Six Sigma conformance (i.e. continuous quality improvement, Lean management initiatives, Six Sigma initiatives, patient safety and teamwork) and quality performance of the hospitals based on demographics such as gender, types of hospital and working experience.

Design/methodology/approach – This study distributed 1,007 self-administered survey questionnaires to hospital staff resulting in 438 useful responses with 43.5 per cent response rate. Research data were analysed based on reliability analysis, exploratory factor analysis (EFA), independent samples *t*-tests and one-way ANOVA using SPSS version 23.

Findings – Research findings indicate that there are significant differences between public and private hospital staff on Lean management initiatives, Six Sigma initiatives, patient safety and teamwork. Private hospital staff perceives Lean management initiatives, Six Sigma initiatives, patient safety and teamwork more favourably compared to public hospital staff. The present study findings also indicate that senior hospital staff (more than 10 years working experience) perceives patient safety and teamwork more favourably compared to other working experience groups.

Research limitation/implications – The research focused solely on the Malaysian health sector, and thus, the results might not be applicable to other countries.

Originality/value – This research provides theoretical, methodological and practical contributions for the Lean Six Sigma approach and the research findings are expected to provide guidelines to enhance the level of quality performance in healthcare organisations in Malaysia as well as other countries.

Keywords Malaysia, Hospitals, Lean Six Sigma, Quality performance

Paper type Research paper

Introduction

In the early 1950s, Taiichi Ohno introduced the "Lean Production System" concept to reduce waste from production processes. The concept was first implemented by the Toyota Company to reduce unnecessary production wastes and to improve production quality (Dahlgaard and Dahlgaard-Park, 2006; Dahlgaard *et al.*, 2011). By implementing the Lean Production System, Toyota was able to increase value added parts to the cars produced by the company and reduced all other non-value added tasks. In 2004, Toyota beat Ford and became the world's second largest automobile producer after General Motors (GM). In 2006, Toyota's profits increased to USD12 billion, which was nearly double GM's highest annual earnings of USD6.9 billion in 1995. In contrast, GM lost USD3.4 billion in the quarter ending

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June 2006 and Ford lost USD12.7 billion (Chalice, 2007). In 2008, Toyota beat GM and became the world's largest and most powerful automobile producer. The "Lean" approach improves performance by reducing operation costs. Toyota's success is partly due to its successful implementation of the Lean Production System. In the late 1990, Xerox Corporation adopted Lean approach to increase quality production by reducing waste and cost. After Lean approach was successfully implemented by Xerox Corporation, many service organisations (i.e. education, banking and tourism) including healthcare organisations started to adopt Lean approach to reduce waste and costs to improve their quality performance towards customer satisfaction.

In addition to the Lean approach, healthcare organisations also adopted the Six Sigma methodology to continuously improve performance and service quality (Rohini and Mallikarjun, 2011; Plonien, 2013). Healthcare service providers embraced the Six Sigma concept after it was fully developed, tested and adopted in the manufacturing sector by companies such as Motorola, Allied Signal and General Electric (Ganti and Ganti, 2004). The integration of Lean and Six Sigma methods can enhance patient care and satisfaction through quality performance and services (Heuvel *et al.*, 2006). The Lean Six Sigma approach ensures the success of healthcare organisations by reducing the number of shortcomings such as patient waiting time and delivery of medical test reports, along with unnecessary medical costs (Gijo and Antony, 2014). The Lean Six Sigma approach also helps healthcare organisations establish a culture of continuous improvement in healthcare service to ensure accurate results in a timely fashion (Neufeld *et al.*, 2013). Therefore, the aim of this study is to investigate Lean Six Sigma and quality performance of Malaysian hospitals. This study also aims to identify the degree of conformance to standards of Lean Six Sigma applications and quality performance based on demographics (i.e. gender, hospital type and working experience).

Literature review

Lean Six Sigma

Lean Six Sigma is a process improvement method that maximises stakeholders' value by improving quality and speed, while reducing waste and costs of the products or services (Laureani *et al.*, 2013). This approach is rapidly gaining popularity and is being implemented in the service industry and manufacturing sectors to improve quality performance of organisations (Hess and Benjamin, 2015). This approach is faster, more efficient and economic, thereby contributing to the quality performance of the organisation by focusing on maximising the process speed of service and reducing costs and cycle time with efficiency (Azadegan *et al.*, 2013).

Since the early 2000s, the Lean Six Sigma methodology has been applied in many healthcare organisations to increase value-added activities to meet their patient's needs (DelliFraine *et al.*, 2010). This methodology not only increases the value-added activities but also reduces non-value-added activities such as waste and unnecessary services that lead to improved performance of the healthcare organisations (Koning *et al.*, 2006; Näslund, 2013). According to Liberatore (2013), the Lean Six Sigma application can improve healthcare quality performance such as nurse care, physician care, hospital environment, patient safety, hospital stay and waiting time in the hospital. These factors can also ensure the level of the quality performance of the healthcare services towards patient satisfaction and loyalty (Linderman *et al.*, 2003).

Lean Six Sigma in healthcare

The application of Lean Six Sigma can be described on many fronts to evaluate the quality performance of the healthcare organisation. This study defined the Lean Six Sigma methodology by five components, namely, continuous quality improvement, Six Sigma initiatives, Lean management initiatives, patient safety and teamwork.

Continuous quality improvement

Continuous quality improvement is an incremental approach towards process improvement and takes an organisation-wide systems perspective, which is tied to the strategic goals and aligned with a culture of quality (Sollecito and Johnson, 2011). This approach integrates continuous quality improvement activities by using interdisciplinary teams at all levels in the healthcare organisation and offers reward/recognition for employees who contribute in the quality improvement process (Ryan and Thompson, 1998).

Six Sigma initiatives

Six Sigma is a business management strategy first implemented by Motorola in 1987. This approach improves the quality of process outputs by identifying and removing the causes of defects and variation in manufacturing and service processes (Gnibus and Krull, 2003). This approach includes process improvement methods such as define, measure, analyse, improve and control processes to focus on continuous improvement (Furterer, 2011).

Lean management initiatives

The Lean management initiatives emphasise patient needs by reducing costs and increasing efficiency of the delivery speed of the medical services (Hagan, 2011). Normally, Lean management initiatives include "5S" practices process mapping, value stream mapping, root cause analysis, Kaizen methods and just-in-time approach for continuous improvement in the quality performance of the healthcare organisation (Protzman *et al.*, 2010; Snyder *et al.*, 2016). The "5S" method improves quality performance of the healthcare organisation by implementing five steps such as sort for necessity, simplify the workplace, shine for cleanliness, standardise processes and sustain standard processes (Gowen *et al.*, 2012).

Patient safety

Patient safety refers to prevention and amelioration of adverse outcomes or injuries that stem from the process of healthcare (Burström *et al.*, 2014). In the healthcare service, patient safety depends on a strong and positive patient safety culture such as awareness of the patient safety, teamwork, communication and work climate (El-Jardali *et al.*, 2014). Failures in communication and teamwork are the main causes of adverse outcomes in the healthcare services (Stead *et al.*, 2009). According to the report of the "Joint Commission on Accreditation of Healthcare Organisations in the USA (USA)", 70 per cent of adverse outcomes are caused by lack of standardised procedures, communication and teamwork in the healthcare organisation (Leonard *et al.*, 2004).

Teamwork

Teamwork can be described as collaboration between functional units, between employees, between employees and managers, between employees and suppliers, and between managers and non-managers (Sabry, 2014). According to Leong and Teh (2013), teamwork promotes mutual trust and respect to one another in solving any organisational problems. For effective teamwork, there should be good employee support in the unit and when

members of the unit become busy, other members of the same unit help out (Leonard *et al.*, 2004). Team leaders should encourage working as a team and offer rewards and recognition (Sabry, 2014).

Quality performance in healthcare

Quality performance is an interconnecting set of policies and practices that enhance workforce management to achieve organisational goals through individual performance (Storey and Sisson, 1993). According to Fletcher (1993), quality performance is a system which creates a vision of the organisation to understand and help each individual employee of the organisation and recognise their contribution to enhance the quality performance to fulfil customer wants and desires (Dahlgaard *et al.*, 2011). To measure quality performance in the healthcare sector, the managers need to clearly define the performance outcomes of a healthcare system that can be judged and quantified against quality improvement (Varkey *et al.*, 2007).

According to Harrington (2007), healthcare quality improvement requires five essential elements for success, namely, developing and clarifying an understanding of the healthcare problems, fostering and sustaining a culture of change and patient safety, continuous monitoring of performance and reporting of findings to sustain the change, testing change strategies for better performance and involving key stakeholders of the healthcare organisation. Moreover, Ovretveit (2000) suggested some lessons which can be useful for the healthcare organisation to improve quality performance, namely, a positive leadership approach in departments to lead quality procedures within a hospital, select quality projects which are strategically significant for the hospital, provide special training to the doctors about the quality tools and applications of the healthcare systems, develop the skills to design and use measures of quality to identify the key performance indicators of the healthcare services, do not train those staff who are not working on quality projects, unless it is general awareness training, do not neglect those services which are doing little to address quality problems, and ensure quality projects working on complex subjects by following the steps of a structured team working process.

Methodology

The present study used self-administered survey questionnaire to collect data from 16 selected hospitals in Peninsular Malaysia applying the Lean Six Sigma approach to improve quality performance. In this study, the sampling was designed according to the four regions in Peninsular Malaysia: Central, Northern, Southern and East Coast. Currently, 354 hospitals (137 public and 217 private hospitals) are serving in Malaysia. Of these 354 hospitals, 157 (86 public and 71 private hospitals) are located in Peninsular Malaysia, having more than 50 beds in all hospitals. From these 157 hospitals, 57 are located in the Central region (36.31 per cent), 49 in the Northern region (31.21 per cent), 25 in the Southern region (15.92 per cent) and 26 in the East Coast region (16.56 per cent). The present study selected 16 hospitals based on 10 per cent of 157 hospitals ($157 \times 0.10 \approx 15.7$ 16 hospitals). These 16 hospitals were selected based on simple random sampling by using Microsoft Excel spreadsheet. According to the ratio of the sampling selection, six hospitals ($16 \times 0.363 = 5.81 \approx 6$) are selected from Central region, five ($16 \times 0.312 = 4.99 \approx 5$) from Northern region, two ($16 \times 0.159 = 2.54 \approx 2$) from Southern region and three ($16 \times 0.165 = 2.65 \approx 3$) from East Coast region. By doing this procedure, it ensured that the selection of the hospitals for four regions was done by chance or randomly.

After randomly selected these 16 hospitals for this study, we observed that these 16 hospitals are located in eight different states in Peninsular Malaysia, namely, Selangor,

WP Kuala Lumpur, Kedah, Penang, Perak, Johor Baru, Melaka and Pahang. In this study, the sampling frame was developed based on the proportion of the medical staffs (i.e. doctors, nurses, pharmacists and medical laboratory technologists) in the selected states with targeted sample size. Currently, approximately 100,700 medical staffs (i.e. doctors, nurses, pharmacists and medical laboratory technologists) are serving in the eight states in Peninsular Malaysia, and of these 100,700 medical staffs, 32.53 per cent (i.e. 32,760 staffs) are doctors, 56.60 per cent (i.e. 56,993 staffs) are nurses, 7.25 per cent (i.e. 7,297 staffs) are pharmacists, and 3.62 per cent (i.e. 3,650 staffs) are medical laboratory technologists (MOH, 2014). In this study, 1,007 survey questionnaires (1 per cent of the population) were mailed to 16 hospitals and 438 completed questionnaires were returned. This represented 43.5 per cent response rate which was regarded as satisfactory (Saunders *et al.*, 2010). After collected data, reliability analysis and exploratory factor analysis (EFA), independent samples *t*-test and one-way ANOVA tests were undertaken using SPSS version 23.

Data analysis

Respondents' demographic profile

The descriptive analysis revealed that the majority of the respondents (57.3 per cent) participated were from private hospitals, and 187 (42.7 per cent) respondents participated from different public hospitals in Malaysia. In this study, female respondents were 355 (81.1 per cent), whereas male respondents were only 83 (18.9 per cent). About the working experience of the respondents, the majority of the respondents had been working in the same hospital for above 10 years (36.1 per cent), whereas 16.2, 29.2 and 18.5 per cent of the respondents were working for 1-2 years, 3-5 years and 6-10 years, respectively (see Table I).

Reliability and validity

There are four common methods to examine the reliability of the research variable, namely, test-retest method, split-half method, alternative form method and internal consistency method known as Cronbach's alpha. Of these four methods, internal consistency is the most popular method for testing the reliability of the research questionnaire (Hair *et al.*, 2010; Cooper and Schindler, 2011). According to Cooper and Schindler (2011, p. 436), "internal consistency is the degree of different items that are homogeneous in measuring the same underlying construct". This method was introduced by Kuder and Richardson in 1937 to measure the internal consistency of the research items by using Cronbach's alpha. The present study used Cronbach's alpha to measure the internal consistency of 29 items for continuous quality

Description	Frequency	(%)
Type of hospital		
Public	187	42.7
Private	251	57.3
Gender		
Male	83	18.9
Female	355	81.1
Working experience		
1-2 years	71	16.2
3-5 years	128	29.2
6-10 years	81	18.5
Above 10 years	158	36.1

Table I.
Demographic profile of the respondents

improvement, Lean management initiatives, Six Sigma initiatives, patient safety, teamwork and quality performance. Cronbach's alpha score ranges from 0 to 1, with values close to 1 indicating high consistency. When the value of Cronbach's alpha is greater than 0.7, then the item scales are regarded as reliable (Hair *et al.*, 2010). Table II illustrates the Cronbach's alpha for six dimensions of the research variables. The alpha values ranged from 0.781 to 0.906, exceeding the minimum requirement of 0.70, the overall instruments were deemed reliable for this study.

Code	Variables	Factor loading	Cronbach's alpha
Continuous quality improvement			0.781
CQ1	Hospital offers reward/recognition for employees who contributed in the quality improvement process	0.677	
CQ2	Hospital measures patient satisfaction by surveys, focus group, etc	0.644	
CQ3	Hospital establishes a culture for continuous quality improvement	0.746	
CQ4	Hospital integrates continuous quality improvement activities interdisciplinary teams at all levels	0.697	
CQ5	Hospital has strong leadership to continuous improvement processes demonstrated by managers at all levels	0.702	
Lean management initiatives			0.786
LM1	Hospital implements "5S" practices to create more efficient work environment	0.546	
LM2	Hospital implements value stream mapping to identify waste and error which are non-value added processes	0.783	
LM3	Hospital implements kaizen methods to continuous improvement in processes	0.814	
LM4	Hospital implements just-in-time to improve work process management	0.665	
Six Sigma initiatives			0.906
SS1	Hospital implements process improvement tools to measure quality improvement process	0.574	
SS2	Hospital, all improvement projects are reviewed regularly	0.731	
SS3	Hospital uses a structured approach to manage quality improvement activities	0.684	
SS4	Hospital has a formal planning process to decide the major quality improvement projects	0.653	
SS5	Hospital, all improvement projects are reviewed regularly during the process	0.728	
Patient safety			0.897
PS1	Hospital focuses on reduction in the frequency of errors to ensure patient safety	0.702	
PS2	Hospital focuses on critical processes to improve patient safety	0.764	
PS3	Hospital increases awareness of errors among employees to ensure patient safety	0.795	
PS4	Hospital reduced the impact of errors in the medical services	0.738	
PS5	Hospital provides a work climate that promotes patient safety	0.681	
Teamwork			0.904
TW1	When a lot of work needs to be done, we work together as a team to get the work done	0.734	
TW2	Hospital, people treat each other with respect	0.630	
TW3	When members of our unit get really busy, other members of the same unit help out	0.713	
TW4	Hospital units work well together to provide the best care for patients	0.739	
TW5	Team leaders encourage the persons who work for them to work as a team	0.710	
Quality performance			0.875
QP1	The cost of medical services have been reduced over the past years	0.750	
QP2	The severity errors of medical services have been reduced over the past years	0.698	
QP3	The patient waiting time (meet with medical personnel) has been reduced over the past years	0.716	
QP4	In our hospital, waste in processes have been reduced over the past years	0.781	
QP5	Number of patient complaints has been decreased over the past years	0.782	

Notes: KMO = 0.949; Cumulative Variance = 72.07%

Table II.
Reliability and factor loadings of the research variables

In addition, this study used 438 usable responses to perform the EFA of the research variables. Based on the EFA test, it was observed that Kaiser-Meyer-Olkin (KMO) value was 0.949, indicating that research data were suitable for principal component analysis (PCA; see Table II). According to Hair *et al.* (2010), factor analysis can be performed when the results of KMO and Bartlett's test of sphericity are significant. The results of KMO and Bartlett's test of sphericity of the present study also indicated the appropriateness of factor analysis.

After confirming the appropriateness of the research constructs, PCA and the varimax rotation method were used to extract the factors for all the 29 items. According to Hair *et al.* (2010) and Sharma (1996), factor loading of each item must be more than 0.5 and above 0.6 are considered highly significant for the research construct. Based on the results of the EFA, 29 items were divided into six constructs (i.e. continuous quality improvement, Lean management initiatives, Six Sigma initiatives, patient safety, teamwork and quality performance) with 72.07 per cent of the total variance explained. EFA results also indicated that the minimum of the factor loading of this present study was 0.546, which meets the requirement acceptable for further analysis.

Comparison analysis on Lean Six Sigma and quality performance

This study analysed six dimensions of the research variables, namely, continuous quality improvement, Lean management initiatives, Six Sigma initiatives, patient safety, teamwork and quality performance based on independent samples *t*-test and one-way ANOVA (see Tables III to V).

Independent samples t-tests

Independent samples *t*-tests were performed to identify the differences or conformance among hospital staff perceptions on continuous quality improvement, Lean management initiatives, Six Sigma initiatives, patient safety, teamwork and quality performance based on gender and type of hospital (Tables III and IV). The results of the independent samples *t*-tests indicate that there is no significant difference between male and female respondents on these six variables (Table III). However, Table IV illustrates that there are four significant differences between public and private hospital respondents. Private hospital staff have better perception on Lean management initiatives (μ = 3.9303, df = 436, p = 0.035), Six Sigma initiatives (μ = 3.9920, df = 436, p = 0.005), patient safety (μ = 4.2390, df = 436, p = 0.000) and teamwork (μ = 4.1243, df = 436, p = 0.012) compared to public hospital staff. The reason is that private hospitals are more serious on patient satisfaction

Variables	Gender	*N*	Mean	*t*-value	*p*-value
Continuous quality improvement	Male	83	3.9373	0.424	0.672
	Female	355	3.9076		
Lean management initiatives	Male	83	3.9036	0.411	0.681
	Female	355	3.8746		
Six Sigma initiatives	Male	83	4.0337	1.950	0.052
	Female	355	3.9025		
Patient safety	Male	83	4.2048	1.184	0.237
	Female	355	4.1307		
Teamwork	Male	83	4.0843	0.354	0.724
	Female	355	4.0592		
Quality performance	Male	83	3.6940	0.993	0.321
	Female	355	3.6090		

Table III.
Independent samples *t*-test on gender

Table IV.
Independent samples *t*-test on type of hospital

Variables	Type of hospital	*N*	Mean	*t*-value	*p*-value
Continuous quality improvement	Public	187	3.8567	−1.780	0.076
	Private	251	3.9554		
Lean management initiatives	Public	187	3.8128	−2.116	0.035
	Private	251	3.9303		
Six Sigma initiatives	Public	187	3.8406	−2.854	0.005
	Private	251	3.9920		
Patient safety	Public	187	4.0182	−4.551	0.000
	Private	251	4.2390		
Teamwork	Public	187	3.9829	−2.526	0.012
	Private	251	4.1243		
Quality performance	Public	187	3.6299	0.124	0.901
	Private	251	3.6215		

Table V.
One-way ANOVA tests on working experience

Variables	Groups	*N*	Mean	F-value	*p*-value
Continuous quality improvement	1-2 years	71	3.8648	2.207	0.087
	3-5 years	128	3.8984		
	6-10 years	81	3.8123		
	Above 10 years	158	3.9987		
Lean management initiatives	1-2 years	438	3.8697	0.233	0.873
	3-5 years	71	3.8770		
	6-10 years	128	3.8426		
	Above 10 years	81	3.9066		
Six Sigma initiatives	1-2 years	158	3.8817	1.239	0.295
	3-5 years	438	3.9141		
	6-10 years	71	3.8642		
	Above 10 years	128	3.9911		
Patient safety	1-2 years	81	4.0676	5.098	0.002
	3-5 years	158	4.0906		
	6-10 years	438	4.0543		
	Above 10 years	71	4.2696		
Teamwork	1-2 years	128	4.0113	3.633	0.013
	3-5 years	81	3.9937		
	6-10 years	158	3.9852		
	Above 10 years	438	4.1848		
Quality performance	1-2 years	71	3.5972	0.141	0.935
	3-5 years	128	3.6250		
	6-10 years	81	3.6000		
	Above 10 years	158	3.6506		

and loyalty compare to public hospitals. Thus, they are regularly conducting training on Lean Six Sigma programme to improve employee skills towards quality performance of the hospital. On the other hand, public hospitals are overworked and their staffs are facing strain to give prompt service to the patient (Ren, 2007).

Analysis of variance tests

According to Hair *et al.* (2010), ANOVA is a statistical technique for testing the hypothesis that there is no significant difference between two or more population means. This study used one-way ANOVA to investigate the significant difference or conformance among

working experience groups of the hospital staff. According to the results of ANOVA tests, it was observed that there are significant differences among the different working experience groups on patient safety (df = 5, F = 5.098, p = 0.002) and teamwork (df = 5, F = 3.633, p = 0.013). The results also indicated that those hospital staff working more than 10 years have better perception on patient safety (μ = 4.2696) compared to other working experience groups (i.e. 1-2 years, 3-5 years and 6-10 years). They also have better perception on teamwork of the hospital (μ = 4.1848) compared to other working experience groups (Table V).

Conclusions

The findings of the present study show that there are significant differences between public and private hospital staff on Lean management initiatives, Six Sigma initiatives, patient safety and teamwork. Private hospital staff perceives Lean management initiatives, Six Sigma initiatives, patient safety and teamwork more favourably compared to public hospital staff. In Malaysia, public health sector plays a more important role in providing healthcare services than the private health sector. However, it was observed that the private healthcare sector has been rapidly growing over the past two decades, and it is playing an important role in the healthcare industry to provide better medical services to the patients such as development of specialist hospitals for serious illnesses and continuous improvement in healthcare information technology (Teo, 2013; MOH, 2012). According to Ren (2007), Malaysian public hospitals are overworked and face difficulty ensuring appropriate appointments between patients and doctors. Even though the public healthcare sector has more doctors (55 per cent) than its private counterpart, the many experienced specialist doctors are opting for the more lucrative private sector, creating shortages in the public healthcare sector (MOH, 2012). To overcome these problems, the public hospital must identify their employee needs and measuring employee satisfaction through engagement surveys. They also need to offer training programmes, continuing education, leadership support, employee suggestion and feedback to improve employee performance towards patient satisfaction.

The present study findings also indicate that senior hospital staff (more than 10 years working experience) perceive patient safety and teamwork more favourably compared to other working experience groups (less than 10 years working experience). The reason is that senior employees have more competence on patient safety and teamwork because of their better experience compared to young staff. They also know how to ensure the maximum patient safety in the hospital and make effective collaboration and cooperation with team members. The healthcare organisations need to focus on young employees to improve their skills and perception on patient safety and teamwork. They also need to select the best employees to work with a team and find the employees who are dedicated and motivated to improve the hospital quality service (Flynn *et al.*, 1994).

From a strategic point of view, this study reveals that the Lean Six Sigma methodology not only binds all operational activities together, it also links between the strategic level and the operational level in healthcare organisations. It is imperative that the management of the healthcare organisation should spend time to understand the Lean Six Sigma applications and incorporate this methodology into management practices for the continuous improvement of quality performance. When this is done properly, the Lean Six Sigma approach can maximise value to the healthcare organisation by improving quality and organisational performance.

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